ENERGY EFFICIENCY AND DEMAND-RESPONSE: TOOLS TO ADDRESS TEXAS' RELIABILITY CHALLENGES: SUMMARY

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Key Takeaways

- Texas has major electric reliability challenges, particularly during summer heat waves and major winter cold fronts.
- Texas's growing population and accompanying load growth are driving increased electricity demand. Between 2018 and 2022, the state's population grew by 5%, statewide electricity use grew by 11%, and ERCOT peak load grew by 9%.
- Energy efficiency (EE) and demand response (DR) programs (DR is sometimes called "load shifting") can substantially reduce summer and winter peak demand in the near future, dramatically reducing the chance of black-outs or brown-outs. Notable savings can be achieved by the end of 2024.
- We find that a set of ten energy efficiency and demand response retrofit measures for residential and commercial buildings and equipment, deployed aggressively under statewide direction over the 2024–2030 period, could serve more than 13 million Texas households and offset about 14,800 MW of summer peak load and 23,500 MW of winter peak load, exceeding the 10,000 MW capability of the ten new gas plants proposed as "insurance" by some power plant developers.
- ENERGY STAR® heat pumps, smart thermostats, and electric vehicle demand response save the most; they could yield a 17,500 MW winter peak reduction at an average cost of about $101 million per year, or about $41 million per 1,000 MW of winter peak reduction. These programs plus demand response programs for central air conditioning (the largest summer peak reducer) can reduce summer peak by about 8,800 MW at an additional average annual cost of about $128 million per year.
- The set of energy efficiency and demand response programs proposed here would cost about $1.2 billion per year for seven years. That is substantially below the $10 to $18 billion capital costs of the proposed 10,000 MW ERCOT generation insurance program, and lower still when additional costs for generator fuel, maintenance, and transmission infrastructure for those "insurance" generators are included.
- These programs are highly cost-effective on their own and compared to generation options. Over the 2024–2030 period, customers will receive an average of $20 per month in benefits at an average monthly cost of $7; the benefits more than offset the increased energy efficiency program fee on customer bills. Customers get improved reliability plus energy bill savings.
- Once installed, these efficiency measures will continue delivering continuous comfort, energy bill savings, and peak load reduction for their 10- to 20-year measure lives. Moreover, they will continue working in extreme weather, unlike some of Texas's power plants.
- Ongoing investment in EE and DR could continue growing these customer savings benefits over time, while giving ERCOT and the Commission time to stabilize the supply-side power market rules and infrastructure.

Summary Report

This summary report is an early release of our analysis results; a full report with substantial details will be published in summer of 2023.

Texas Has Substantial Electric Reliability Problems

Texas has recently experienced major electric reliability problems or close calls on multiple occasions due to a combination of extreme weather (hot or cold) and failures of its power system. Despite multiple actions by Texas state and utility officials, more change is needed to address growing power demand in the state and periodic equipment failures. In May, the Electric Reliability Council of Texas (which supplies electricity to 90% of Texans) forecast record peak demand for the summer of 2023 and adequate power availability *unless* there is a confluence of extreme heat, widespread outages at fossil fuel plants, and low renewable energy output (ERCOT 2023a). The convergence of these three events is highly possible. At a May 2023 press conference, Public Utility Commission Chairman Peter Lake stated: "The Texas grid faces a new reality…. Data shows, for the first time, that the peak demand for electricity this summer will exceed the amount we can generate from on-demand dispatchable power….So we will be relying on renewables to keep the lights on," he continued (Walton 2023).

Texas's most dramatic recent reliability event occurred during Winter Storm Uri in February 2021, when ERCOT had to cut electric service to over 4.5 million customers for multiple days of extremely cold weather. This event reflected the extraordinarily high demand for electric home heating (from inefficient homes and equipment) combined with the loss of 50% of the state's generation fleet (due to freezing weather, reduced fuel supply, and equipment failures). Supplies were again tight in December 2022 during Winter Storm Elliott, when low temperatures led to some gas outages. ERCOT has also faced recent summer supply challenges, as illustrated by calls for voluntary power conservation in June 2021 and summer 2022. In June 2021, the shortage was driven by a large number of plants being out of service for unplanned repairs. In summer 2022, record demand nearly exceeded available generation supplies, but blackouts were averted by a mixture of operating extra plants to keep reserves high, industrial demand response, and requests for households to raise their thermostats. Together, these measures cost about $1 billion through the first seven months of 2022 (Verma 2022). ERCOT's energy-only wholesale market design and evolving generation resource mix are widely viewed as complicating the task of maintaining reliability as the power supply mix changes.

