Impact of Demand Side Management in ERCOT

May 1st, 2025

Prepared for the Texas Association of Business and South-central Partnership for Energy Efficiency as a Resource

Context for this report

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- **This report, prepared for the Texas Association of Business (TAB) and South-central Partnership for Energy Efficiency as a Resource (SPEER), is an assessment of the role of demand side management programs in ERCOT.**
- **The report analyzes demand response (DR) and energy efficiency (EE) and the potential impact on market outcomes from increase demand response participation and increased heat pump adoption.**
- The purpose of this study is to provide independent analysis, informing policymakers on how demand side management could impact the ERCOT market by **enabling continued economic growth in Texas while maintaining affordable prices and grid reliability.**
- Aurora modeled three unique scenarios to evaluate the impact of demand side management:
  1. **Aurora's Central Case**, which assumes a continuation of existing policies at the state and federal levels and is the reference case
  2. **Increased Heat Pump Adoption**, which models increased levels of heat pump adoption as a % of residential homes
  3. **Demand Response Participation**, which increases the amount of demand response participation from residential and industrial customers

Disclaimer

- **This analysis is a deterministic evaluation under certain weather and system conditions.** Weather conditions and generation outages are modeled based on past observed system behavior to evaluate key system metrics under similar conditions in the future, once load growth and expected capacity additions are considered. The forecasted capacity build and impact of market design changes is based on projected economics. We do not assign probabilities to each outcome.
- **This report does not advocate for any specific policy or market design change** but rather aims to evaluate the impact of the proposed changes to system reliability, pricing, and emissions.

Sources: Aurora Energy Research, ERCOT

Agenda

Executive Summary

1 ERCOT has been able to meet rapidly rising demand in recent years due to its interconnection process, but accelerating growth driven by data centers presents a new challenge

- Texas has experienced some of fastest load growth in the country, fueled by population growth, industrial and oil & gas activity, and emergent demand from data centers and bitcoin mining.
- ERCOT has a unique "connect-and-manage" approach to interconnection, leading the country on new capacity additions. This has allowed the grid to match load growth with capacity, despite record setting weather and peak load in recent years.
- Demand growth is expected to accelerate, driven by increases in population, industrial activity and data centers.

2 As supply chain and transmission constraints limit new capacity additions, demand side management can play a crucial role in helping ERCOT meet demand while keeping cost low

- Energy Efficiency (EE), in particular via the adoption of heat pumps, can reduce energy usage to achieve the same level of output through installation and use of more efficient technologies.
- Demand response (DR), provide an additional level for ERCOT via an energy flexibility program for business and commercial customers to reduce energy consumption in response to tight grid conditions in exchange for compensation.

3 Adoption of further energy efficiency and demand response programs would sharply reduce power bills for consumers and effectively reduce the risk of power outages during periods of highest system stress

- In a "Demand Response Participation" scenario, load shed in 2030 can be reduced by 3.5GW with 10% industrial DR participation and eliminated with 50% participation. An industrial consumer's costs decrease by $7 million and a residential customer could save up to $485 by participating in a demand response program.
- In an "Increased Heat Pump Adoption" scenario, with 50% adoption across all residential homes, load shed can be almost completely mitigated in a 2030 winter storm. Residential consumers can save almost $500 and industrial consumers close to $2 milllion on their annual electricity costs.

1) Representative of a 100MW baseload industrial consumer.

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As an attractive market for economic development and data center siting, expectations for load growth in Texas are strong

