Transforming Texas: How Heat Pumps Can Replace Electric Resistance Heat, Reducing Costs and Winter Power Peaks

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This fact sheet summarizes the findings from an ACEEE report by the same name. For additional details, see the full report: https://www.aceee.org/white-paper/2024/11/transforming-texas-how-heat-pumps-can-replace-electric-resistance-heat

Introduction: Winter Peak Demand Is High in Texas, and Heat Pumps Can Reduce This Demand

Over 25% of Texas households (2.76 million units in 2020) get their heating and cooling from a central air conditioning system combined with an electric resistance furnace that heats air to be distributed throughout the home via ducts and registers. When temperatures drop, these systems average about 9 kW of peak demand per home; thus, they are one of the most significant contributors to winter peak electric demand. While power demand in Texas generally peaks on hot summer days, winter demand peaks when cold fronts move through the state can be just as large. In fact, 2021's Winter Storm Uri would have produced an all-time record peak if the power stayed on.

Figure 1 illustrates the impact of electric resistance heat on peak electric demand and shows how demand can be higher on cold winter days than on hot summer days.

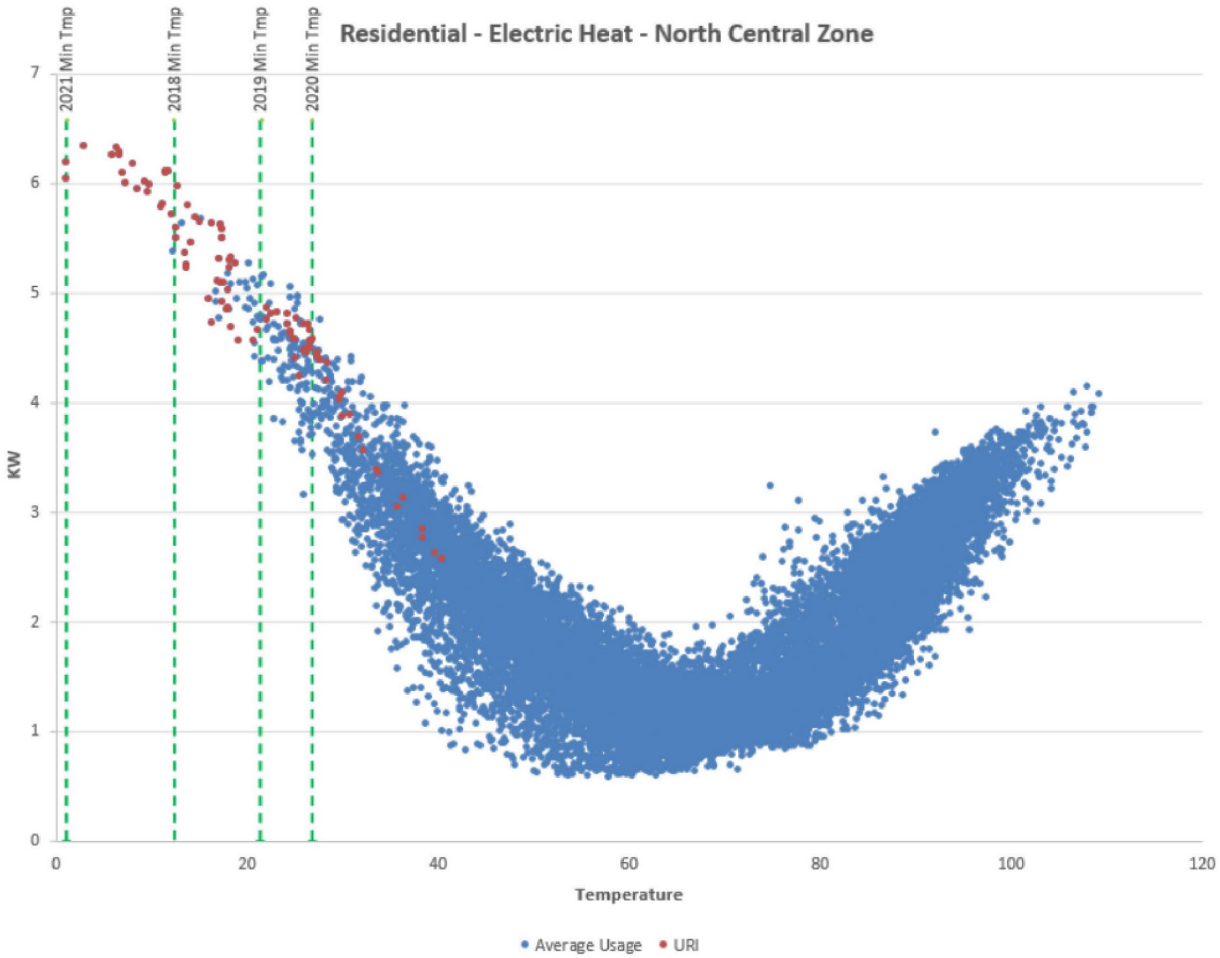

Figure 1. Data on residential demand in North-Central Texas homes as a function of outdoor temperatures. Demand significantly higher at low winter temperatures than at high summer temperatures. Sources: Barnes *and NRG 2021.*[i]

Homes and apartments can be upgraded to use a high-efficiency heat pump when the existing central air conditioning unit needs replacement. Heat pumps provide cooling in the summer, just like an air conditioning-only unit, and heat in the winter. Heat pumps are a cost-effective alternative to electric resistance furnaces that reduce energy use and peak demand roughly in half. They