Texas's growing population and accompanying load growth are driving increased electricity demand. Between 2018 and 2022, the state's population grew by 5%, statewide electricity use grew by 11%, and ERCOT peak load grew by 9%. Texas's population increased by 24% from 2008 through 2022, with little check on electric usage from energy efficient building codes or utility efficiency programs (EDF et al. 2023).

Potential Solutions

Texas policymakers have proposed numerous supply-oriented solutions to address these problems, including winterization of existing power plants and critical grid infrastructure, subsidized construction of many new power plants, and additional financial incentives to reward dispatchable generation. For instance, pending Senate bill 6 (SB 6) would invest $10–18 billion in a fleet of new gas-fired power plants—to be used only in emergency conditions but paid for by all ERCOT electric customers. A proposal developed by the Public Utility Commission of Texas and its consultant for a performance credit mechanism has also passed the Senate (SB 2012) with a $500 million per year cost cap, but lobbyists are seeking to raise or eliminate the cap. It should be noted that new power plants cannot be built overnight—if a decision to build new power plants is made this summer, it could be three years or longer before the first new plant can be connected to the transmission system and begin operations. As noted in the Key Takeaways above, expanded energy efficiency and demand response programs can achieve notable savings by the end of 2024.

Another important way to address these problems is to expand Texas utilities' currently limited energy efficiency (EE) and demand response (DR) programs,[1] with a focus on programs that can substantially reduce summer and winter peak demand. A variety of proven and targeted EE and DR measures could be used immediately to address Texas's electric reliability and affordability challenges. Texas has some very good energy efficiency and demand response programs, but these programs are often limited by budget constraints. Current Texas EE and DR programs aim for low goals with low funding; they could be expanded to slow energy demand growth at lower cost than traditional supply-side solutions.

Since we started work on this report, SB 258 has been introduced and passed by the Texas Senate.[2] This bill would set an annual energy saving target for energy efficiency programs of 1% of electricity sales to be achieved by 2030, approaching targets in other nearby states such as Arkansas and Arizona. This is a very substantial increase from the 0.21% as a percent of sales that Texas efficiency programs achieved in 2021 (Subramanian et al. 2022). The programs we recommend, while largely designed for peak demand reductions, would likely also meet this energy-saving objective when combined with current programs.

[1] In 2021 (the last year for which data are available), Texas ranked 36th in the country on energy efficiency savings as a percent of electricity sales and 37th in the country on energy efficiency spending as a percent of MWh electricity sales, behind such states as Arizona, Arkansas, Indiana, Oklahoma, and Utah (Subramanian et al. 2022).

[2] In addition, another pending bill should be noted—House Bill 4811—which would establish a Texas Energy Efficiency Council to help coordinate energy efficiency efforts between investor-owned utilities (which are regulated by the Public Utility Commission of Texas (PUCT)) and municipal and cooperative utilities (which are not regulated by PUCT).

This Report: Energy Efficiency and Demand Response as Tools to Address Texas's Reliability Challenges

Energy efficiency and demand response solutions are the focus of this report, which explores the impact of a set of utility-administered energy efficiency and demand response programs largely targeting the residential sector, but with a few commercial sector programs.[3] These programs could be ramped up more quickly than power plant construction and could have significant impact on peak demand beginning in the summer of 2024.

This report is a major update and expansion of a 2021 ACEEE report on this subject. In this new report we update our prior work, account for new federal funds that will soon reach Texas and add new programs serving low-income households plus two commercial sector opportunities. We also update the perspective to the 2023 situation.

Findings

We find that this set of ten energy efficiency and demand response retrofit measures, deployed aggressively under statewide direction over the 2024–2030 period, could serve over 13 million Texas households and offset about 14,800 MW of summer peak load and 23,500 MW of winter peak load (see figure 1). These demand reductions would exceed the 10,000 MW capability of the proposed new gas plants in SB 6. The proposed set of energy efficiency and demand response programs would have a total cost over the 2024–2030 period of about $8.4 billion, substantially less than the $10–18 billion capital cost of SB 6,[4] and not including additional costs for generator fuel, maintenance, and transmission infrastructure. These findings are for all of Texas; since ERCOT represents about 90% of Texas loads, impacts for ERCOT can be estimated by multiplying these figures by 90%.