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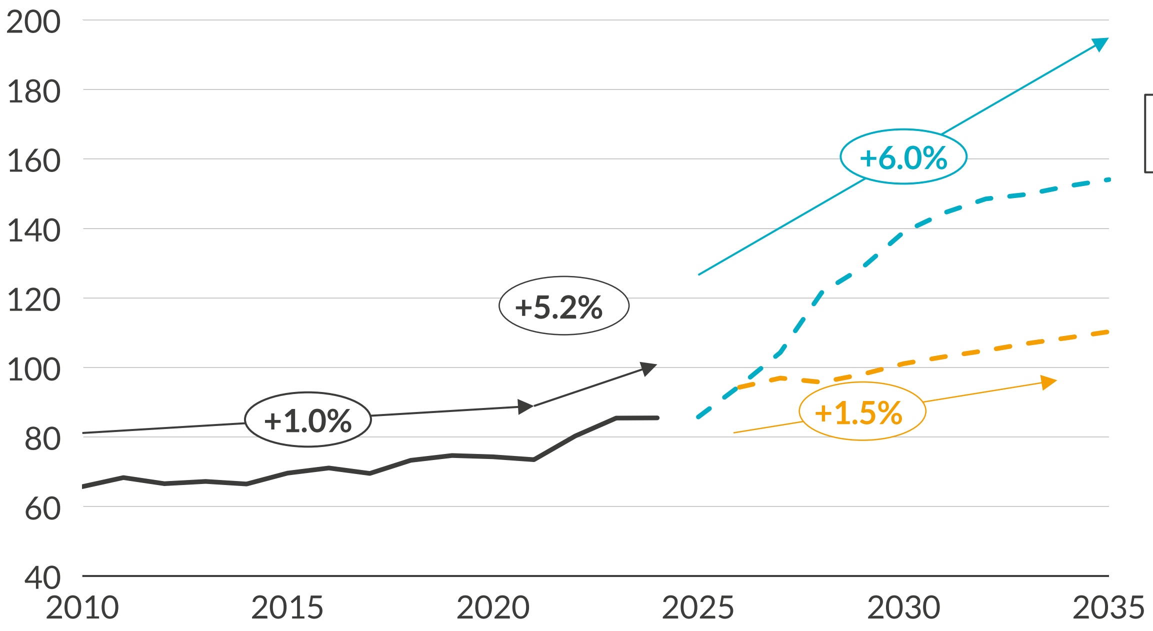
1 Data center and industrial load growth are driving a sharp increase in peak demand, regardless of the scenario considered

