

Natural Gas and Electricity Costs
Office of Sustainability
September 26, 2018

Overview

- Current City of Austin Energy Code **requires** the usage of natural gas for residential water heating where available.
- Council Adopted a target of net zero GHG emissions by 2050
 - This means near ZERO usage of gasoline, diesel, natural gas, and coal
- **Technology lock-in** is a form of economic path dependence whereby the market selects a technological standard and because of network effects the market gets locked-in or stuck with that standard even though market participants may be better off with an alternative.
- In the past, using electricity for heating air and water emitted more carbon and was more expensive than using natural gas. Due to Austin Energy's shift to renewable energy and efficiency advances in heat pumps, this is all changing.

Impetus of Project

- Resource Management Commission and Joint Sustainability Committee Member requested analysis on this topic.
- Project Goal: Gain insight into emissions and cost implications of gas versus electricity in single family residential homes.

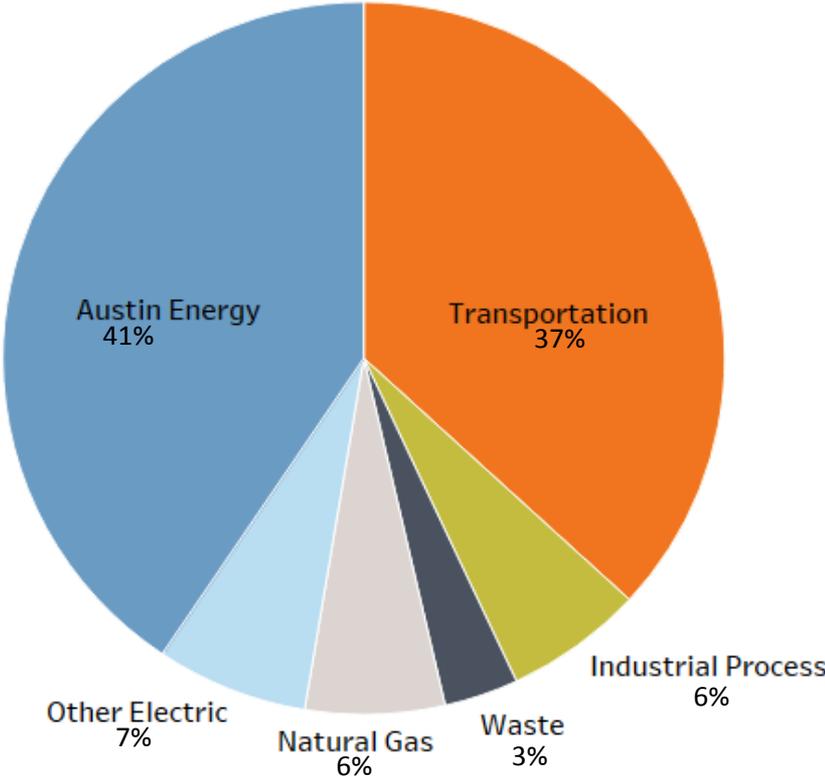
This is an Emerging Area of Study

- Rocky Mountain Institute – The Economics of Electrifying Buildings Now – June 2018
 - With an increasingly low-carbon electric grid comes the opportunity to meet nearly all our buildings’ energy needs with electricity, eliminating direct fossil fuel use in buildings and making the gas distribution system—along with its costs and safety challenges obsolete.
 - Stop supporting the expansion of the natural gas distribution system, including for new homes.
- American Gas Association – Implications of Policy Driven Residential Electrification – July 2018
 - The GHG emissions are very small – 4% of the total
 - The switch from gas will be expensive for customers