do this by concentrating the heat that is in the outside air. It takes less energy to move this heat than it does to generate heat in an electric resistance coil. Even when it is 15° F outside, the typical winter low in Dallas, a heat pump uses only about half the energy of the electric resistance systems that are common in Texas homes. As a result, consumer space heating costs will be reduced by at least 50%, helping to stretch consumer budgets.

Analysis and Findings: Average Return on Investment Is High for Heat Pumps

In this study, we examine a detailed representative sample of more than 350 Texas homes that presently use electricity as their primary source of heat, as collected by the U.S. Energy Information Administration. We have detailed data on each home's characteristics and energy use, allowing us to examine heat pump costs and energy savings on a home-by-home basis.

On average, installing a heat pump instead of a central air conditioner with electric resistance heating coils increases costs by about $391 in new construction and $697 when replacing an existing central air conditioner. (For equipment replacement, the increase is 5% to 21%, depending on air conditioner size.) Based on our sample, electricity savings start accruing in Year One and steadily increase over 15 years, the typical lifespan of this equipment,[ii] as shown in Figure 2. In Year 15 electricity savings total over 7 billion kWh (equivalent to the annual electricity use of over 660,000 average American homes, e.g., enough power to serve every home in El Paso), and winter peak demand savings total about 12,000 MW (equivalent to the power output of about 40 new gas-fired power plants of 300 MW each).

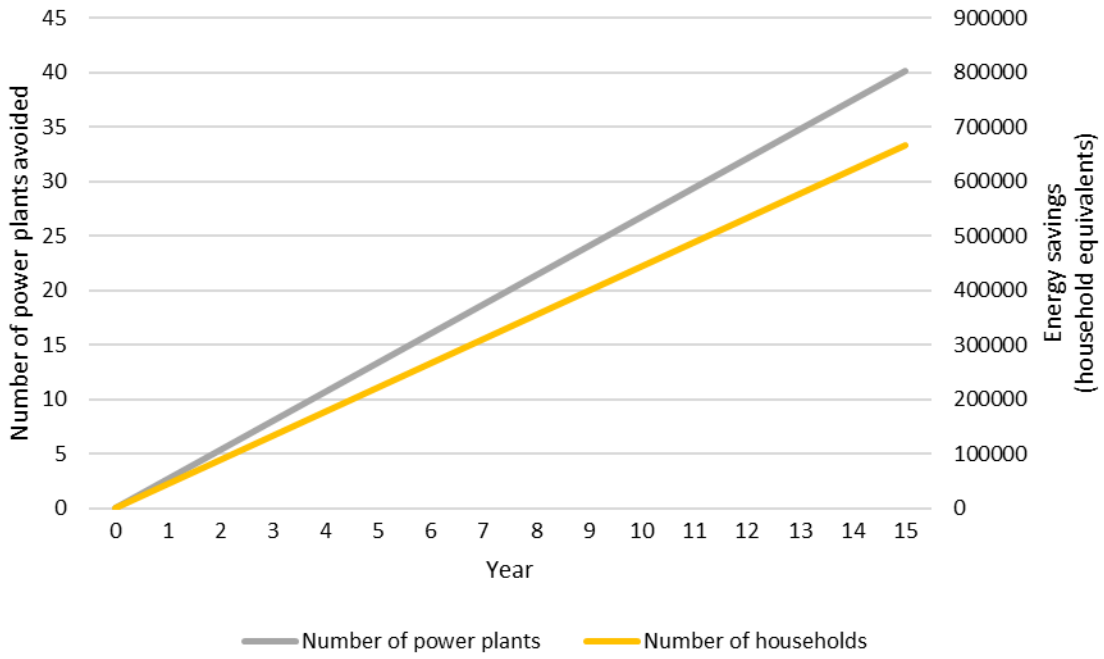

Figure 2. Energy and winter peak savings grow over time. Energy savings are expressed in household equivalents based on U.S. households' average annual electricity consumption. Power plant equivalents based on 300 MW power plants.