Once installed, these efficiency measures will continue delivering continuous comfort, energy bill savings, and peak load reduction for all customers in Texas and ERCOT over the course of their 10- to 20-year measure lives. Ongoing investment in energy efficiency and demand response could continue growing these customer savings benefits over time, while giving ERCOT and the Commission time to stabilize the supply-side power market rules and infrastructure.

[3] This paper focuses primarily on energy efficiency (EE) and demand response (DR) opportunities in the residential sector because current Texas EE and DR programs direct the bulk of their efforts toward commercial and industrial customers. Since fully half of ERCOT's summer and winter peak loads come from residential customers' weather-sensitive loads, and Texas utilities deliver energy efficiency to fewer than 30,000 homes per year, residential electricity use is an under-utilized efficiency target that can have immediate, strategic impact on peak loads. However, we also include two commercial-sector programs in areas not addressed by most current investor-owned utility programs.

[4] $8 billion or a little more was the 2021 estimate for proposals by Berkshire Hathaway and Starwood Energy (Proctor 2021). $18 billion is an estimate by the Lower Colorado River Authority (Foxhall 2023).

This paper looks at ten specific retrofit and demand response measures selected for their proven capability to reduce summer or winter peak electricity demand. This paper estimates these measures' potential to improve Texas's and ERCOT's system reliability by cutting summer or winter peak loads or delivering grid flexibility services.

Efficiency measures

- Program to replace electric furnaces with ENERGY STAR® heat pumps
- Attic insulation and sealing incentive program
- Heat pump water heaters incentive program
- Smart thermostat incentive program (both an efficiency and demand response program)
- Set of energy efficiency programs serving low-income homeowners and renters, including low-cost kits distributed by community groups and more comprehensive whole-home retrofit programs for single-family homes and multifamily apartments
- Small commercial and industrial retrofit program
- Monitoring-based commissioning program for large commercial buildings[5]

Demand response measures

- Central air conditioner with smart thermostat control
- Water heater
- Electric vehicle managed charging

Most of these measures can be used to reduce peak demand in both the summer and the winter. However, air-conditioner demand response is a summer-only program, small C&I saves a lot more in the summer than in the winter, and electric furnace replacement primarily reduces winter loads and peaks.

If these programs were implemented at wide scale with suitable levels of program investment beginning in 2024, by 2030 they could deliver enough summer peak savings to eliminate nearly 19% of Texas's all-time summer peak (80,038 MW (Woodfin and Ögelman 2022). Similarly, prompt and aggressive efficiency and demand response investments starting in 2024 could reduce 2030 winter peak load by about 30% of what the peak would have been in February 2021 had power been provided to all customers without power shutoffs (estimated 78,000 MW, ERCOT 2021; ERCOT's documented winter peak was 74,427 MW in 2022 [ERCOT 2023b]). The energy efficiency programs will reduce annual electricity consumption by about 14,500 million

[5] Monitoring-based commissioning is a process developed at Texas A&M that uses data from building energy management systems that are common in large buildings, along with some additional strategically placed sensors to help analyze and optimize building operations. Typical energy savings of about 9% can be achieved.

kWh of electricity, equivalent to the annual power draw of about 1,150,000 Texas homes. Savings by year are shown in figure 1.