Emissions

Austin Community GHG Inventory

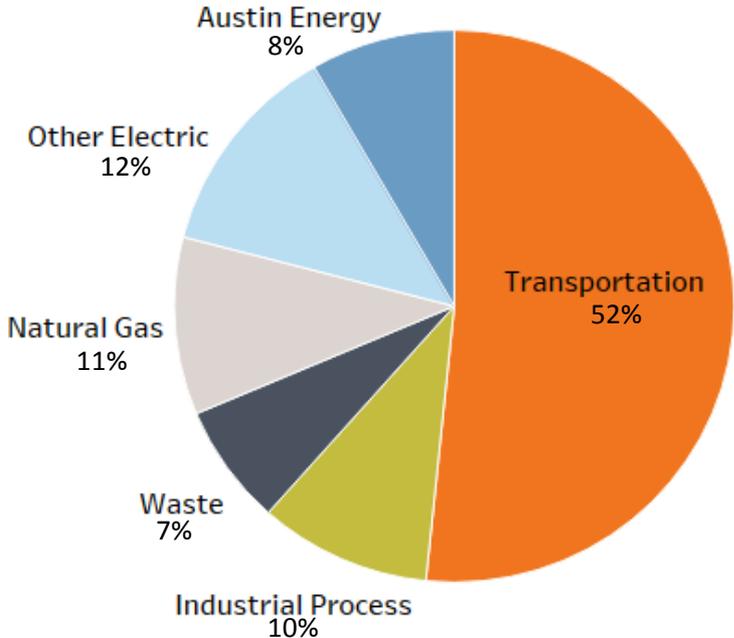
2016



13.5 Million Metric Tons CO₂e



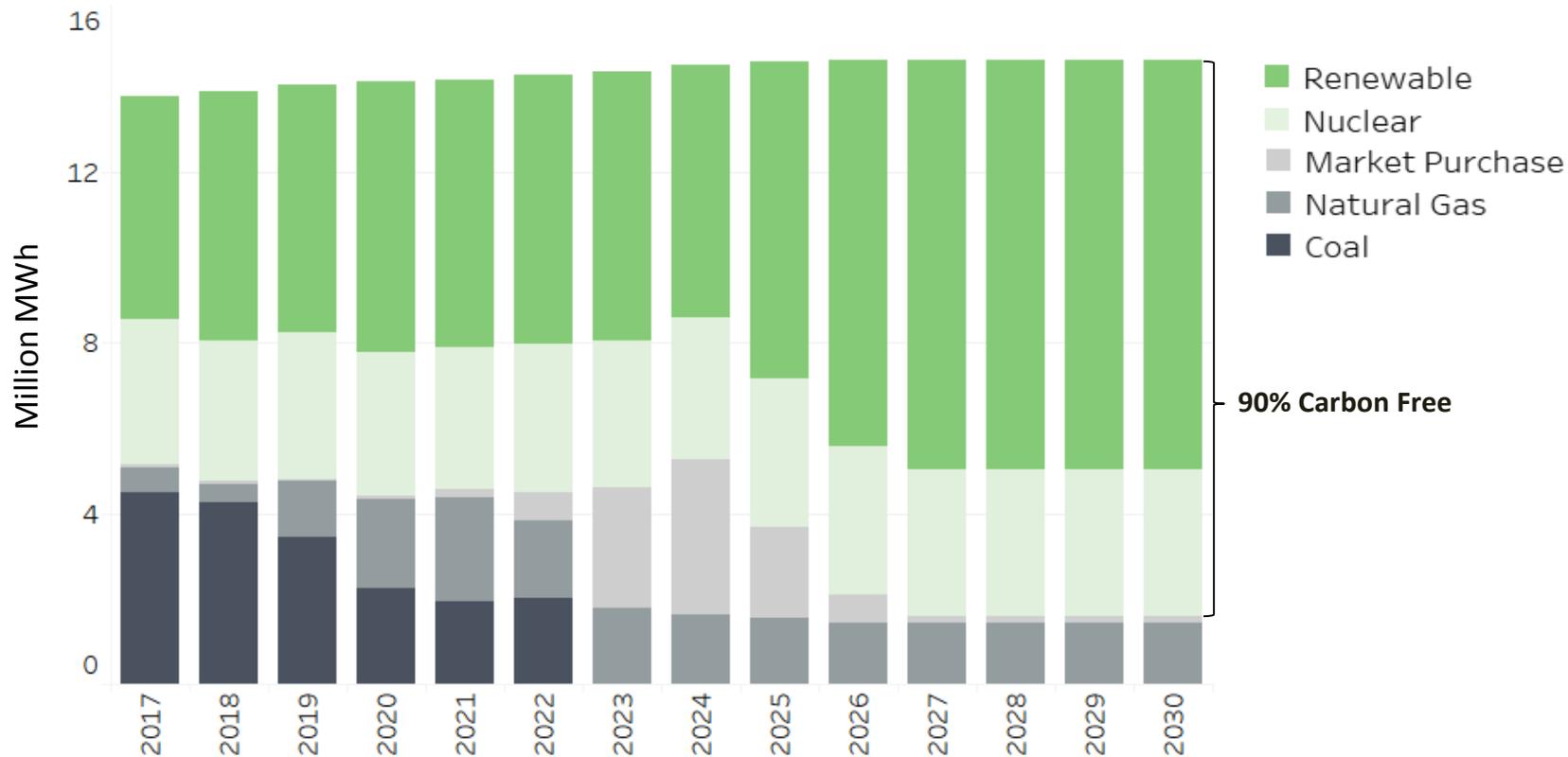
2030



8.0 Million Metric Tons CO₂e

Source: Austin GPC GHG Inventory, COA OOS

Projected AE Load and Offset by City Generation Resources



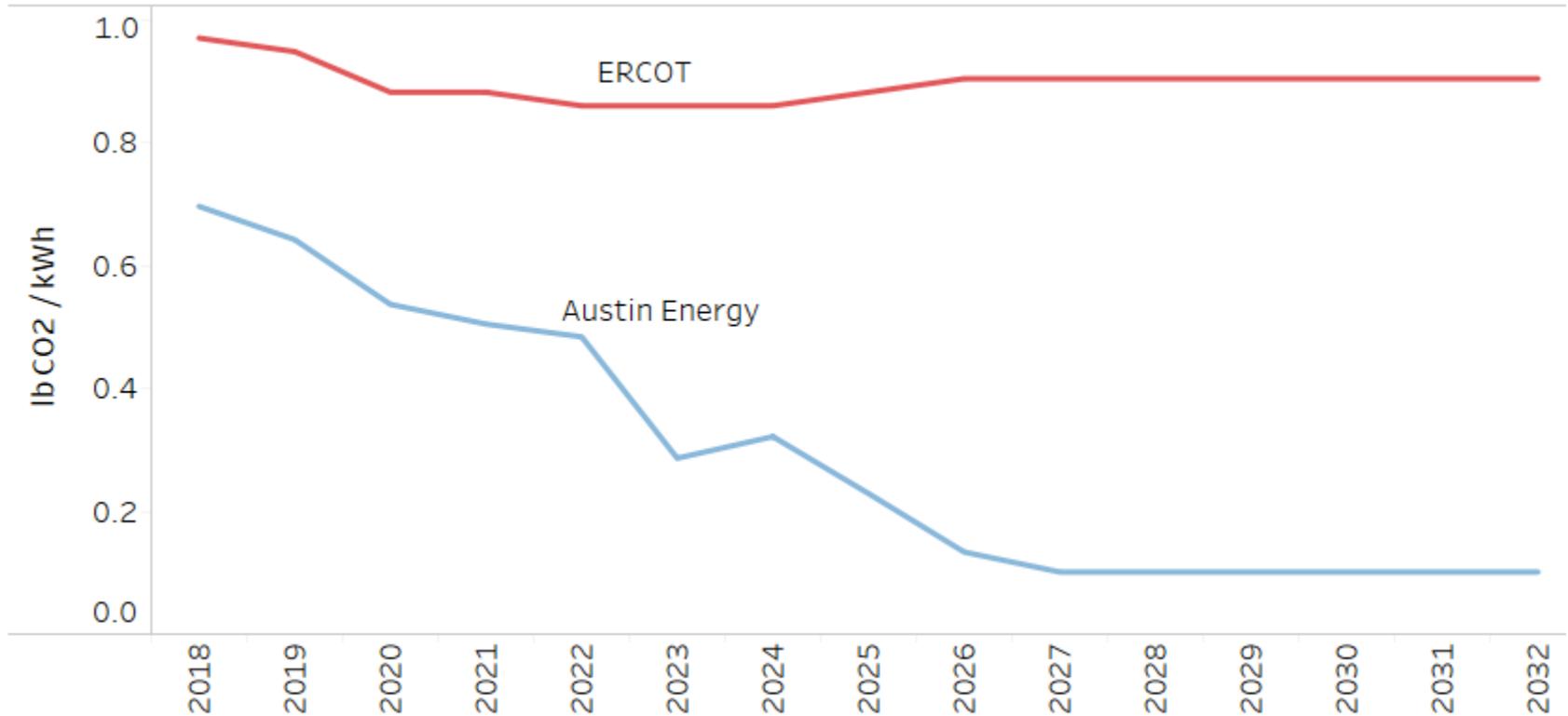
2017 Council Adopted Austin Energy Generation Plan Highlights