Our results are similar to the findings from the October 2024 study *Energy Efficiency and Demand Response in ERCOT* prepared by Texas A&M and commissioned by ERCOT, the power pool that covers most of Texas. This study looked at a variety of energy efficiency and demand response scenarios, including one with minimum efficiency heat pumps and using the existing heat source as backup. For this scenario, the A&M study found 13,660 MW of winter peak demand reduction (slightly more than our estimate) and 1,680 MW of summer demand reduction (for which we did not prepare an estimate).[iii]

By the 15th year, we find that annual energy bill savings across Texas would be about $1 billion per year, an average of $343 annually per Texas household that replaces the central air conditioner and electric resistance coils with a heat pump. The total benefits over the equipment lifetime are about nine times higher than the cost of switching from a central air conditioner to a heat pump. For an average Texas home replacing the air conditioner and electric resistance heat with a heat pump, the 15-year utility bill savings are about $5,000. This is illustrated in Figure 3, which shows how the energy bill savings for a typical Texas household grow over time, with the extra cost paid back in one year on average for new construction and three years for equipment replacement.

In 2023, the U.S. Energy Information Administration estimated that a new combined-cycle power plant costs over $1.3 million per MW.[iv] If, as a rough estimate, we assign one-third of this cost to the winter peak, since summer peaks will still be more common than winter peaks, the 12,000 MW of winter peak reductions from installing heat pumps instead of central air conditioners would avoid over $5 billion in power plant construction costs that are ultimately recovered in Texas electric rates, not even counting avoided transmission and distribution costs or the operating costs of these new power plants. Our analysis finds that installing heat pumps instead of air conditioners might cost a total of about $1.6 billion, and the heat pumps will have much lower operating costs than the systems they replace. In other words, installing heat pumps can reduce capital costs by more than $3 billion, plus reduce heating costs by about 50%. This is an important opportunity to reduce growth in power costs, helping Texans keep more of the money they earn.