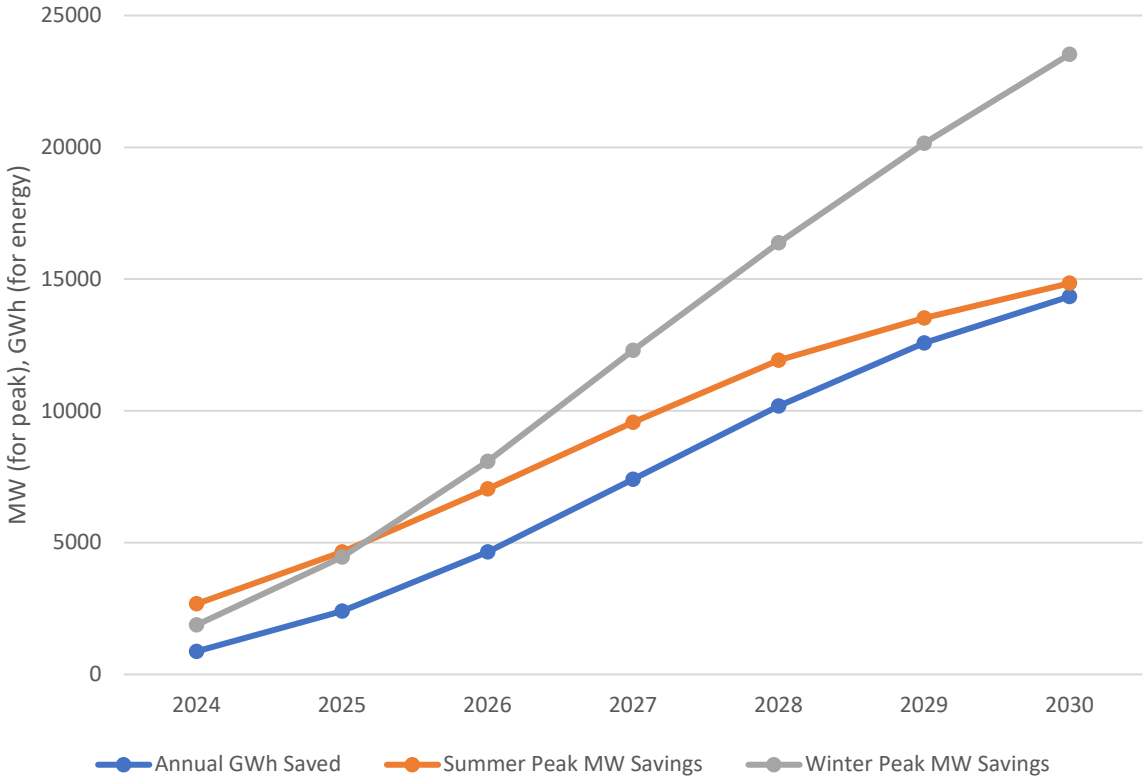
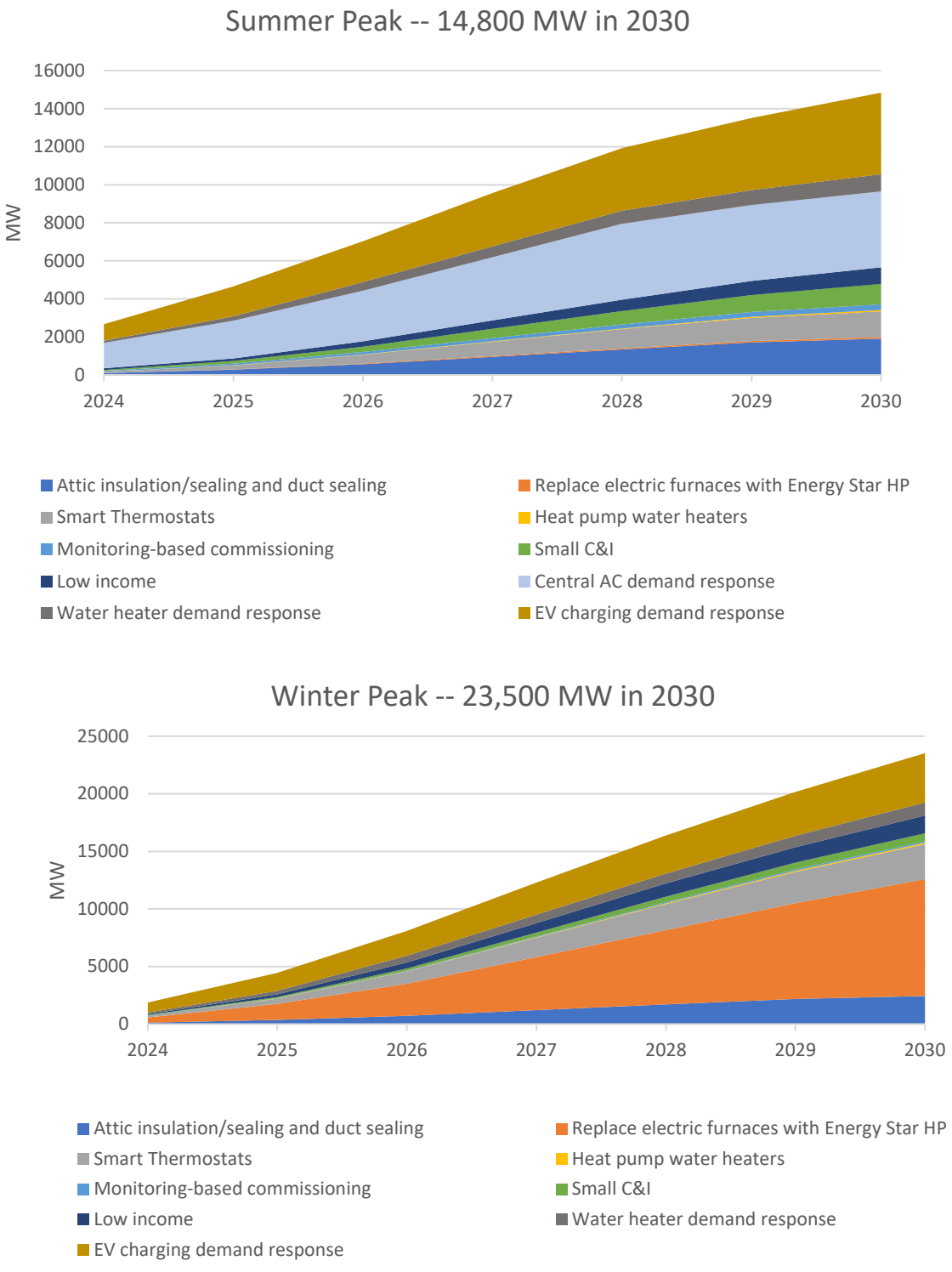