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

Emission Factor Calculation

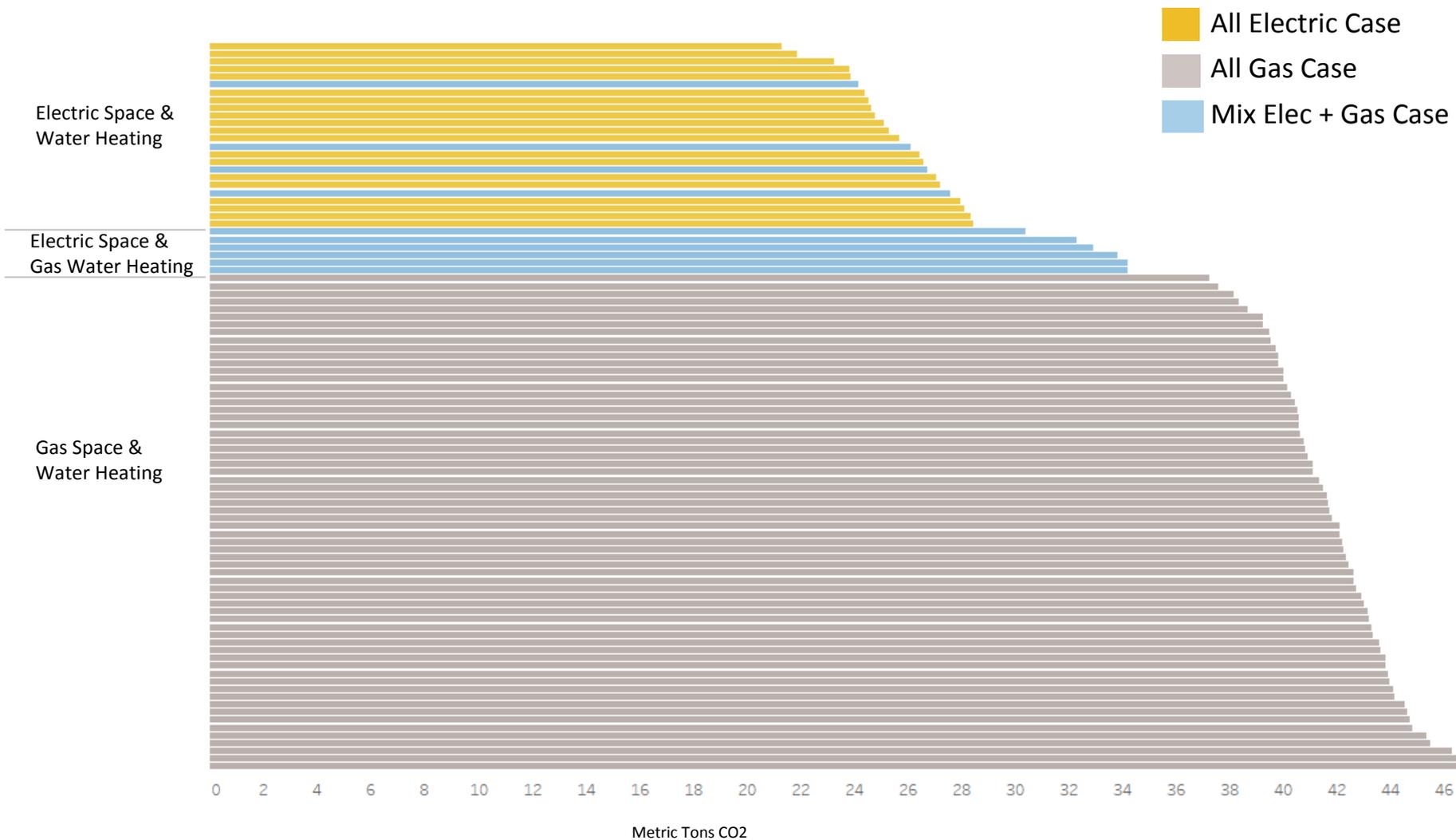
- At any given time electric load is served by the diverse mix of resources online throughout the ERCOT grid that includes gas, coal, nuclear and renewable resources;
- Austin Energy serves customer load and manages its own generation resources that provide energy to the ERCOT grid on behalf of its customers;
- Austin Energy has invested in a generation resource mix that is less carbon intense than the ERCOT grid as a whole, and considers the environmental attributes of its own resources to be for the benefit of its own customers
- Austin Energy therefore calculates the carbon footprint of customer energy use based on their own fleet-averaged carbon emissions

Electricity Carbon Intensity



2018 – 2032 GHG Emissions

AE Carbon Intensity



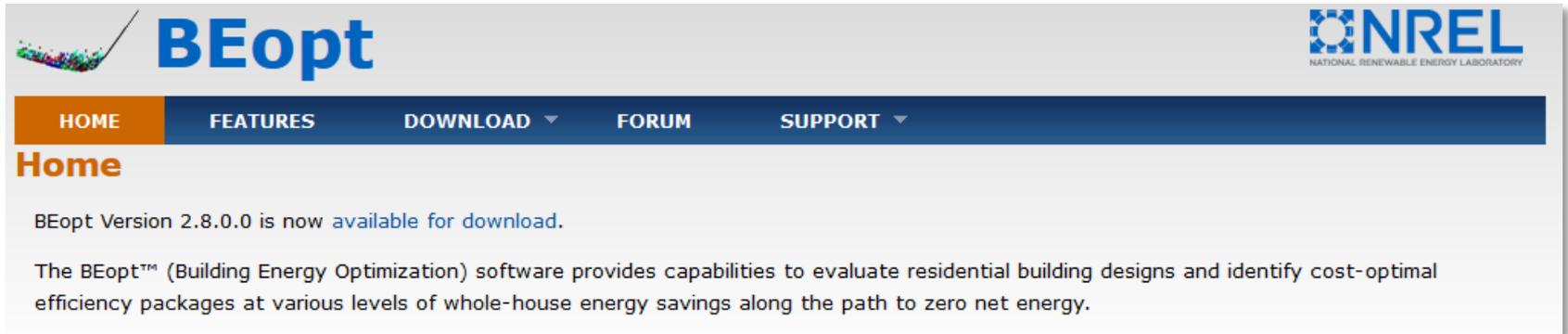
Emissions Analysis Takeaways

- Achieving the Austin Energy 2027 Generation Plan will dramatically lower Austin Energy GHG emissions and therefore customer electricity emission factors.
- New heat pump technology is very energy efficient.
- Over a 15 year lifetime, a code compliant all-electric new single family home using Austin Energy electricity will create less GHG emissions than the comparable home with natural gas space and water heating equipment.

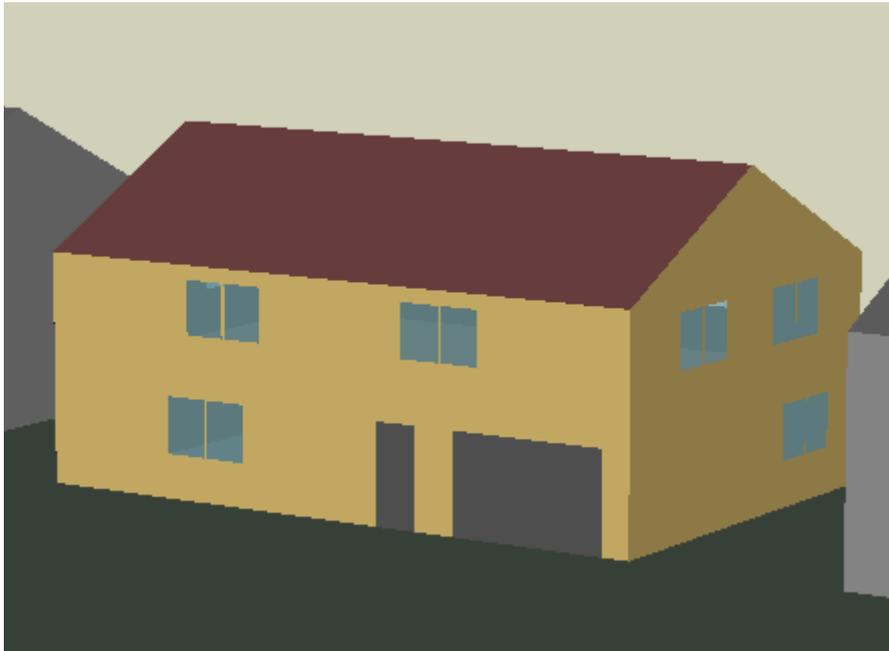
How do capital and operating costs compare for new construction single family residential homes with gas + electric versus electric only?