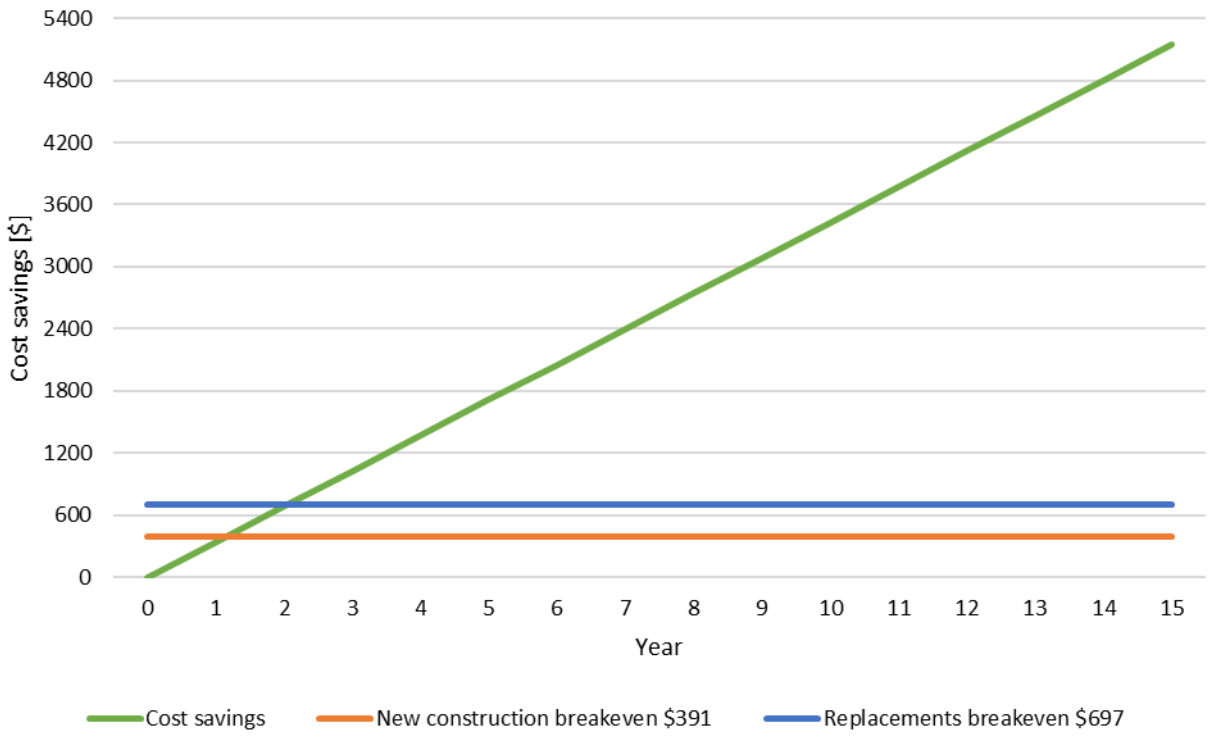

Figure 3. Average savings per household from purchasing a heat pump at time of replacement compared to the incremental cost of a heat pump relative to a central air conditioner with electric resistance strip heat. The incremental cost is paid back in one year for new construction and three years for equipment replacement.

We can also examine individual homes and apartments, separately analyzing subsets such as new construction versus retrofits, single versus multifamily, and the northern versus southern portion of the state. To do this, we looked at the return on investment (ROI)—the annual savings divided by the incremental cost of switching to a heat pump at the time of equipment replacement.

- For new construction, we find that almost 90% of Texas homes and apartments could earn more than a 30% ROI by purchasing a heat pump instead of a central air conditioner with electric resistance coils, as illustrated in Figure 4.

- For equipment replacement, 96% of Texas homes and apartments could have an ROI greater than 10%, and 83% could have an ROI greater than 20%, as shown in Figure 5.

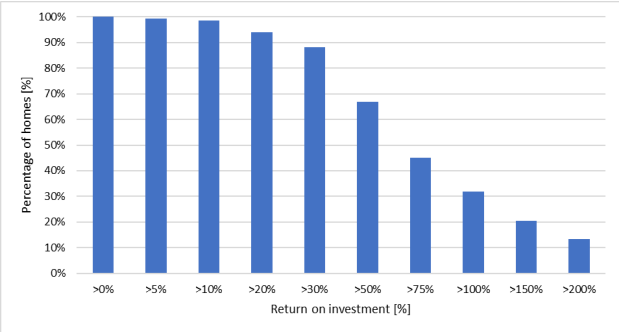

Figure 4. ROI distribution for new construction.

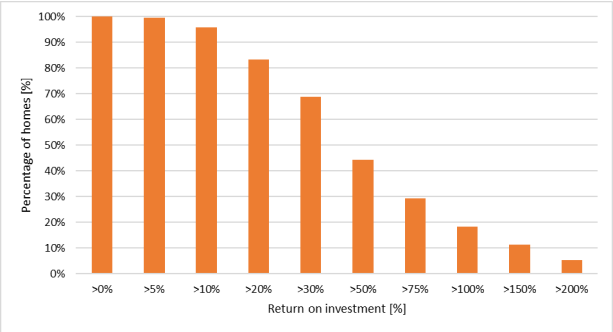

Figure 5. ROI distribution for equipment replacement.

Figure 6 summarizes the average ROI for some key subgroups in our analysis. In all cases, the ROI is substantially better than for the stock market or a bank certificate of deposit.