Figure 1. Cumulative annual energy and peak savings by year from the sum of the programs analyzed

Results by program are summarized in table 1 at the end of this summary report. The largest winter peak reductions (over 10,000 MW by 2030) come from replacing electric furnaces with heat pumps. The largest summer peak reductions (about 4,000 MW by 2030) are from central air conditioner demand response. Peak demand reductions by program are illustrated in figure 2. The attic insulation and sealing program delivers the largest energy savings (about 5,000 million kWh in 2030) while also delivering 1,900 summer peak MW and 2,400 winter peak MW in 2030. This program is also valuable because better-insulated homes are more effective for sustainable demand response and occupant comfort. This program accounts for about 40% of the total cost of the ten-program package but is foundational to make heating and cooling measures more effective. The smart thermostat and heat pump water heater programs have the best benefit-cost ratio.

Figures 2 and 3 show how much each energy efficiency and demand response program would contribute to summer and winter peak load reduction. If these programs are implemented with sufficient funding and smart program delivery plans between 2024 through 2030, these measures could cut Texas's summer peak loads by about 14,800 MW and winter peak loads by 23,500 MW. In an important distinction from current Texas demand response programs, these

programs would require the electric utilities to recruit additional new participants every year, not merely maintain current customers.



Figures 2 and 3. Summer peak (top) and winter peak (bottom) demand savings by year and program

The proposed programs will cost about $600 million in the first year (2024), ramping up to about $1.6 billion of spending per year in year four. If these programs were marketed and delivered aggressively over the first four years, spending on the attic insulation program in particular could begin to decline in 2028 as the program starts to saturate its potential market. We recommend that additional efficiency programs be undertaken in 2026 and beyond, to provide additional savings beyond the ten programs we analyze.

Spending by program and year is shown in figure 4. We recommend that the balance of 2023 be used for program planning, with the programs launching in 2024 and expanding in 2025. New federal energy efficiency grant programs could make substantial contributions to these budgets, particularly to the heat pump, heat pump water heater, and attic insulation programs. A forthcoming detailed report (scheduled for summer 2023) will describe all of the programs, including the role of federal funds.

