

Natural Gas and Electricity Emission Profiles

Office of Sustainability

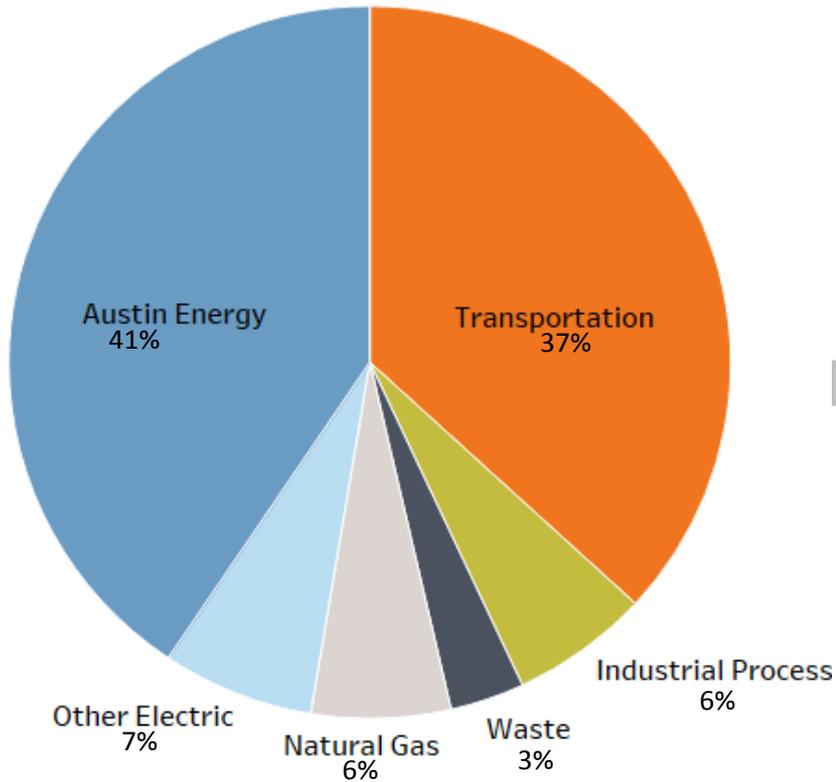
May 15, 2018

Takeaways

- Renewable energy and coal retirement commitments will dramatically lower Austin Energy user emissions from electricity use.
- New heat pump technology is very energy efficient.
- By 2023, emissions from heating air and water in buildings will be lower using electricity than natural gas for all use cases.
- Further Analysis Needed:
 - Site v. source energy to account for electricity losses as well as upstream gas leakage (less important as renewable energy grows).
 - Operational and capital costs of potential changes for new and existing buildings (important for affordability).