Cost Analysis

Modeling Assumptions



The screenshot shows the NREL BEopt website. At the top left is the BEopt logo, and at the top right is the NREL logo (National Renewable Energy Laboratory). Below the logos is a navigation bar with links for HOME, FEATURES, DOWNLOAD, FORUM, and SUPPORT. The main content area has a heading "Home" and a paragraph stating: "BEopt Version 2.8.0.0 is now available for download." Below this is another paragraph: "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."



Model parameters based on the latest COA Energy Code

- 4 bed 2 bath 2475 SF
- Fiber-Cement Siding
- Insulation
 - R-19 Wall (Fiberglass Batt)
 - R30 Ceiling (Cellulose)
- Asphalt shingles
- Window U-Value = 0.35
- Window Area 324 SF
- 7.5% Leakage R-8 ducts
- Heat Set point 71 / Cool Set point 76
- Austin climate data
- 15 year project analysis period

Appliances Examined

84 unique house combinations of appliances were examined

Appliance Category	Electric Case	Natural Gas Case
Space Conditioning	SEER 14 / HSPF 8.2	SEER 14 AC 80% Furnace
	SEER 15 / HSPF 8.5	SEER 15 AC 90% Furnace
	SEER 17 / HSPF 8.7	SEER 17 AC 95% Furnace
	SEER 19 / HSPF 9.5	SEER 24.5 AC 98% Furnace
	SEER 22 / HSPF 10.0	
Water Heating	Electric Tank (92%)	Natural Gas Tank (59%)
	Electric Tankless (99%)	Natural Gas Premium Tank (67%)
	Heat Pump - 50 Gal	Natural Gas Tankless (82%)
	Heat Pump - 80 Gal	Natural Gas Tankless Condensing (96%)
Cooking	Electric Range	Natural Gas Range
Clothes Dryer	Electric Dryer	Gas Dryer

Methods and Assumptions

Energy Modeling

- NREL's BEopt models hourly building energy consumption based on hundreds of input parameters
- BEopt modeling program produced appliance specific energy outputs for the modeled home inputs.
- Comparisons include all system energy. The natural gas case includes electricity consumption when it is required.

Inputs

The screenshot displays the BEopt software interface with various input categories and a table of cooling system options.

Input Categories:

- Thermal Mass:** Carpet, Floor Mass, Exterior Wall Mass, Partition Wall Mass, Ceiling Mass.
- Windows & Doors:** Window Areas, Windows, Interior Shading, Door Area, Doors, Eaves, Overhangs.
- Airflow:** Air Leakage, Mechanical Ventilation, Natural Ventilation.
- Space Conditioning:** Central Air Conditioner, Room Air Conditioner, Furnace, Boiler, Electric Baseboard, Air Source Heat Pump, Mini-Split Heat Pump.

Cooling System Options Table:

Option	Compressor	Cycling [frac]
1) None		
2) SEER 13	1 Stage	0.07
3) SEER 14	1 Stage	0.07
4) SEER 15	1 Stage	0.07
5) SEER 16	1 Stage	0.07
6) SEER 16 (2 Stage)	2 Stage	0.11
7) SEER 17	2 Stage	0.11
8) SEER 18	2 Stage	0.11
9) SEER 21	2 Stage	0.11
10) SEER 24.5	Var. Speed	0.25

Building Settings:

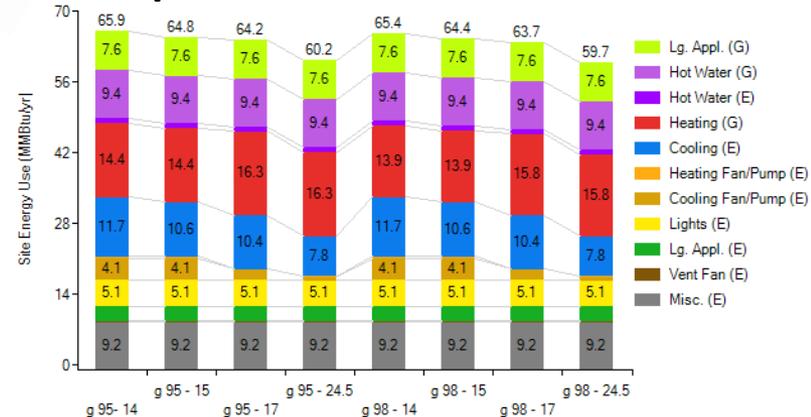
- EPW Location: USA_TX_Austin.722540_TMY2.epw
- Terrain: Suburban
- Natural Gas Hookup:

Economics:

- Project Analysis Period: 15 years
- Inflation Rate: 2.0 %
- Discount Rate (Real): 3.0 %