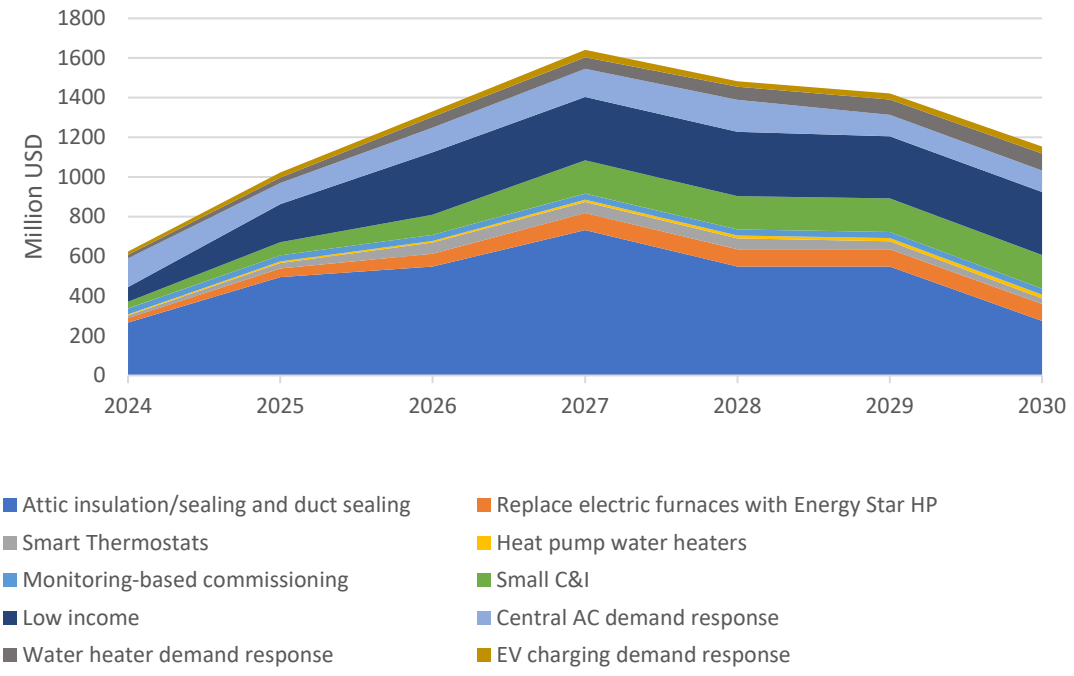


Figure 4. Utility spending by year and program (2023$)

Averaged over the 14.165 million electricity customers in Texas (EIA 2023), the costs of our proposed programs average less than $85 per customer per year, which is about $7 per customer per month. The benefits by 2030 average about $20 per customer per month. Thus, customers get improved power system reliability and net savings on their energy bills.

To put these costs and savings in current perspective, in 2020, Texas investor-owned utilities (which excludes the large municipal utilities serving Austin and San Antonio) spent a total of $128 million on energy efficiency and demand response programs, reducing summer peak demand by 502 MW and electricity sales by 692 million kWh (Frontier Energy 2021). The

programs proposed here are designed to complement and expand the current Texas programs. Current programs emphasize commercial and industrial savings; our programs focus more on residential, including a significant expansion of current low-income program efforts.

While the costs of our proposed programs are substantial in comparison to current efficiency expenditures, they pale in comparison to recent cost increases hitting ERCOT customers' electric bills. Annual transmission congestion costs exceed $2 billion per year ($2.6 billion as of the end of November 2022; Bivens 2022) and ERCOT is spending about $3 billion per year in scarcity payments to assure that enough power plants are standing in reserve to cover sudden thermal plant outages, a drop in renewable generation, or a surprise jump in demand over forecast levels (Lewin 2023). The expanded efficiency and demand response programs will cost a fraction of the cost of new power plants, which will deliver capacity and energy relief more slowly due to construction time and incur additional annual costs for fuel and maintenance.

The energy efficiency and demand response program budgets modeled include annual utility operating costs. Over the life of these measures, the average cost of these energy savings is about 4.8 cents/kWh, just over half the 9.1 cents/kWh avoided cost estimated by the Public Utility Commission of Texas (Harris 2022) and less than half the 13.55 cents/kWh average residential electric rate in Texas in 2022 (EIA 2023). And when extreme Arctic storms or summer heat waves strike, these measures will already be installed in homes, protecting Texans and posing no deliverability challenges.

Cost Effectiveness and Getting the Most Bang per Dollar

The programs we propose cost less than half as much as their "avoided cost" as estimated by the Public Utility Commission of Texas (Harris 2022) and therefore will save Texas ratepayers at least two dollars or more for every dollar spent on energy efficiency and demand response.

We calculated a benefit-cost ratio for each program and overall. As a group, the benefits of these programs are nearly 2.9 times greater than the costs. The ratio is a little higher (better) for the energy efficiency programs (over 2.9) than for the demand response programs (2.5) since the efficiency programs avoid both peak demand and energy costs and deliver savings year after year. Benefit-cost ratios for individual programs are illustrated in figure 4 and range from over 10 (EV charging demand response), to not quite one (for water heater demand response). In addition to EV charging demand response, Texas should prioritize highly cost-effective programs (benefit-cost ratio greater than four): heat pump water heaters, smart thermostats, heat pumps to replace electric furnaces, and monitoring-based commissioning of large commercial buildings.

Texas should also prioritize the attic insulation program because insulation delivered under that effort makes the heating, air conditioning, and smart thermostats installed in the same home more effective for customer comfort and savings.