Austin Community GHG Inventory

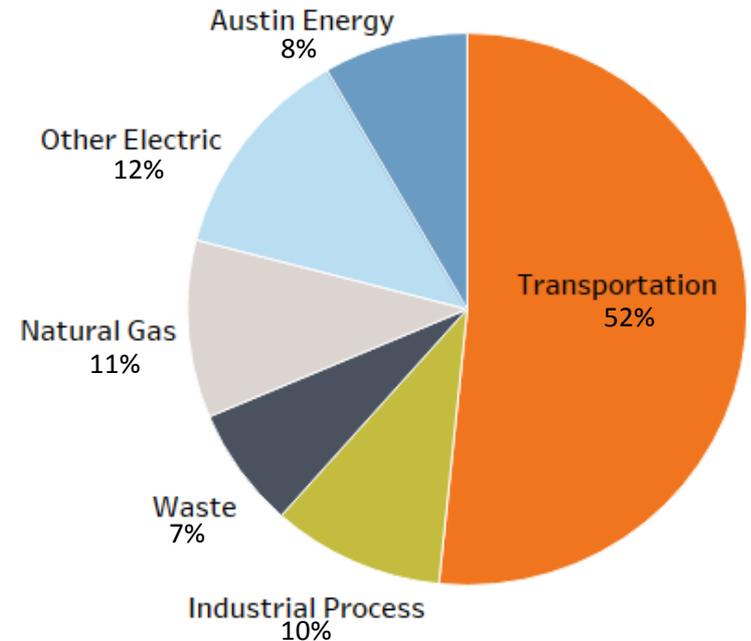
2016



13.4 MMT CO₂e

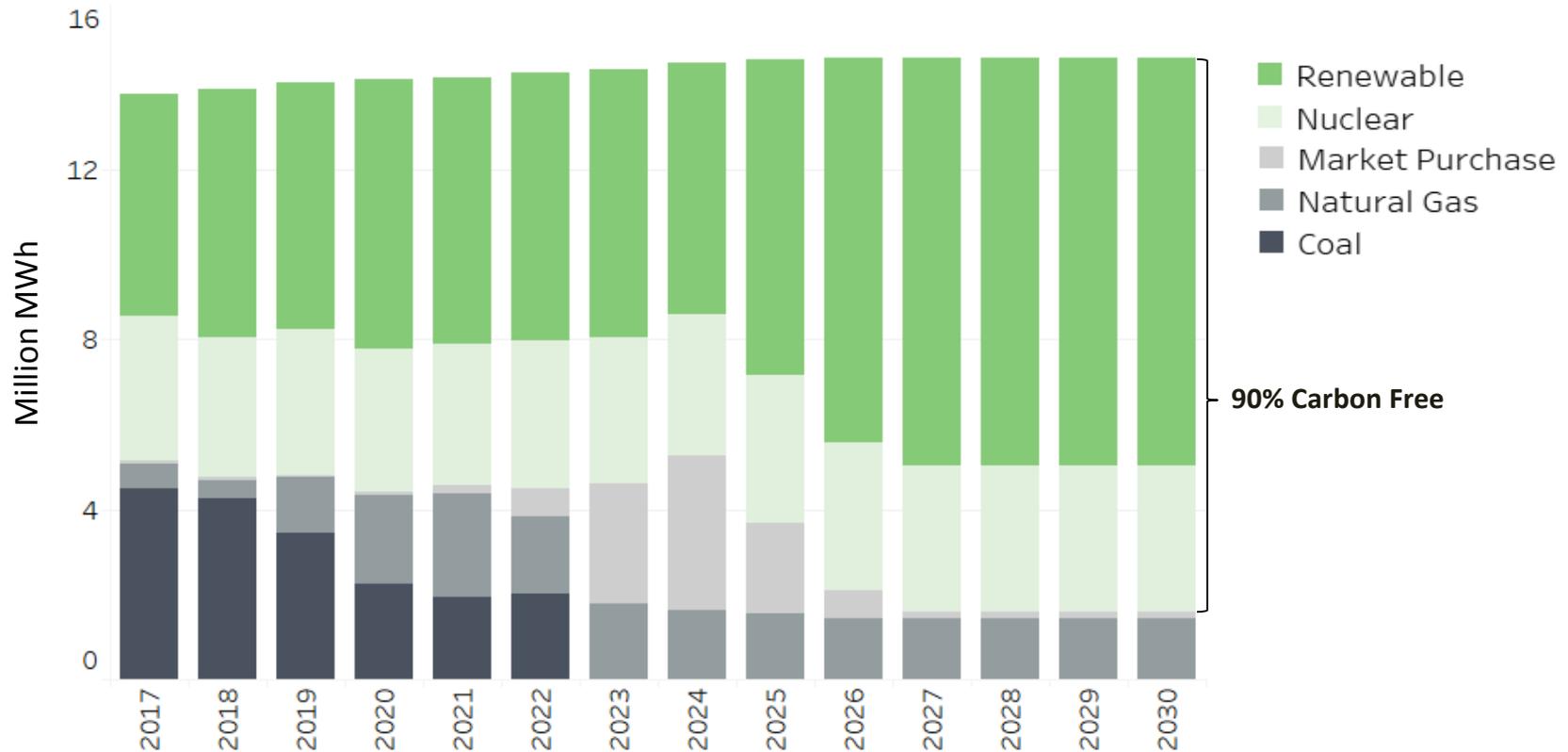


2030



8.0 MMT CO₂e

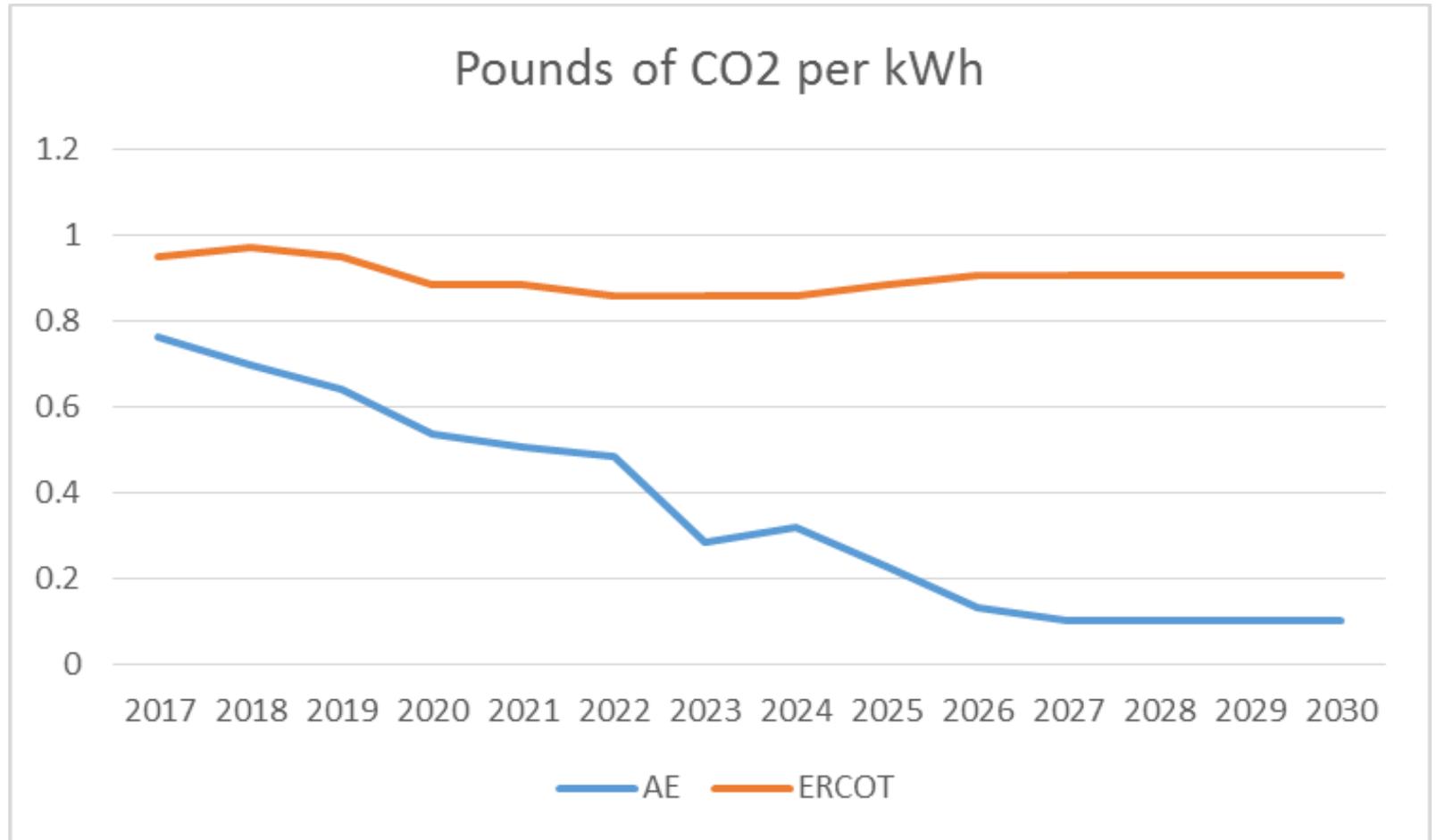
Projected AE Load and Offset by City Generation Resources



2017 Council Adopted Austin Energy Generation Plan Highlights

- Reach 65% renewable energy by 2027
- Target retirement of selected Decker units in 2020 – 2021
- Target retirement of Fayette Power Project beginning in 2022

Electricity Carbon Intensity



Questions For Analysis

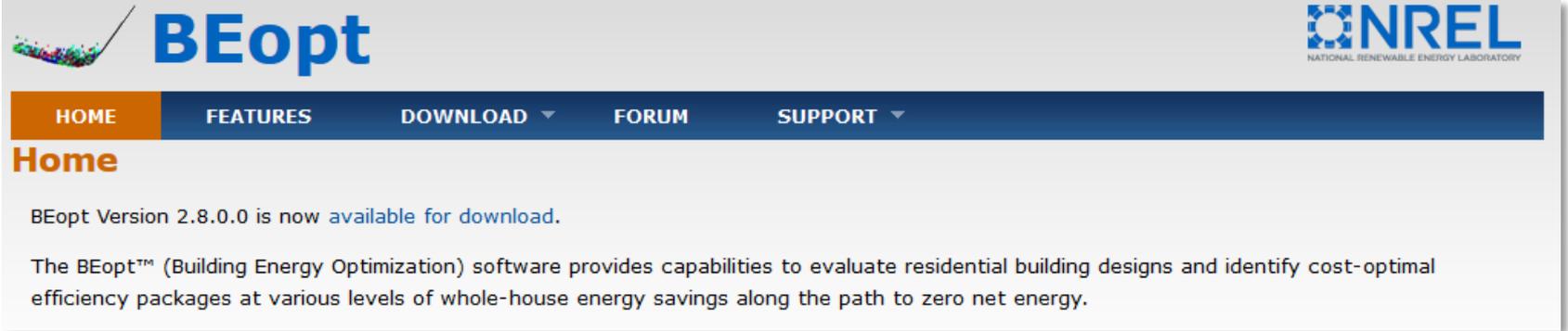
1. How do GHG emissions compare between natural gas and electric home appliances given the changing carbon intensity of Austin Energy's electricity?