Outputs



Cost Modeling

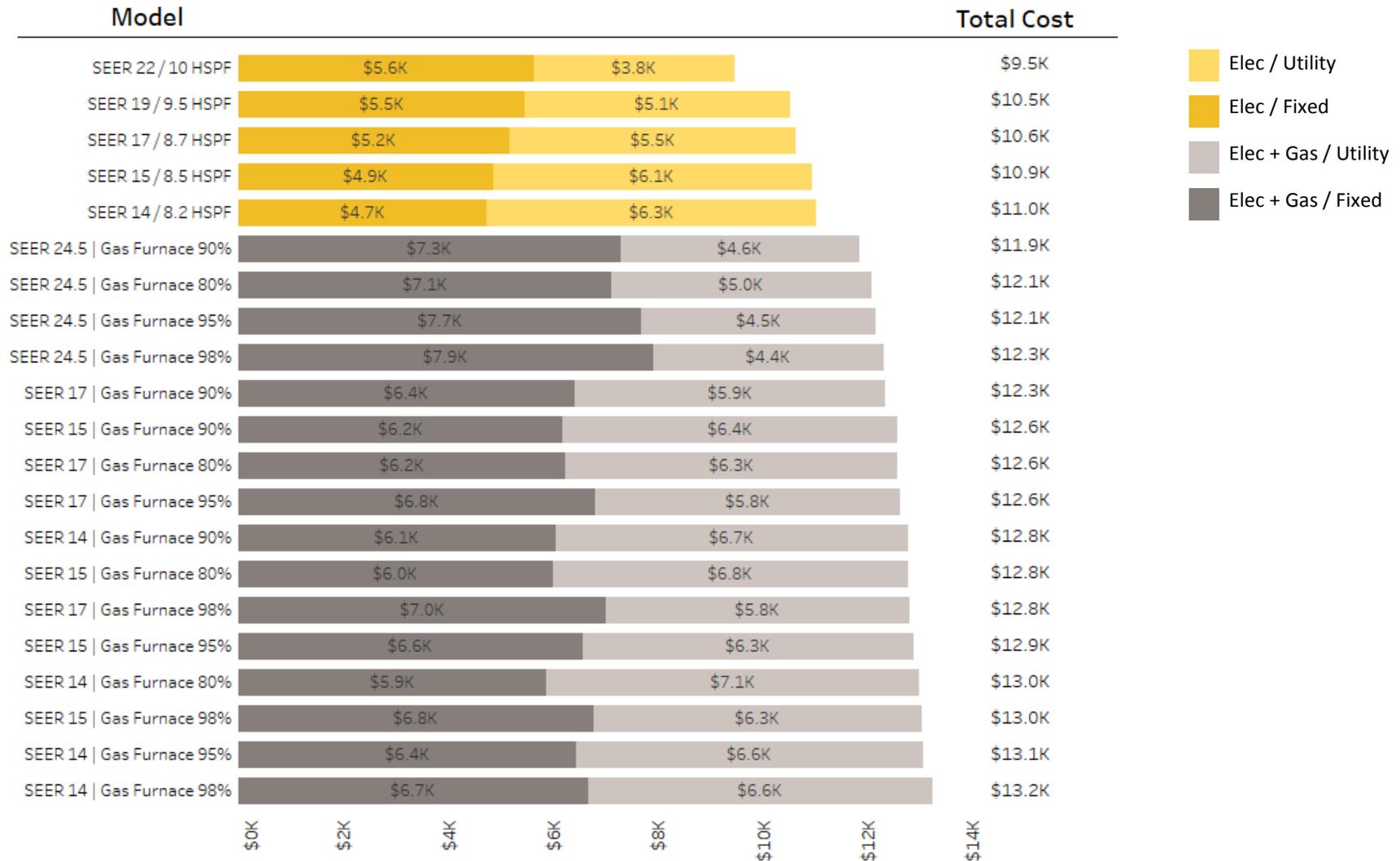
Fixed Costs

- BEopt models net present cost over the analysis period using designated appliance lifetime and replacement costs

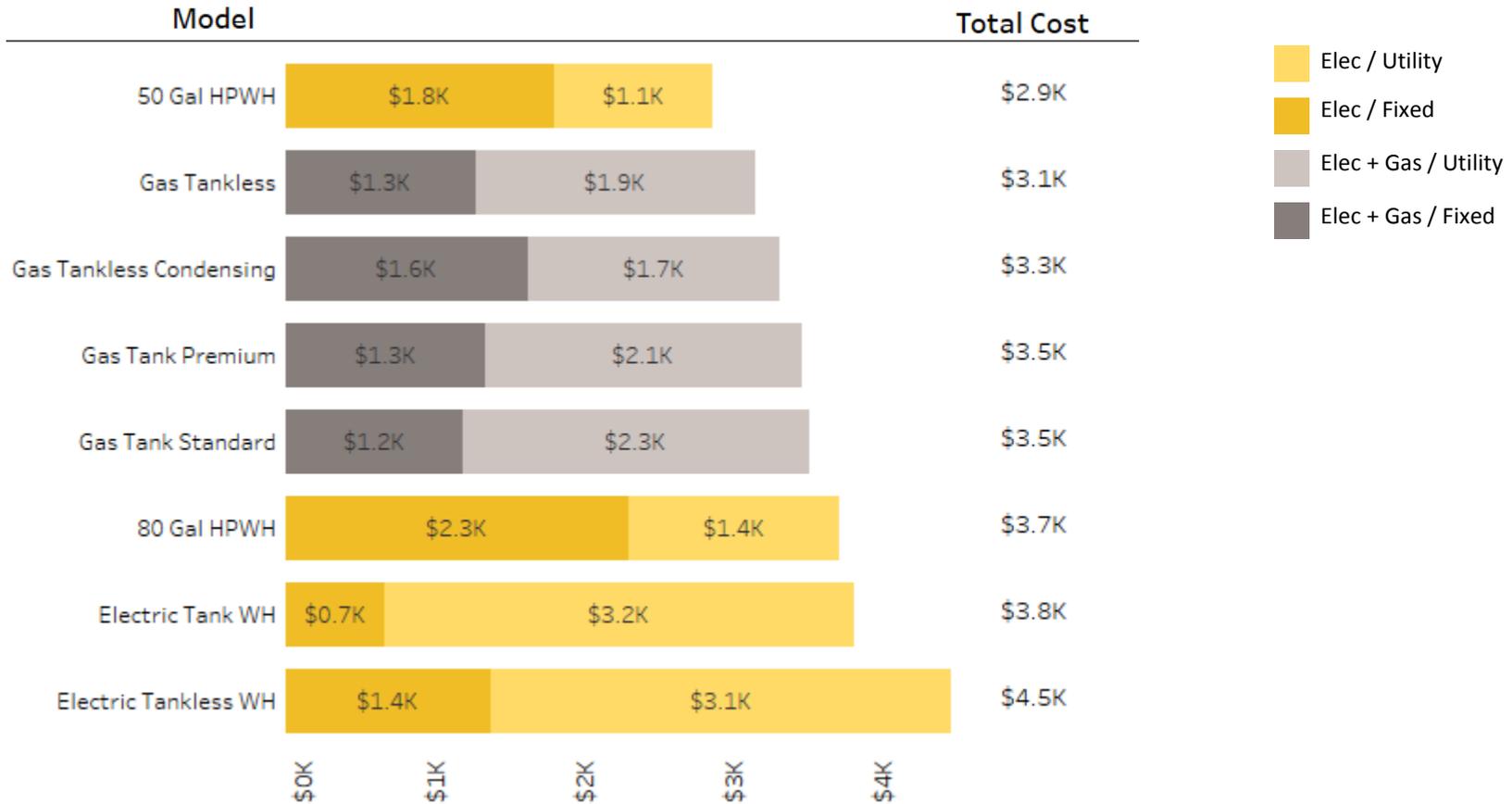
Utility Costs

- Energy outputs in kWh of electricity and therms of natural gas were priced using Austin Energy and Texas Gas Service's rate structures.
- Current yearly pricing was extended without inflation and the Net Present Value was calculated over the 15 year timeframe with a 3% real discount rate.
- An entire home's energy use was modeled for a year to account for tiered rate structures and seasonal variance in pricing.
- Individual appliance costs were then derived from the annual home utility cost.
- Each appliance's yearly cost depends on the other appliances in the house. The median value across all modeled homes was used in the final analysis.