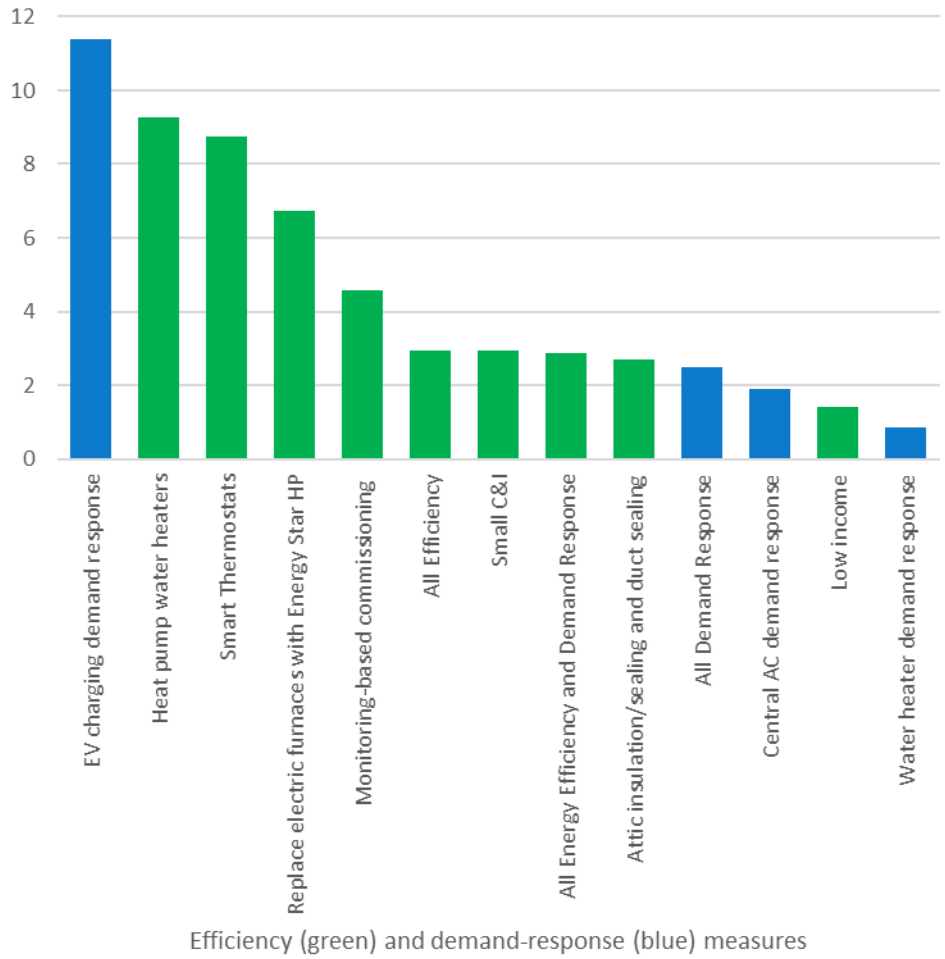


Figure 5. Benefit-cost ratios for individual programs and for all EE and all DR programs

Private Sector Roles

We recommend that distribution utilities be in charge of these programs since they serve all the customers in a specific geographic area and can use economies of scale and geographic targeting to help reduce costs. Retail energy providers could be allowed to offer these services to their customers, preferably offering comprehensive services that serve all customers under the same program rules and cost allotments as the utilities. Short of this, retail providers could offer a much more limited program focused only on smart thermostats. Even where distribution utilities oversee the programs, most of the costs will be for private-market program support contractors and installation contractors such as insulation and air-conditioning contractors.

Workforce for Energy Efficiency and Demand Response

These expanded EE and DR programs will require thousands of workers, ranging from insulation installers to skilled engineers. These programs provide an opportunity to create many high-skilled, Texas-based jobs, as installation of measures cannot be imported. We gradually ramp-up participation in our analysis in order to permit a growing workforce to be hired and trained.

Training for providing these efficiency services can be leveraged using state and local job training programs, including the expanded state-based home energy-efficiency contractor training funded in the federal Inflation Reduction Act of 2022. These programs will be led by the Texas State Energy Conservation Office. There will also be increased demand for heating and air-conditioning technicians, and we recommend increased efforts to train these technicians via high school and community college technical training programs as well as via combined classroom and apprenticeship programs.