ERCOT Peak Load
GW

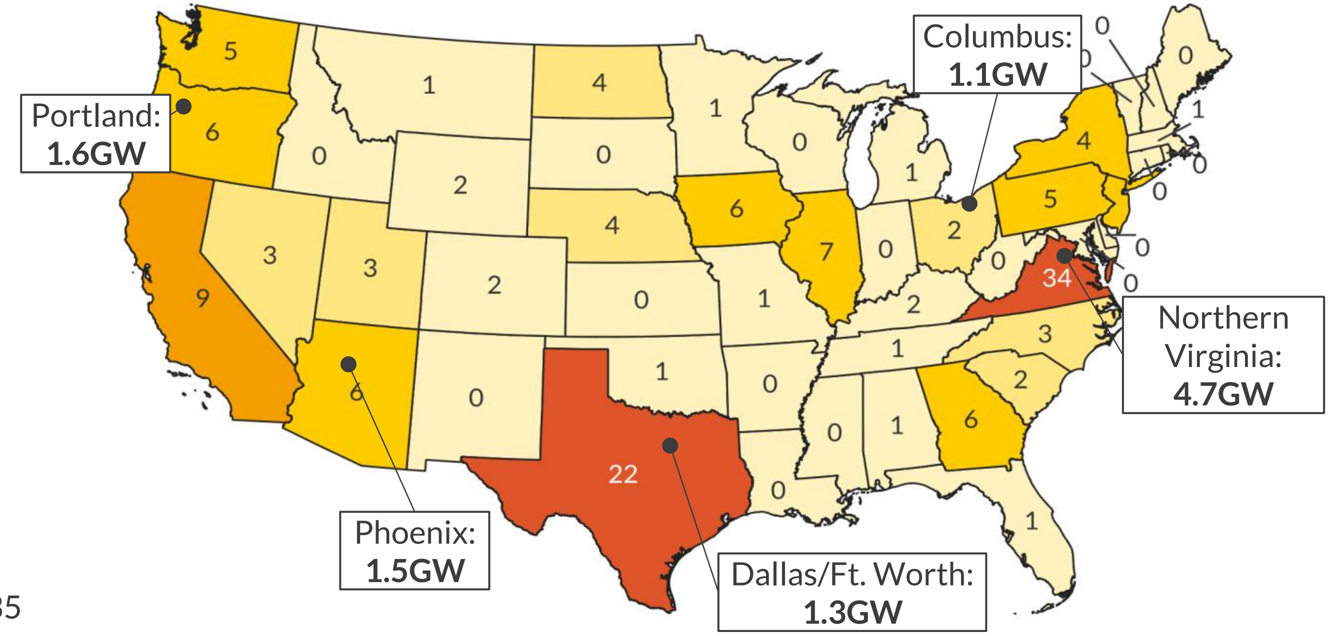


- In recent years, demand growth has been growing sharply, driven by population growth, heavy industrial electrification, data centers and bitcoin mining, and extreme weather.
- This trend is expected to continue at an even faster rate in the ERCOT 2025 Long Term Load Forecast due to higher data center and industrial load growth.

ERC25 LTLF[1] Historical Aurora Central

2 Texas has been a popular target for datacenter investment historically and remains an attractive market for future expansion

Total annual datacenter load by state and cluster[2] (2023)
TWh



- Texas has benefitted from competitive power prices, land availability, and areas with high renewables share and low emission intensity, making it attractive for datacenter investment.

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1) ERCOT Adjusted 2025 Long-Term Load Forecast. 2) Top 5 clusters by operational IT load (2023) shown for clarity.

Sources: Aurora Energy Research, National Weather Service, ERCOT, EIA

Substantial capacity buildout has enabled ERCOT to meet this recent load growth, driven by the fastest interconnection queue in the United States

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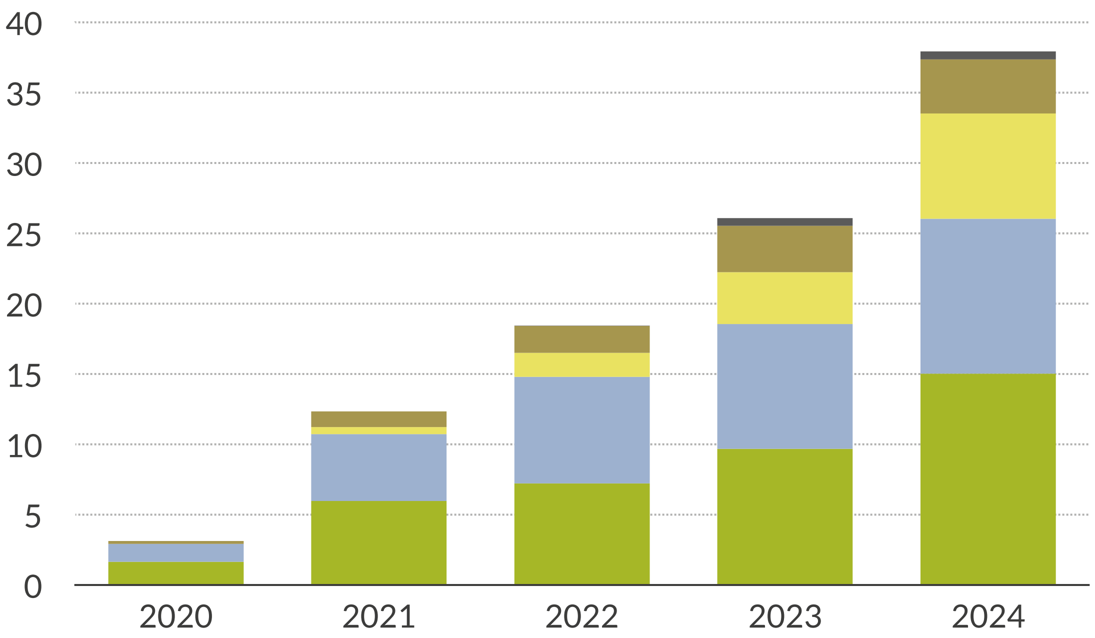
1 ERCOT has added nearly 38GW of new capacity since 2020, consisting primarily of renewables and flexible capacity