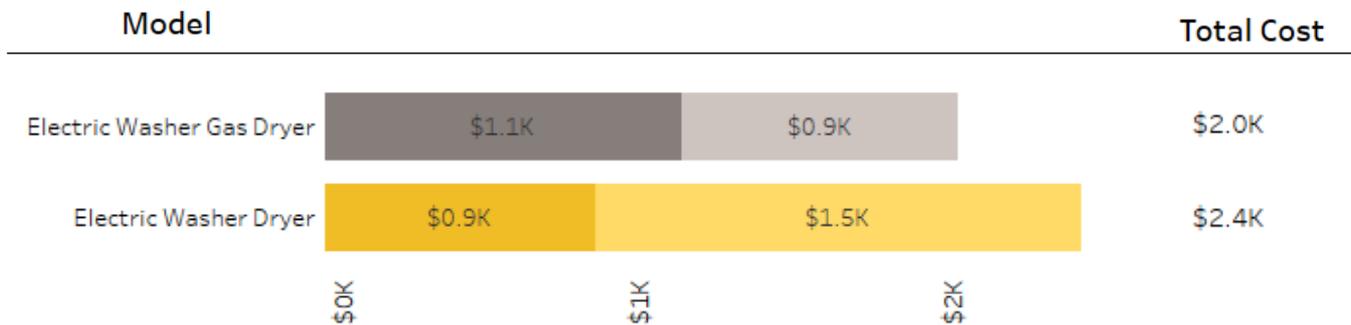
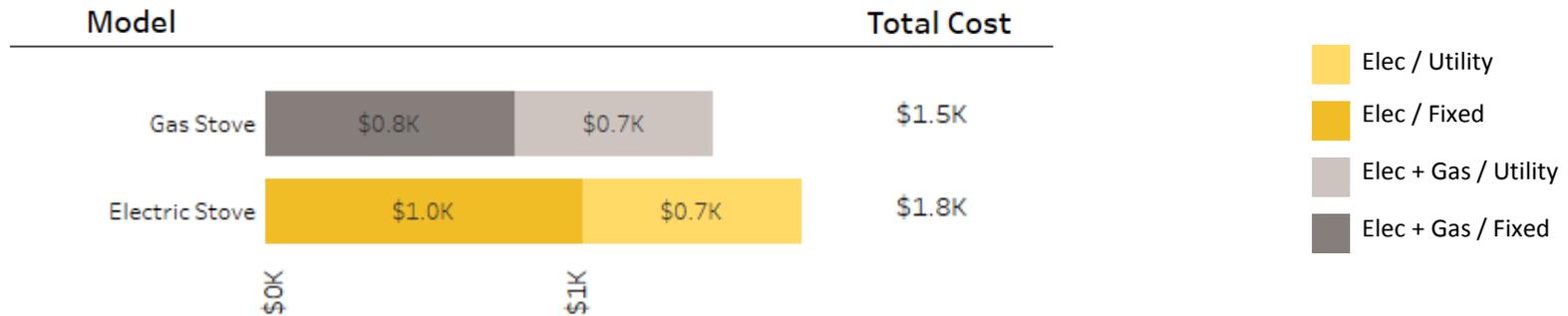
Space Conditioning 15 Year Cost