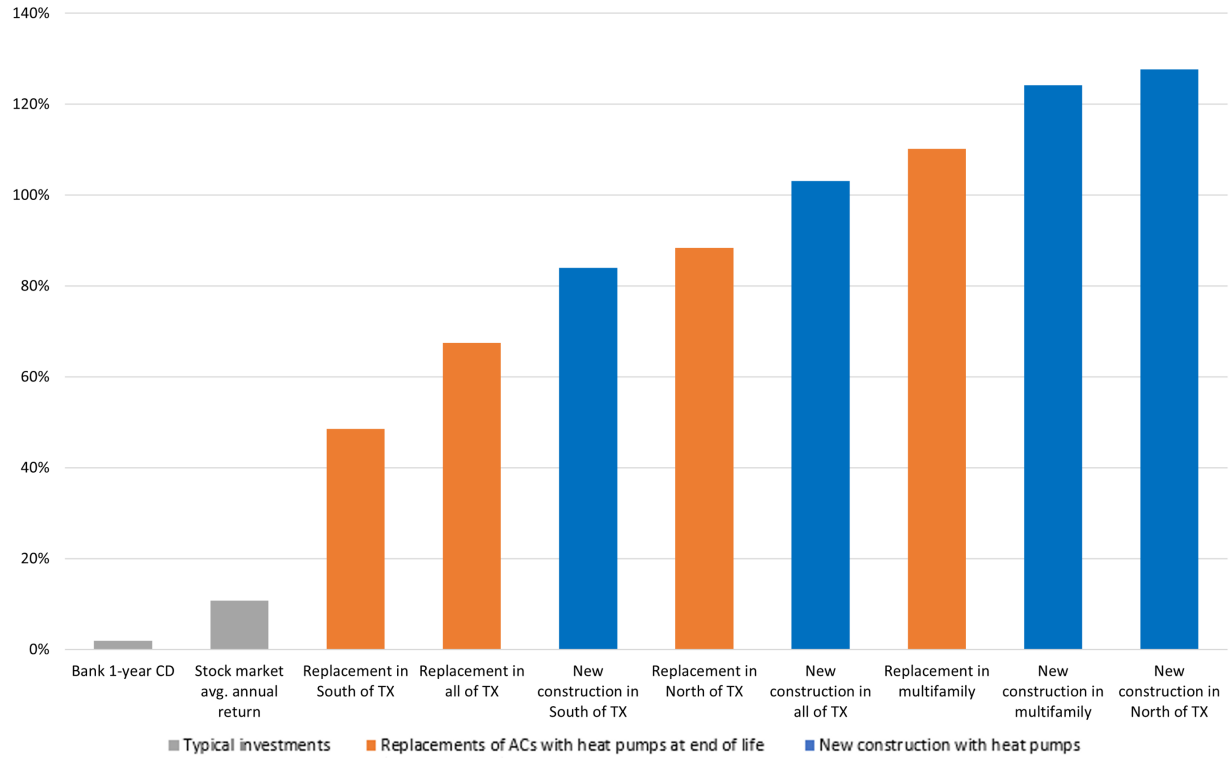

Figure 6. Return on investment for installing a heat pump at time of new construction or equipment replacement compared to average returns from the stock market or bank certificates of deposit (CDs). Bank CD rates as of September 2024. Stock market returns are the 30-year annual average return on the S&P 500. North of Texas means more than 2,020 heating degree days (e.g., just north of Austin, as shown in Figure 7). Additional subgroups are illustrated in Table 1 at the end of this fact sheet.

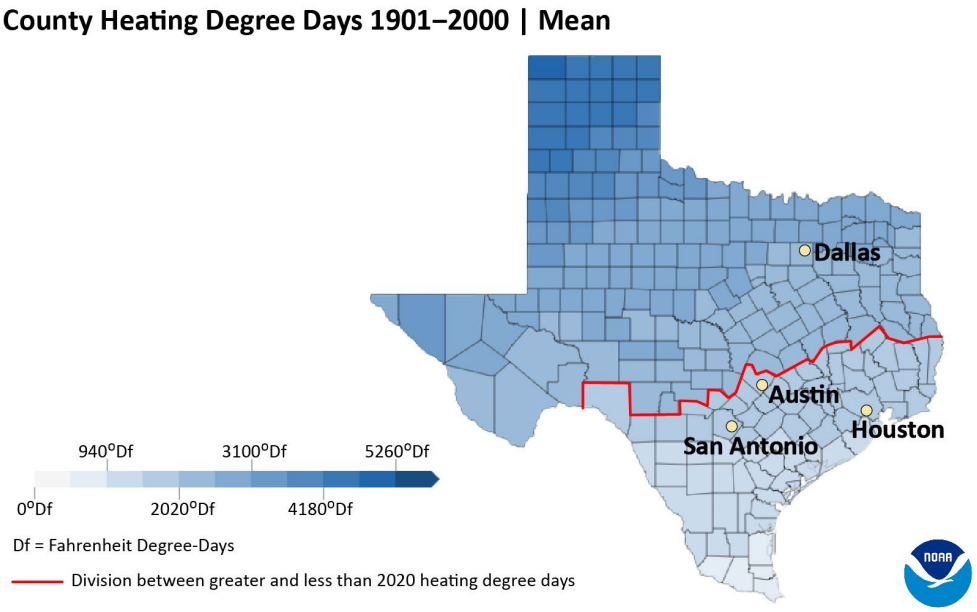

Figure 7. Heating degree days by county showing where we divided north from south.