2. How would GHG emissions change if code requirements to include natural gas connections were removed?

Electricity vs. Gas Appliances

Appliance	Electric Case	Natural Gas Case
Space Conditioning Low Efficiency High Efficiency	Electric Heat Pump SEER 14 / HSPF 8.2 SEER 19 / HSPF 9.5	Gas Furnace + Electric Central Air SEER 17 / 80% AFUE SEER 17 / 90% AFUE
Water Heating Low Efficiency High Efficiency	Electric Tank (92%) Heat Pump - 50 Gal	Natural Gas Tank (59%) Natural Gas Tankless (82%)
Cooking	Electric Range	Natural Gas Range
Clothes Dryer	Electric Dryer	Gas Dryer

Modeling Assumptions



The screenshot shows the top portion of the BEopt website. At the top left is the BEopt logo, which includes a colorful arc of dots above the text "BEopt". To the right is the NREL logo, consisting of a blue square with a white grid pattern followed by the text "NREL" and "NATIONAL RENEWABLE ENERGY LABORATORY" below it. Below the logos is a dark blue navigation bar with white text for "HOME", "FEATURES", "DOWNLOAD", "FORUM", and "SUPPORT". The "HOME" link is highlighted with an orange background. Below the navigation bar, the word "Home" is written in orange. The main content area has a light gray background and contains the following text:

BEopt Version 2.8.0.0 is now [available for download](#).

The BEopt™ (Building Energy Optimization) software provides capabilities to evaluate residential building designs and identify cost-optimal efficiency packages at various levels of whole-house energy savings along the path to zero net energy.



- 3 bed 2 bath 2300 SF
- 10ft lot lines
- OSB sheathing
- Cement Siding
- Fiberglass batt insulation
 - R15 Wall
 - R38 Ceiling (vented)
- Asphalt shingles
- Low-e Double pane windows
- Window Area 300 SF
- 15% Leakage R-8 ducts
- Heat Set point 70 / Cool Set point 75
- Austin climate data
- 15 year project analysis period
- Austin Energy Carbon Intensity

Calculation Methods

Emissions

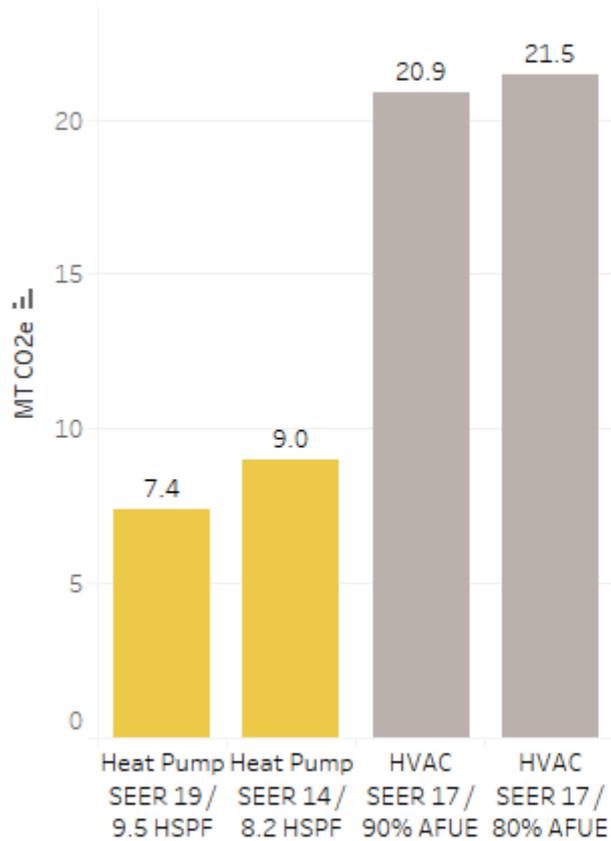
Austin Energy GHG emissions projections (CO₂ / kWh) are based on the adopted 2027 Generation Plan and extrapolated to 2033.