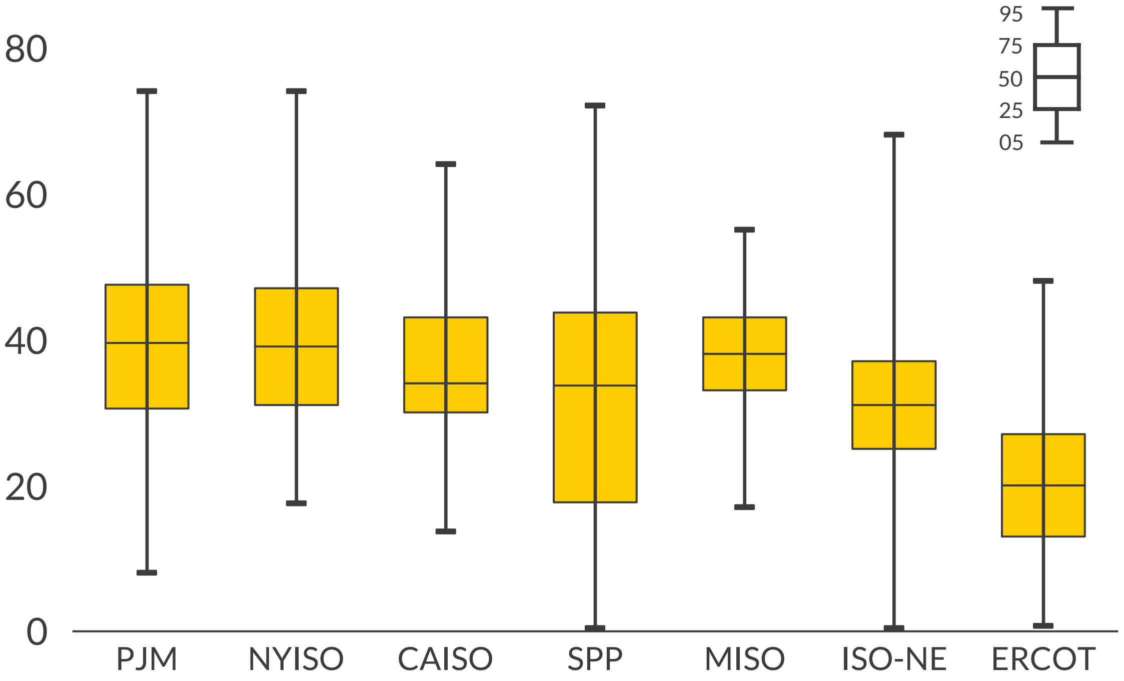
Cumulative historical new capacity in ERCOT
GW



- Driven by ERCOT's "connect-and-manage" approach to interconnection, nearly 38GW of new capacity was added from 2020 – 2024, the fastest rate of renewables growth in the country.
- This rapid capacity expansion has been instrumental in facilitating demand growth in the state.

2 This growth has been achieved due to ERCOT's pace-setting interconnection process, fastest in the United States

Duration, Interconnection Request to Agreement by market, (2018–2023)[2]
Months



- Since ERCOT is not synchronously interconnected to other grids, it is the only market in the US that is not subject to direct regulatory oversight from FERC.
- ERCOT's streamlined process has enabled faster project development, contributing to its position as the fastest market for interconnection in the United States.

1) Historical operational reserves are calculated as reserves available during net peak demand divided by net peak demand. 2) Sample includes 3,864 projects from seven ISO/RTOs and five non-ISO balancing areas with executed interconnection agreements since 2005.
Sources: Aurora Energy Research, ERCOT, NYISO, ISO-NE, PJM, MISO, CAISO, SPP

Thermal supply chain constraints could prevent additional gas plants from being built to enable growing demand