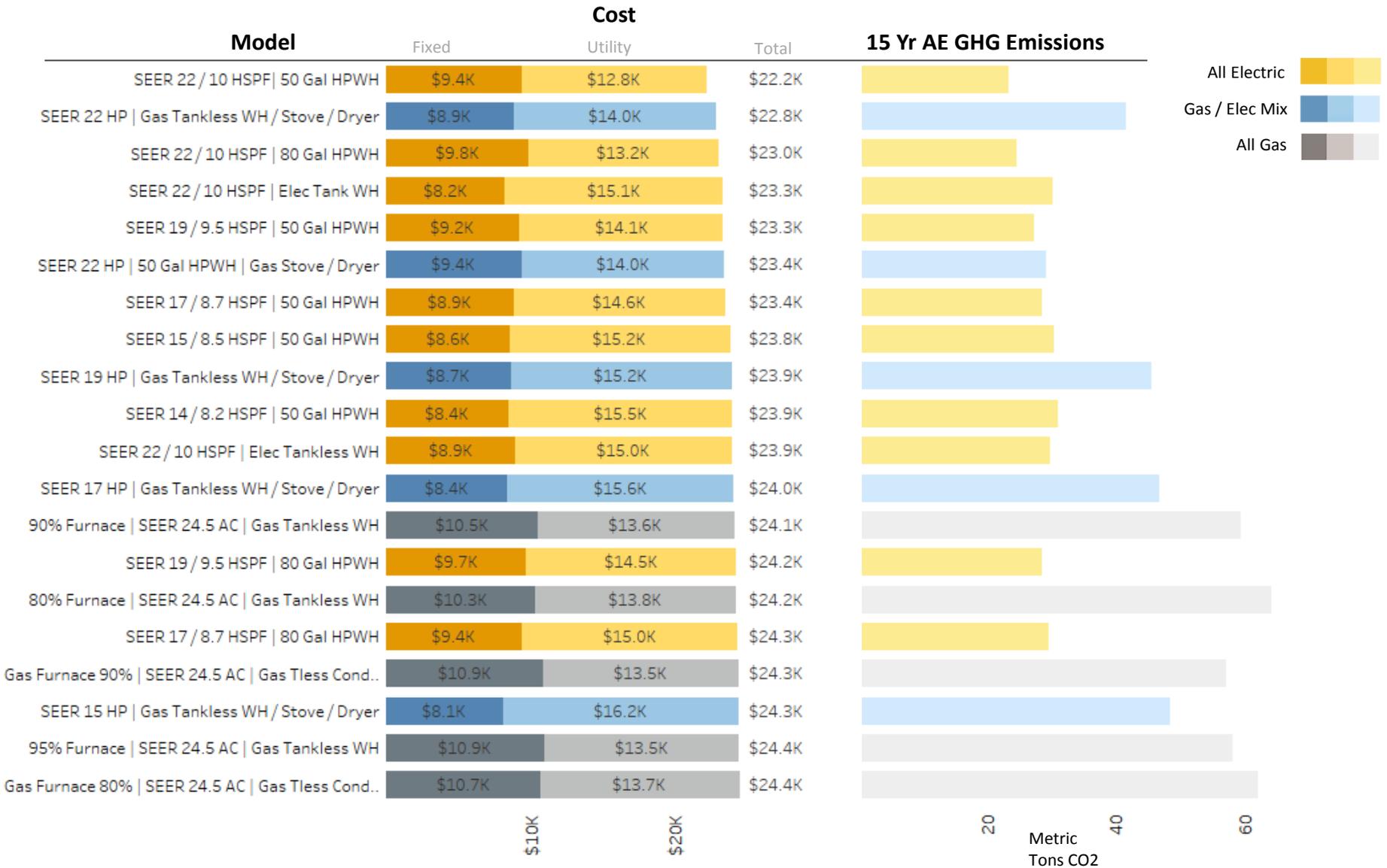
Water Heating 15 Year Cost



Stove / Dryer Appliance 15 Year Cost



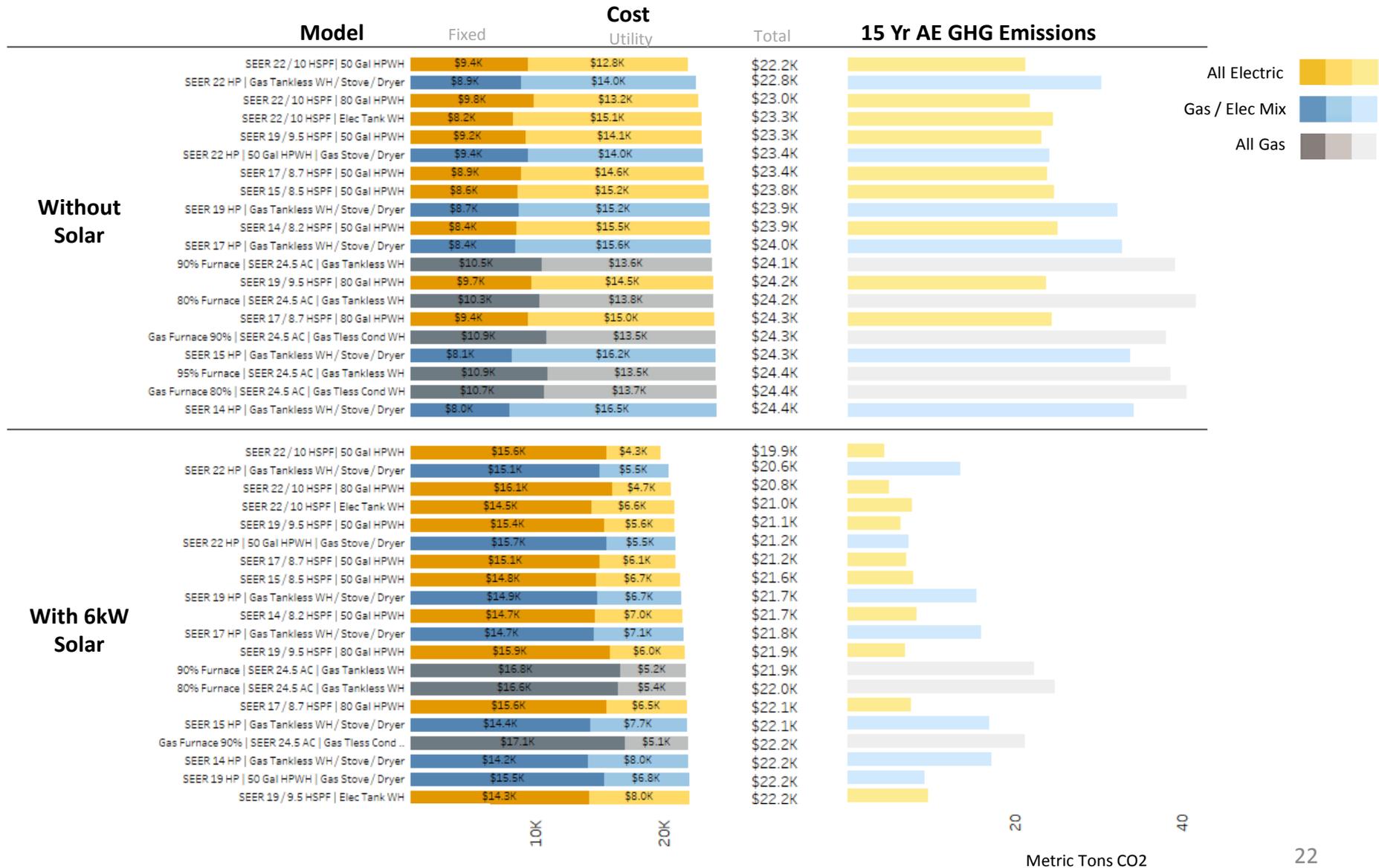
Whole House 15 Year Cost (Top 20)



Solar PV Assumptions

- 6kW Solar PV System modeled for all homes
- 15 Year analysis period
- 30% Federal Solar Investment Tax Credit and \$2500 Austin Energy rebate are included
- \$ 0.085 Value of Solar used for the entire 15 year analysis period
- All cash flows discounted to NPV at 3%