Calculation Method

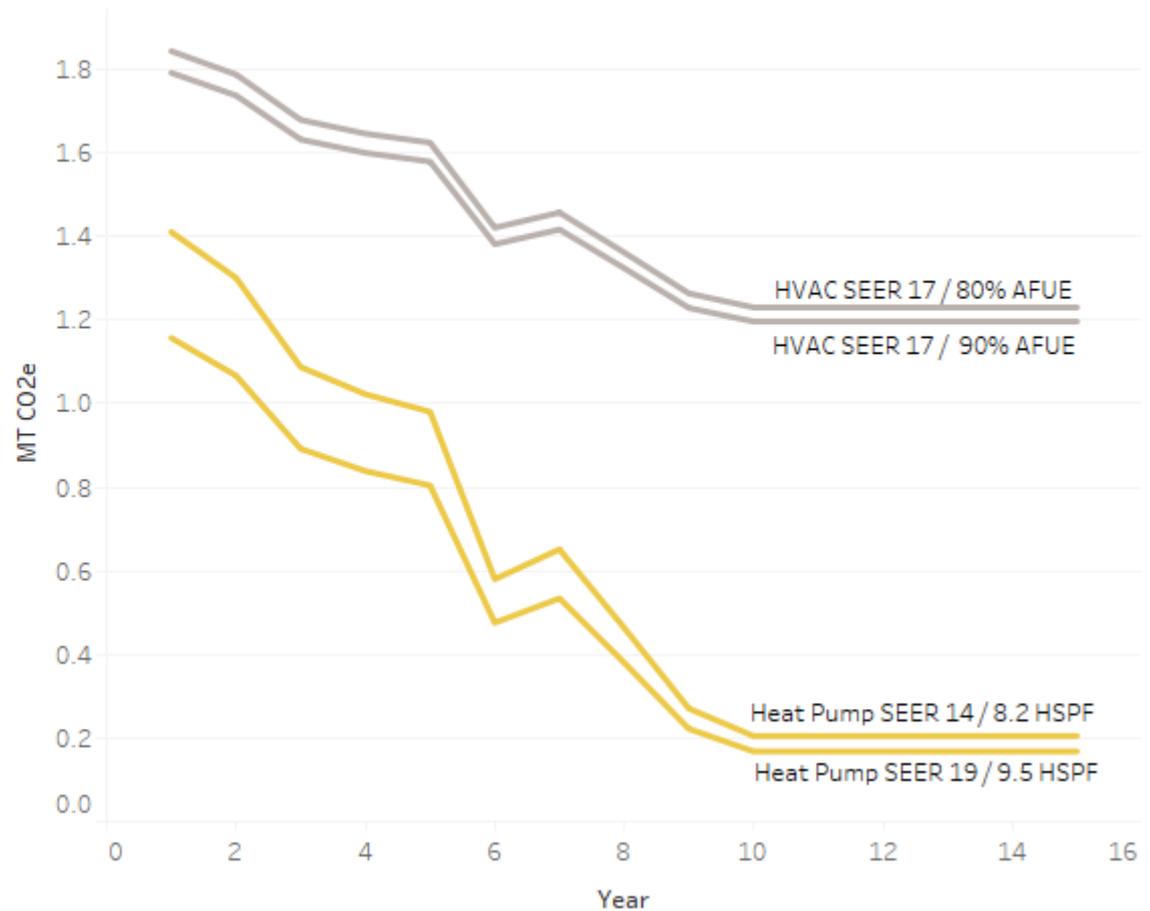
1. BEOpt modeling was run multiple times with fixed input parameters for each appliance / system under evaluation.
2. BEOpt outputs for the site energy used by each system.
3. Site energy outputs are multiplied by annual grid carbon intensity to project GHG emissions.
4. Comparisons include all system energy needed for functional performance. The natural gas case includes electricity consumption when it is required.