Conclusions

This preliminary analysis is intended to offer approximate estimates for what energy efficiency and demand response could accomplish quickly in Texas. Additional analysis will be needed. ACEEE is prepared to conduct a more detailed analysis looking more fully at program costs, load shape impacts, rate impacts, and employment impacts (e.g., these investments will create many jobs).

The bottom line is that the energy efficiency and load management programs examined will deliver large benefits to Texas consumers and utilities. Consumers will benefit from the following:

- **Reduced peak demand in summer and winter** will enhance grid reliability by better balancing power demand and supply and creating more grid flexibility tools with demand response. These measures will make Texas much less likely to reach the demand-supply imbalance that triggers power curtailments. And these efficiency and demand response measures continue to work in extreme weather, unlike some of Texas's power plants.
- **Lower energy bills** (due to reduced consumption and reduced need for utility capital expenditures) will be useful for all Texas households but particularly useful for low- and moderate-income Texas households who often face high energy bills as a percentage of their income. At the avoided cost of energy and capacity, all Texas consumers will save approximately $24 billion on their electricity bills over 2024–2030, with about $2.5 billion accruing to low-income households.
- **Improved occupant comfort, safety, and health** because insulation and sealing will make homes more comfortable and better able to retain temperatures during power outages, among other non-energy benefits.

These ten programs, executed at speed and scale, can reduce Texas winter peak demand by over 23,500 MW and summer peak demand by nearly 14,800 MW by 2030 for an estimated cost averaging $1.2 billion per year. This is substantially less than the cost of building ten new gas plants, even before adding on the costs of gas plant fuel and maintenance as well as risks of plant non-performance or fuel shortages. As efficiency delivery spreads to more customers and communities, these savings will also reduce ERCOT's congestion and operating scarcity costs over time.

Utilities will see reduced capital needs because lower demand will decrease needed transmission and distribution investments. ERCOT and Texas residents will benefit from a more reliable grid that is less vulnerable to increasing extreme weather events.

These measures focus mostly on residential energy efficiency retrofit measures, since Texas's large stock of old, inefficient homes is where much of the state's energy waste is occurring. While we include two commercial programs, there are substantial additional opportunities for commercial and industrial energy efficiency and demand response savings. Also, since Texas's population and economy are growing at robust rates, Texas can and should capture additional long-term energy savings and avoid locking in additional energy waste by adopting more rigorous energy efficiency standards for all new building construction.

Texas is now at a crossroads. The state can continue down the same path that led to massive power outages in February 2021 and more limited curtailments in 2022. Or Texas can diversify its energy portfolio by tapping the huge potential of inefficient homes, buildings, and appliances to create energy efficiency and demand response resources that save money and improve reliability for all Texans.

Table 1. Estimated 2024–2030 costs, savings, and households served for ten energy efficiency and demand response programs targeting peak demand reductions

Program	Customers Served	Peak Savings in 2030 (MW) Summer	Winter	Energy Savings (GWh)	Costs ($million)
Efficiency					
Replace electric furnaces with Energy Star HP	602,933	86	10,154	1,281	$302
Attic insulation/sealing and duct sealing	2,180,980	1,907	2,435	4,992	3,420
Smart Thermostats	2,764,622	1,355	3,029	2,488	276
Heat pump water heaters	299,385	69	120	636	82
Monitoring-based commissioning	735	300	125	1,315	215
Small C&I	86,301	,077	718	2,734	876
Low-income (sum of 3 subprograms)	2,224,912	869	1,532	2,012	1,816
Subtotal	8,159,868	5,663	18,114	15,459	6,987
Demand Response					
Central AC demand response	2,611,032	3,988	-		896
Water heater demand response	2,224,000	904	1,130		389
EV charging demand response	750,000	4,286	4,286		132
Subtotal	5,585,032	9,178	5,416		1,417
TOTAL	13,744,900	14,841	23,530		8,403
Add 13.75% reserve margin		16,882	26,765		

***These totals include some households that participate in more than one program.**

Notes: These savings are for all of Texas and include investor-owned utilities, large municipal utilities (Austin Energy and CPS Energy, both of which are already implementing many of these programs), and smaller coops and municipal utilities. ERCOT serves about 90% of this load and thus multiplying the figures in this table by 90% will approximate the ERCOT impacts.

The allowance at the bottom for reserve margin reflects the impact of reduced demand on needed generating capacity. ERCOT's board has established a 13.75% minimum reserve margin (ERCOT 2023c); we use this figure for our calculation.

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