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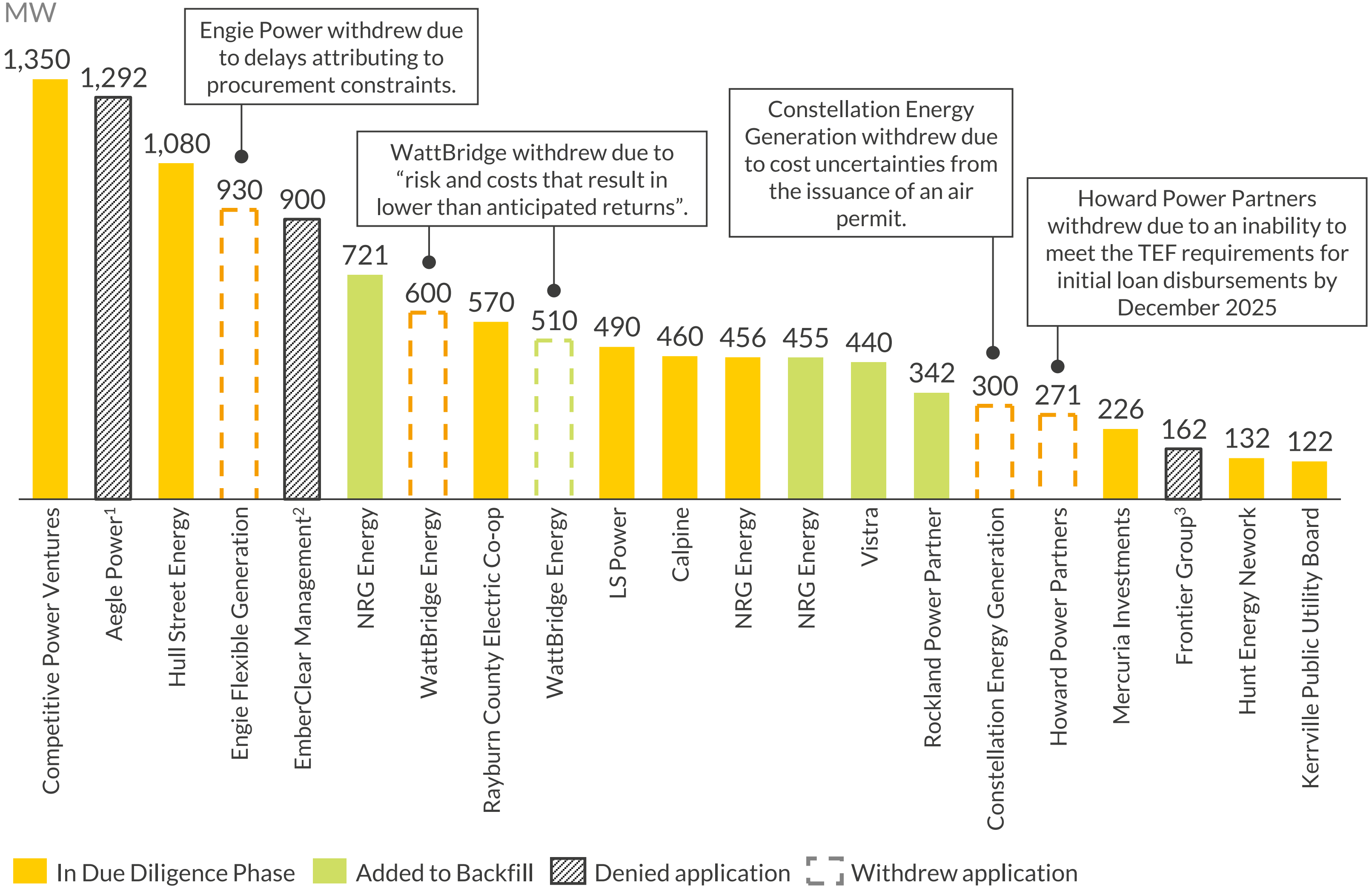
Thermal supply chain challenges and recent impacts

- Manufacturing **capacity for gas-turbine generators may not be sufficient** to cover the needs of a rapidly growing power sector.
  - Major gas turbine manufactures such as GE Vernova, Siemens and Mitsubishi Power are receiving high order volumes and pushing **delivery times to 2029 and beyond.**
  - The Texas Energy Fund, and its corresponding low interest loan program established for the construction of new gas plants, has recently seen projects drop out, citing an inability to comply with program timelines due to **supply chain delays**.
- **Why does it matter?**
  - The reliability of the grid is dependent on having sufficient supply to meet demand. If load continues to grow and supply chain constraints limit thermal capacity, the grid is at **an increased risk of a capacity shortfall**, which could lead to forceable load shed and power outages.