Space Conditioning Summary

Cumulative Emissions

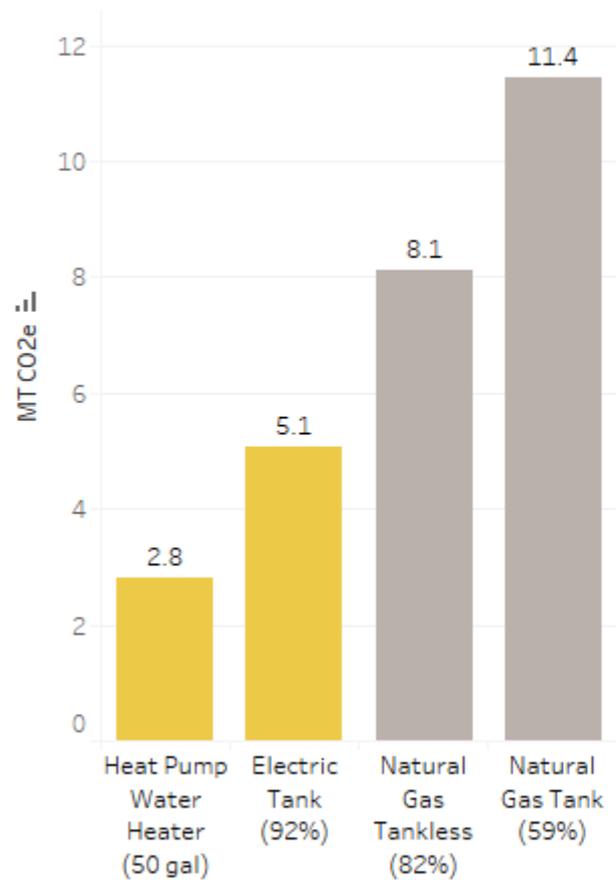


Annual Emissions

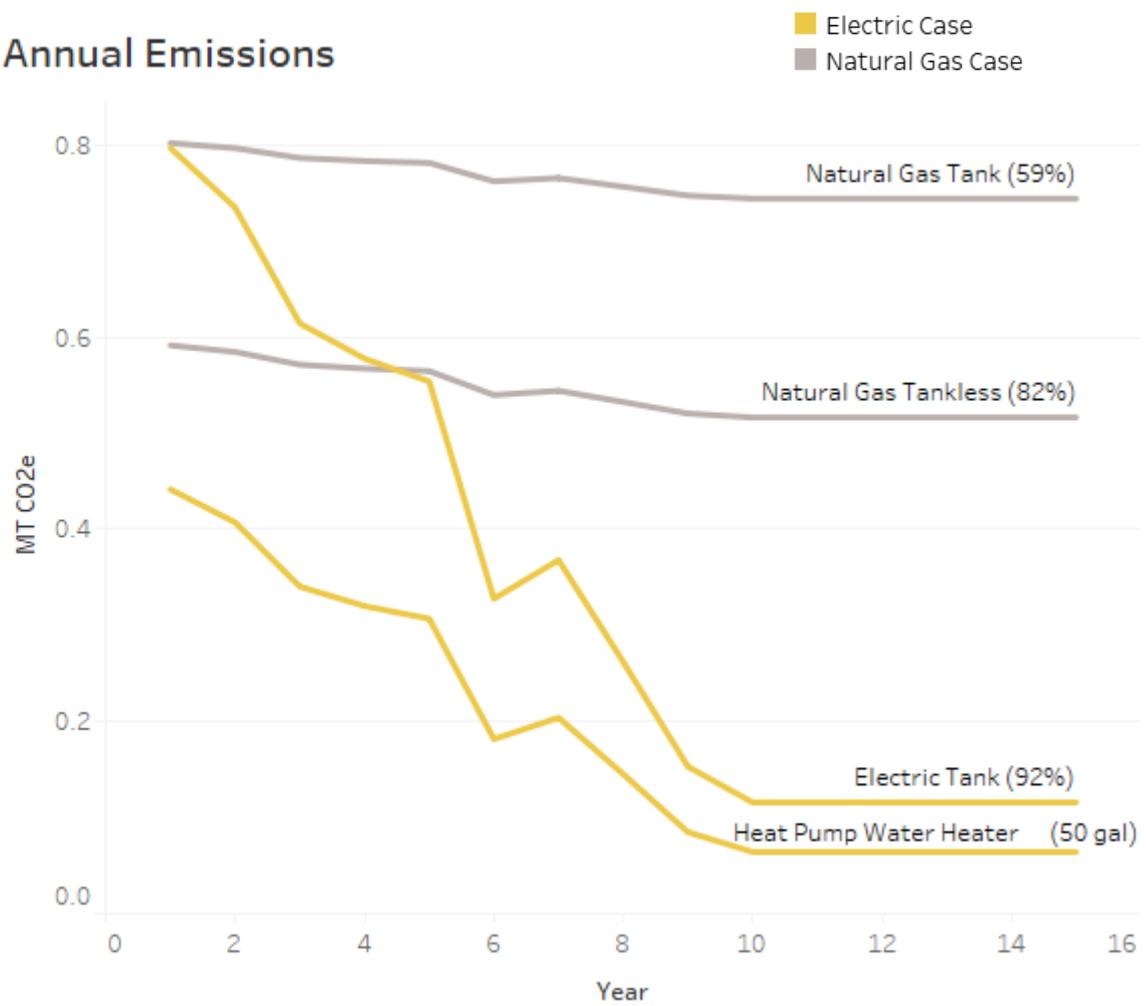


Water Heating Summary

Cumulative Emissions

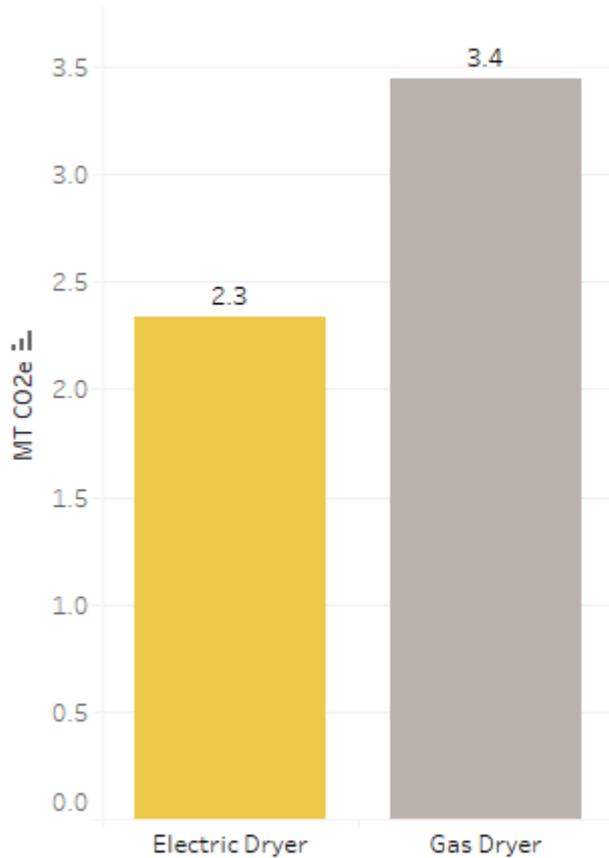


Annual Emissions

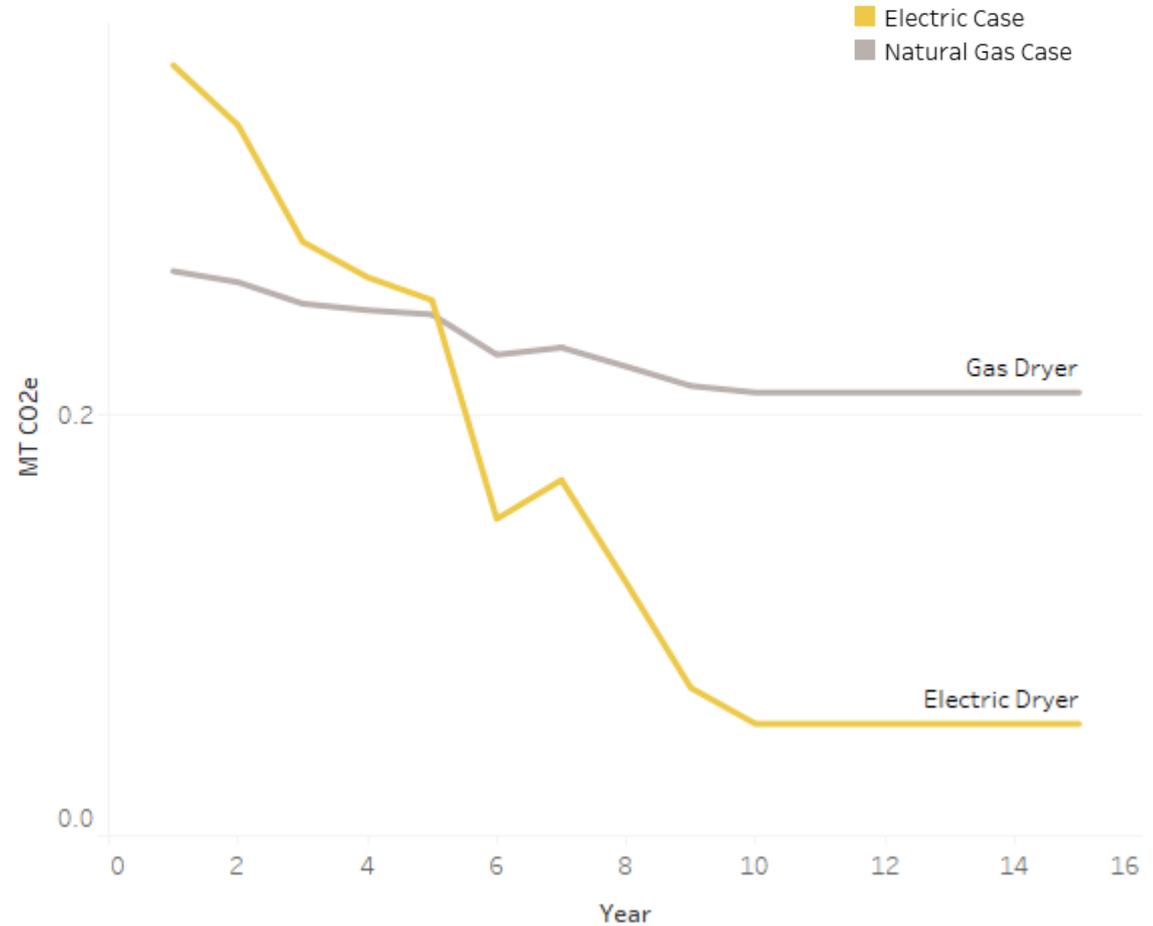


Clothes Dryer Summary

Cumulative Emissions

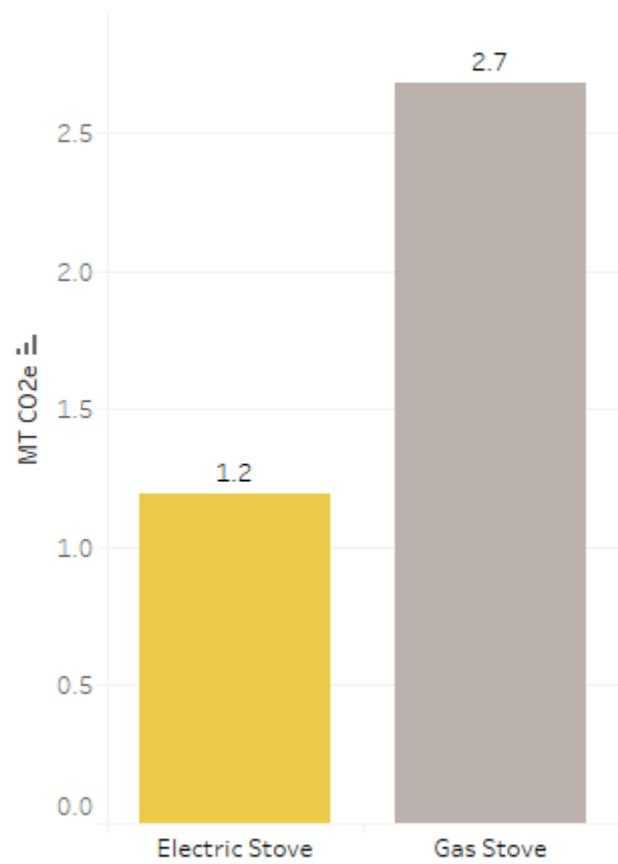


Annual Emissions

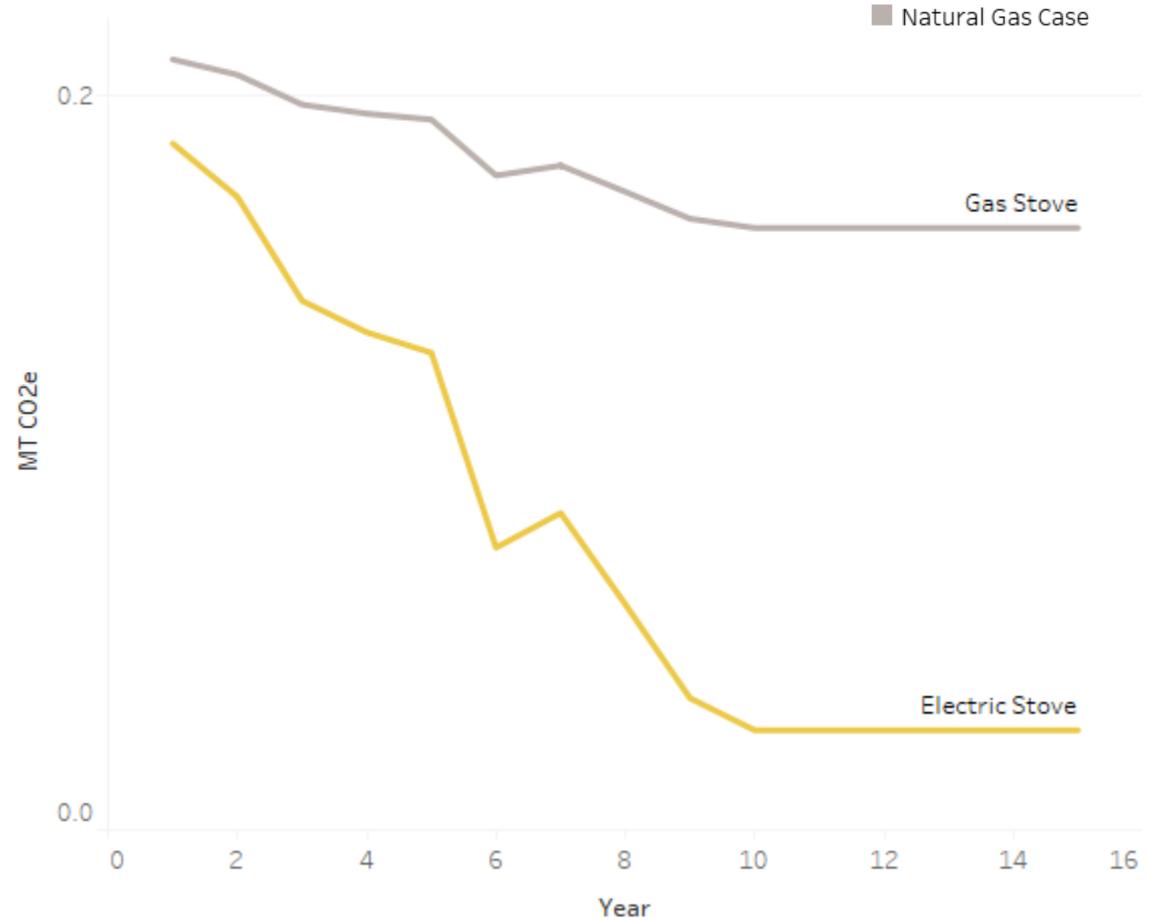


Stove Summary