Solar Analysis

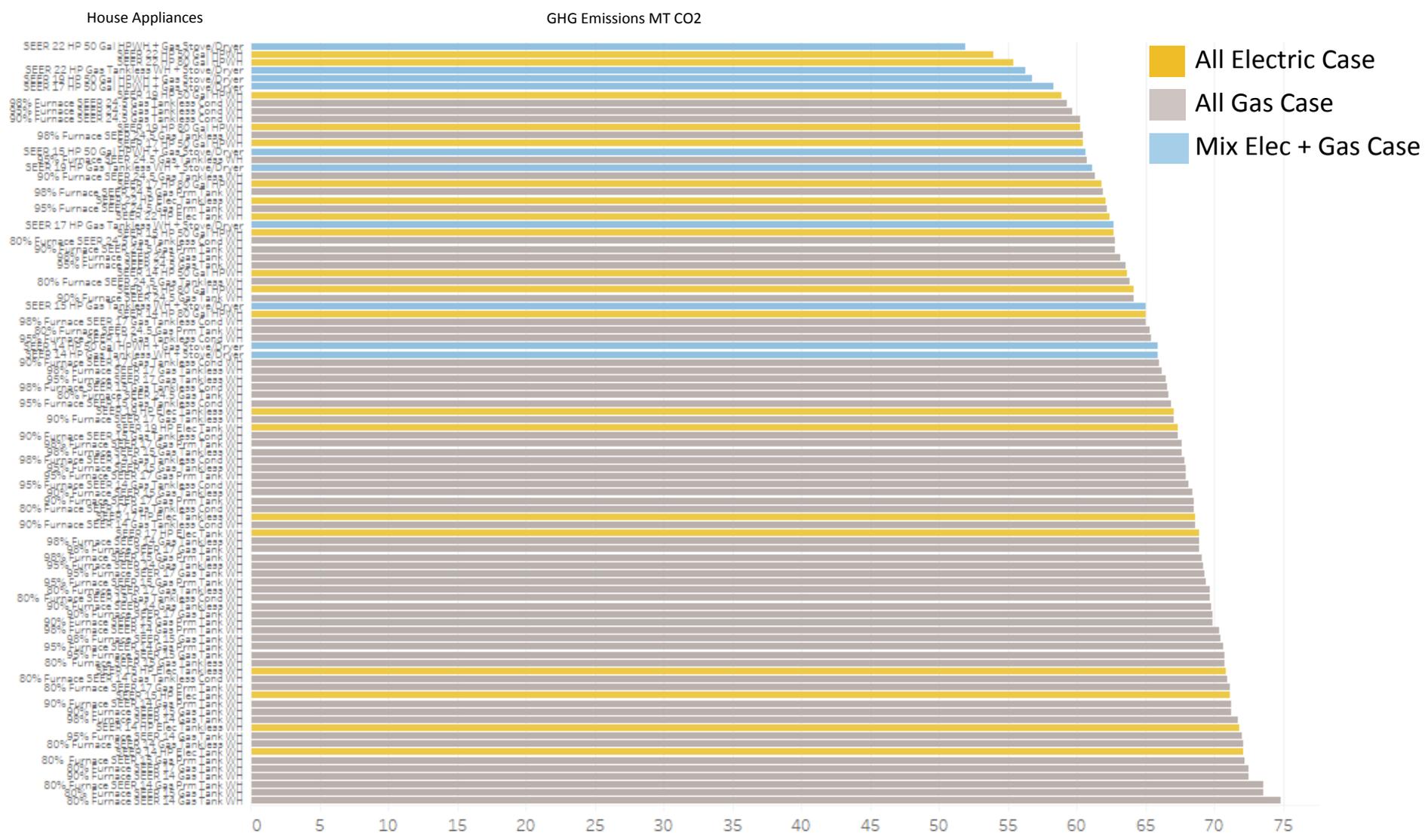


Takeaways

- Over a 15 year lifetime, a code compliant all-electric new single family home using Austin Energy electricity will create less GHG emissions than the comparable home with natural gas space and water heating equipment.
- Over a 15 year lifetime, a code compliant all-electric new single family home can have lower equipment plus utility costs than the comparable home using natural gas and electricity.
- Factors not included in this analysis:
 - Local equipment costs
 - Gas / electric connection infrastructure costs
 - Additional scenarios including different size homes and higher electricity usage
 - Retrofitting existing buildings
 - Multi-family and commercial buildings and construction trends

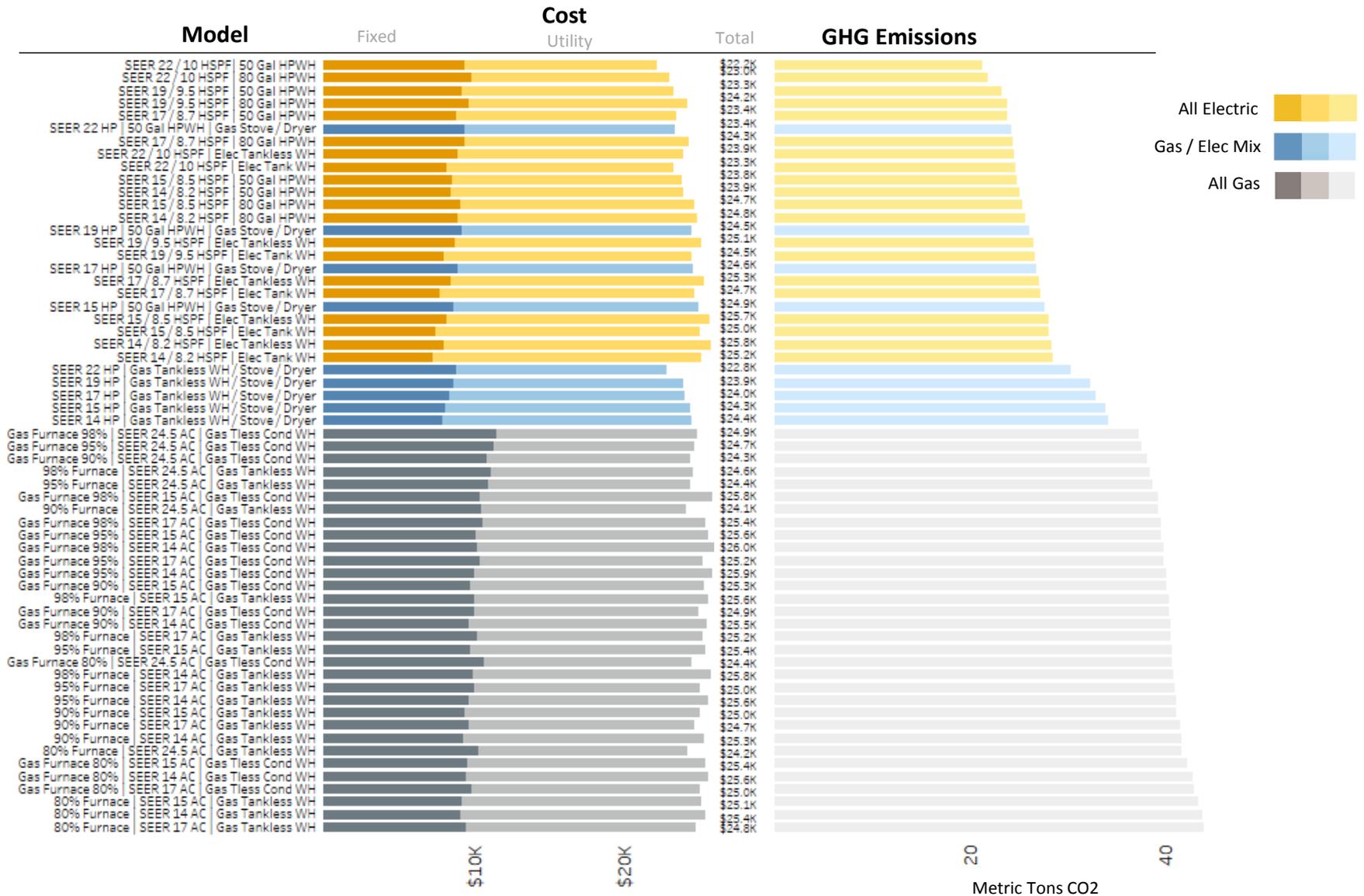
Extras

2018 – 2032 GHG Emissions 750 lb / MWh Carbon Intensity



Source: NREL BEopt, COA OOS

Cost vs. AE GHG Emissions 2018 - 2032



Rebates

Texas Gas

- Dryer - \$225
- Tankless water heater - \$650
- 92% efficiency furnace - \$675

Austin Energy

- Heat Pump Water Heater - \$800
- Heat Pump
 - 15 SEER – \$300
 - 16 SEER - \$400
 - 18 SEER - \$500

The affordability goal approved by City Council is composed of two metrics: a) Maintain system average rates at or below 2% annual compound growth rate that begin October 2012; and b) Maintain an average annual system rate in the lower 50% of all Texas utilities serving residential, commercial and industrial customers as measured by published data from the Energy Information Administration Form 861. 28

2016 Energy Code

- Ordinance 20160623-099, updates last made in 2016
- **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.
- Next scheduled Energy Code update in 2018.

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 – 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.