Table 1 summarizes the average and median ROI and average, and median simple payback for new construction and replacements in homes and apartments. Outliers affect some of the averages, so the average results often differ from the median results.

Table 1. Summary of results

	New construction				Replacements			
Characteristic of homes	**Average ROI [%]**	**Median ROI [%]**	**Average payback [years]**	**Median payback [years]**	**Average ROI [%]**	**Median ROI [%]**	**Average payback [years]**	**Median payback [years]**
Overall	103%	66%	2.02	1.52	67%	42%	3.21	2.36
Single family (1 unit)	96%	63%	1.99	1.59	52%	37%	3.60	2.71
Multifamily (2 or more units)	124%	83%	2.10	1.21	110%	78%	2.11	1.29
Owner occupied	94%	60%	2.00	1.68	52%	37%	3.62	2.72
Renter occupied	121%	80%	2.06	1.24	96%	66%	2.46	1.52
Below median income (<$75,000/yr)	112%	72%	1.97	1.38	75%	48%	2.95	2.07
Above median income (>$75,000/yr)	94%	65%	2.07	1.55	56%	37%	3.59	2.70

	New construction				Replacements			
Characteristic of homes	Average ROI [%]	Median ROI [%]	Average payback [years]	Median payback [years]	Average ROI [%]	Median ROI [%]	Average payback [years]	Median payback [years]
Regions (30 yr avg HDD) North (>2020 HDD)	128%	89%	1.86	1.12	88%	65%	2.33	1.54
South (<2020 HDD)	84%	57%	2.14	1.76	49%	34%	4.01	2.97
ENERGY STAR heat pumps overall	7%	6%	31.8	16.9	6%	5%	30.9	20.0

Programs and Policies Can Spur Use of Heat Pumps

Energy efficiency programs and policies can help to spur the use of heat pumps instead of electric resistance heat. For example, as Texas moves forward with its application to the U.S. Department of Energy for the state's federally funded Home Energy Rebate programs, the State Energy Conservation Office should consider how to target homes with electric resistance heat as a priority in their programs. Likewise, utilities and the Public Utilities Commission of Texas (PUCT) should consider how utility investments can expand the reach of these programs by offering complementary programs for new construction and heating system replacements, targeting low-income households and multifamily housing in particular because landlords often pay for new equipment, but it is typically the tenant who benefits from the reduced energy bills. As the PUCT considers the state's investor-owned utility energy efficiency portfolio, it should explore opportunities to increase residential program participation. The role of midstream programs that target distributors with incentives to stock heat pumps instead of central air conditioners and electric furnaces should also be considered.

State and local governments have adopted restrictions on electric resistance heating through building codes, requirements for construction projects receiving public funding, and other policy mechanisms. The City of Austin's code, for example, prohibits electric resistance heating, providing a practical and cost-effective example that could be adopted by other municipalities. Ultimately, something similar could be included in the state energy code, following the example of states such as Florida and Georgia. This change in the code can help the state manage the impact of a growing population and economy on statewide energy demand.

Conclusion

Installing heat pumps when central air conditioners need replacement substantially reduces peak demand and has large economic benefits. Texas energy efficiency programs and policies should encourage the switch from electric resistance heat to heat pumps in new construction and when existing central air conditioners need to be replaced.

References

[i] Barnes and NRG Energy. 2021. “Comments in Docket 52373: Review of Wholesale Market Design, NRG Energy, Inc.’s Comments on the Commission’s September 2,2021 Questions for Comment.” www.interchange.puc.texas.gov/Documents/52373_109_1152444.PDF ..

[ii] ASHRAE. 2019. ASHRAE Handbook, HVAC Applications. Chapter 38, Table 4, Comparison of Service Life Estimates. Atlanta, GA: ASHRAE.

[iii] Xie, Le and Texas A&M. 2024. Demand Response and Energy Efficiency in ERCOT. www.interchange.puc.texas.gov/Documents/38578_135_1432200.PDF .

[iv] EIA. 2023. “Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2023.” Washington, DC: EIA. www.eia.gov/outlooks/aeo/assumptions/pdf/elec_cost_perf.pdf .