Cumulative Emissions



Annual Emissions



Question 2 Analysis

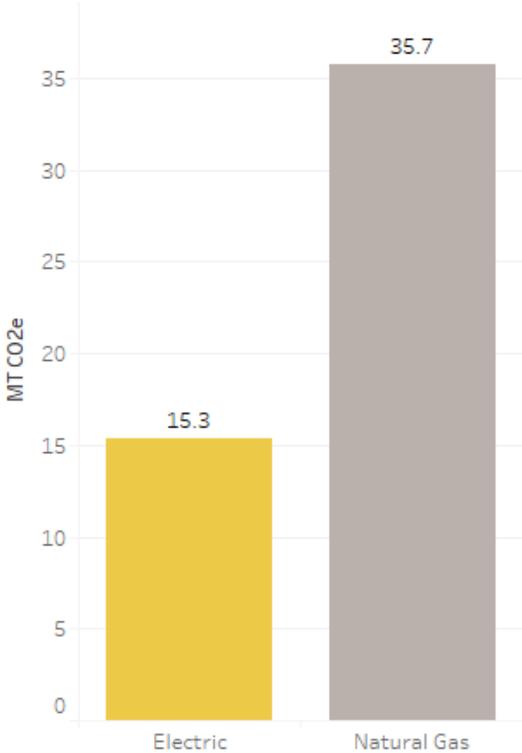
How would GHG emissions change if code requirements to include natural gas connections were removed?

- Many new single family homes will be built over the next 15 years.
- How do emissions compare between an all-electric home and a natural gas-dominant home?
- What are the emissions savings (annually and cumulative) if all new single family homes are built as all-electric?

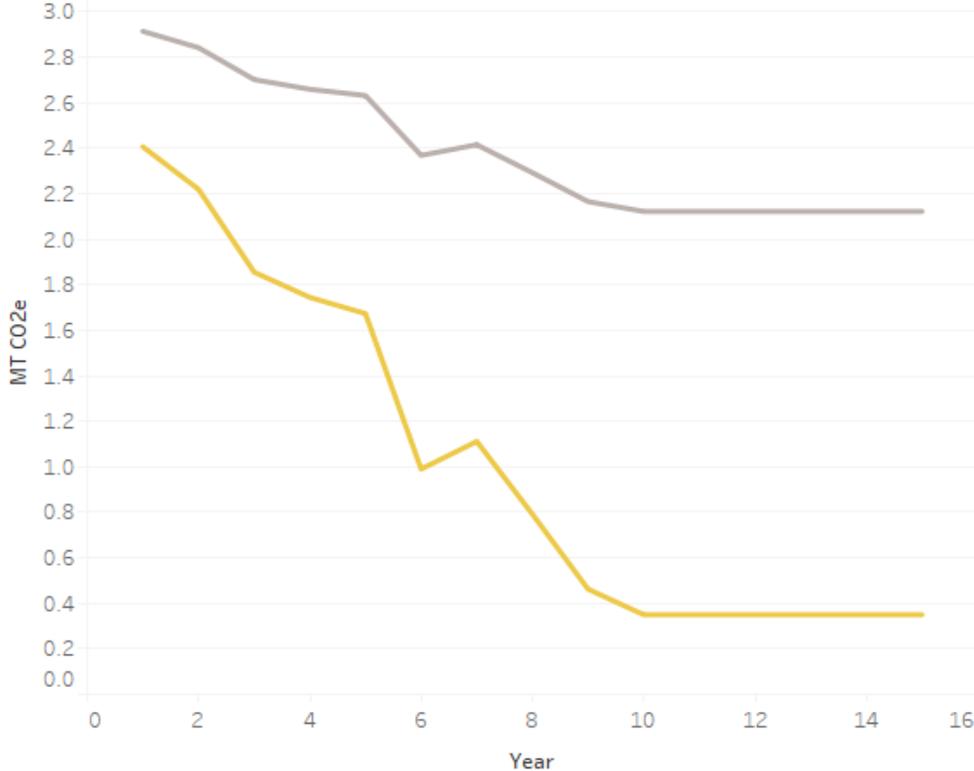
Whole House Comparison

Appliance	Electric Case	Natural Gas Case
Space Conditioning	Heat Pump SEER 14 / HSPF 8.2	HVAC SEER 17 / 80% AFUE
Water Heating	Heat Pump - 50 Gal	Natural Gas Tankless (82%)
Cooking	Electric Range	Natural Gas Range
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Cumulative Emissions

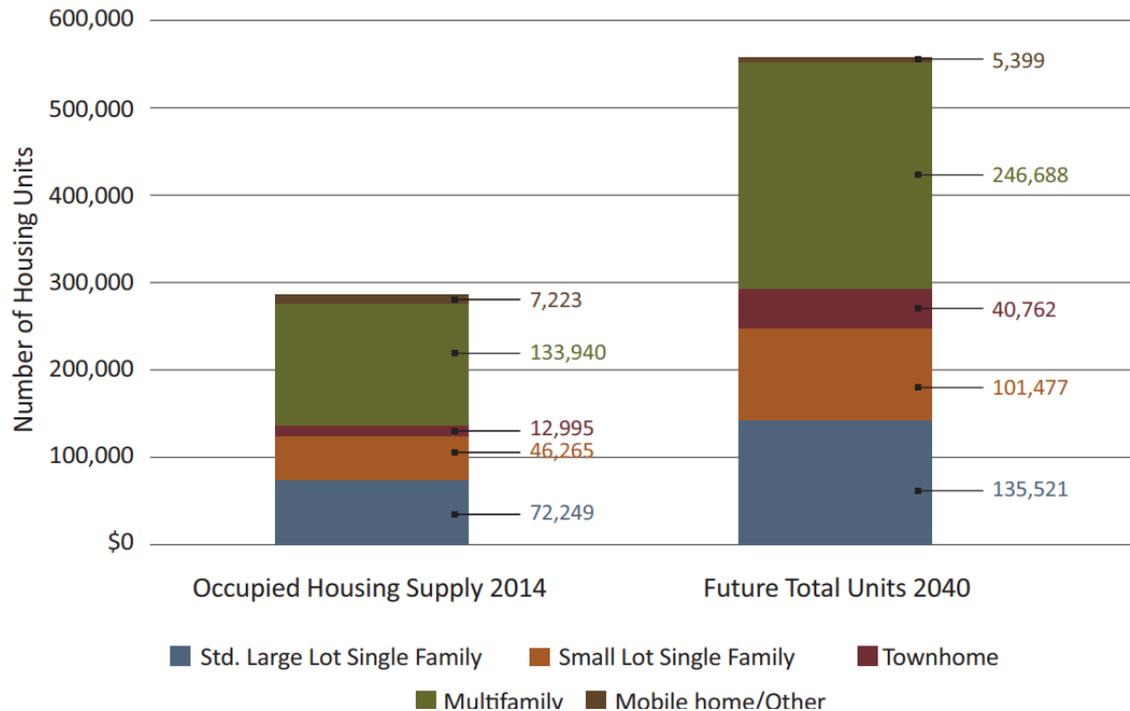


Annual Emissions



Code and Housing Assumptions

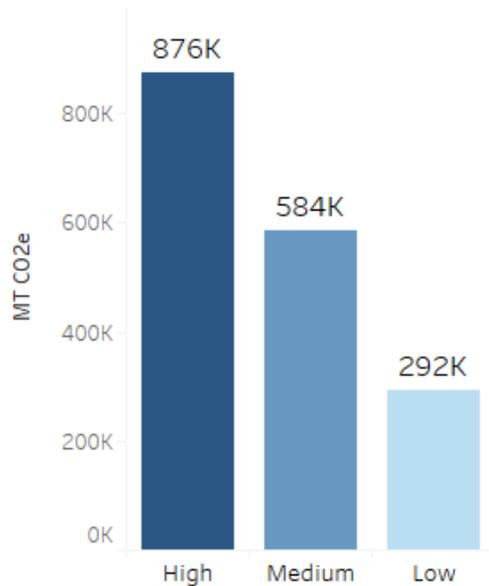
CITY OF AUSTIN'S CURRENT VERSUS FUTURE HOUSING MIX



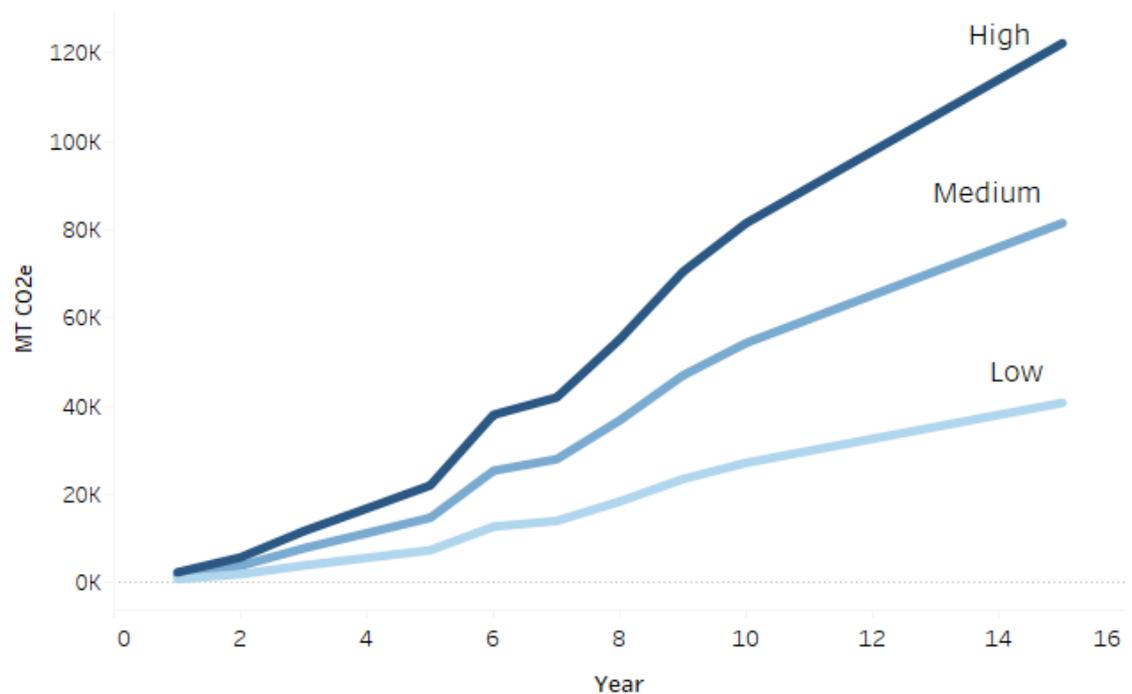
- The Austin Housing Blueprint projects 119k Single Family units will be built over 26 years (4,557 units / year)
- We estimated 68,355 new single family units over the next 15 years as our High scenario and added Medium and Low scenarios to explore a range of outcomes

Whole House Emissions Reduction

Cumulative Avoided Emissions



Annual Avoided Emissions



These charts show emissions that are avoided in the all electric case vs the natural gas case.

Single Family Homes Built by Scenario

Scenario	Annual	Cumulative Total (15 yrs)
High	4,557	68,355
Medium	3,038	45,570
Low	1,519	22,785

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- New heat pump technology is very energy efficient.
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Extras

2016 Energy Code

- R403.5.5 Water Heating With Adjacent Gas Service.
- **Residential buildings having existing or planned natural gas service or equivalent district gas service located within the adjacent right-of-way, shall not use electric resistance as the primary means for heating water.**
Residential buildings not having natural gas service or equivalent district gas service located within the adjacent right-of-way, may install electric resistance water heaters controlled by a preprogrammed water heater timer in lieu of gas fired water heating. The timer shall be preprogrammed to turn the water heater off between the hours of 3:00PM and 7:00PM from June 1 to September 30 and from 12:00AM to 4:00AM throughout the year. The timer shall have a readily accessible override, as defined by the building official, capable of restoring power to the water heater for one hour when activated. The timer shall be permanently programmed by the manufacturer or locked to prevent alteration of the programming by the building occupants. Buildings that are accessory to a residential building are considered residential buildings for the purposes of this section.

2016 Energy Code

- Ordinance 20160623-099
- **AN ORDINANCE REPEALING AND REPLACING ARTICLE 12 OF CITY CODE CHAPTER 25-12 TO ADOPT THE 2015 INTERNATIONAL ENERGY CONSERVATION CODE AND LOCAL AMENDMENTS.**
- Residential Code applies to single family homes as well as apartment buildings, 4 stories or less.

2016 Energy Code – Water Heating Exceptions

R403.5.5 Water Heating With Adjacent Gas Service.

1. Electric resistance water heater that is secondary to a primary system where the primary system is documented to provide at least 75% of the hot water from June 1 to September 30 and at least 50% of the hot water from October 1 to May 31. The secondary electric resistance water heater in such a system shall be controlled by a pre-programmed timer.
2. Heat pump water heaters where electric resistance is the secondary means of heating.
3. Existing residential buildings where the furnace and water heater are housed in a common interior mechanical room. Electric resistance water heaters installed in these buildings shall be controlled by a pre-programmed timer.
4. Electric resistance water heaters with a rated requirement of 3500 watts or less. Electric water heaters will be controlled by a pre-programmed timer.

2016 Energy Code

- R403.9 Space Heating.

The use of electric resistance as a primary source of space heating is prohibited in all dwelling units having a conditioned floor area in excess of 500 square feet.

Exception: Buildings where dwelling units are cooled using chilled water.

This local amendment doesn't prohibit the electric backup system on heat pumps and if your space is small enough you can go with electric resistance but the implication is that heating should be supplied by gas or by heat pumps.

Economics

FUEL	ENERGY CONTENT	UNIT PRICE	HEAT CONVERSION EFFICIENCY	COST PER MILLION BTU
Kerosene	134,000 BTU/gal	\$2.75/gal	78 %	\$26.31
#2 Fuel Oil	138,000 BTU/gal	\$2.50/gal	78	\$23.23
Propane	92,000 BTU/gal	\$2.15/gal	78	\$29.96
Natural Gas	100,000 BTU/therm	\$1.15/therm*	78	\$14.74
Electricity - Resistance	3,412 BTU/kWh	\$0.11/kWh**	100	\$32.24
Electricity - Heat Pump	3,412 BTU/kWh	\$0.11/kWh**	200	\$16.12
Coal	13,200 BTU/lb	\$300.00/ton	75	\$15.15
Firewood-Hardwood	25,000,000 BTU/cord	\$250.00/cord	50	\$20.00
Wood Pellets	8,200 BTU/lb	\$225.00/ton	80	\$17.15
Shelled Corn	6,800 BTU/lb	\$4.00/bushel	80	\$13.13