Approved dispatchable generation projects recommended by PUCT staff by capacity by company
MW



1) Aegle Power's application was denied in September 2024 due to fraud allegations. 2) EmberClear's application was denied, and they received a notice of deficiency. 3) Frontier Group's project was denied because it "failed to meet due diligence requirements"

Sources: Aurora Energy Research, Heatmap

Demand side management programs may be an effective way to enable economic growth in Texas, focusing on energy efficiency and demand response

	Energy Efficiency (EE)	Demand Response (DR)
Purpose	**Reduce energy usage** to achieve the same level of output through installation and **use of more efficient technologies**.	**Energy flexibility program** for business and commercial customers to **reduce energy consumption** in response to tight grid conditions **in exchange for compensation.** Demand response improves operational flexibility by providing an additional lever to grid operators to balance supply and demand.
Design	Reduced energy usage, commensurate to technological improvements and application. **Energy savings may be magnified during specific periods**, (i.e., heat pumps for heating demand vs resistance heat).	Participants are notified through a signal from the grid operator or utility, alerting them of an upcoming event. A **call to reduce electricity usage** triggers energy consumers to respond to **avoid power charges during peak hours**.
Implementation	Most benefits should be **realized automatically** after new efficiency improvements are installed.	Participants can **monetize flexible energy** usage via a reduction of load or by **shifting consumption** to behind the meter generation. May be enabled through smart grid solutions that use digital technology and artificial intelligence to monitor, control, and optimize electricity use according to price signals.
Examples	Heat pumps, adding insulation to buildings, replacing windows, energy-efficient appliances, smart thermostats, energy-saving practices	Industrial participation (4CP) during peak hours, residential demand response programs, ERCOT Emergency Reserve Service (ERS)

Sources: Aurora Energy Research, ERCOT

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Aurora modeled the impact of increased demand response and heat pump adoption on power prices and reliability

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As per *Aurora Central* scenario unless otherwise indicated		Aurora Central	Demand Response (DR)	Heat Pump Adoption (HP)	2022 Weather Year (WY)
Demand	Underlying demand	+25GW peak load growth to 2035 driven by population and industrial growth	• **Residential/Commercial:** 14GW participation, resulting in 3.5GW of demand response by 2030 • **Industrial:** 10% of datacenters responsive to price signals, 50% available to ERS[1]	Higher numbers of heat pumps are built and/or retrofitted relative to Aurora Central, resulting in lower electricity consumption from residential heating	Base demand and capacity identical to the Aurora Central and the DR and HP scenarios and adjusted for weather impact.
	Bitcoin mining	3GW of mining load and bitcoin price of $60,000 held constant through forecast			
	Data centers	7GW by 2030, 8+ GW by 2035			
	EVs	2.3GW in 2025, 3.5GW by 2030			
Weather Year Methodology	Reference year	2013 (Moderate Weather)	2013 (Moderate Weather)	2013 (Moderate Weather)	Winter Storm Elliot (Cold Winter) Hot Summer
Technology	Renewables	Late-stage development projects are assumed to reach commercialization. Long-term, renewables build based on economic signals			
Policy	Intended objective	Continue the status quo. Demand side response participation and heat pump adoption continue at historical levels	Increase the amount of demand response participation from both residential and industrial (data center) customers	Test the impact of increased heat pump adoption on market prices and reliability	
	Renewables incentives	Inflation Reduction Act provisions for wind, solar and battery out to 2035.			

1) Emergency Response Service

Sources: Aurora Energy Research, ERCOT

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Demand Response scenario | Aurora modeled Demand Response (DR) programs in the industrial (datacenters) and residential/commercial sectors

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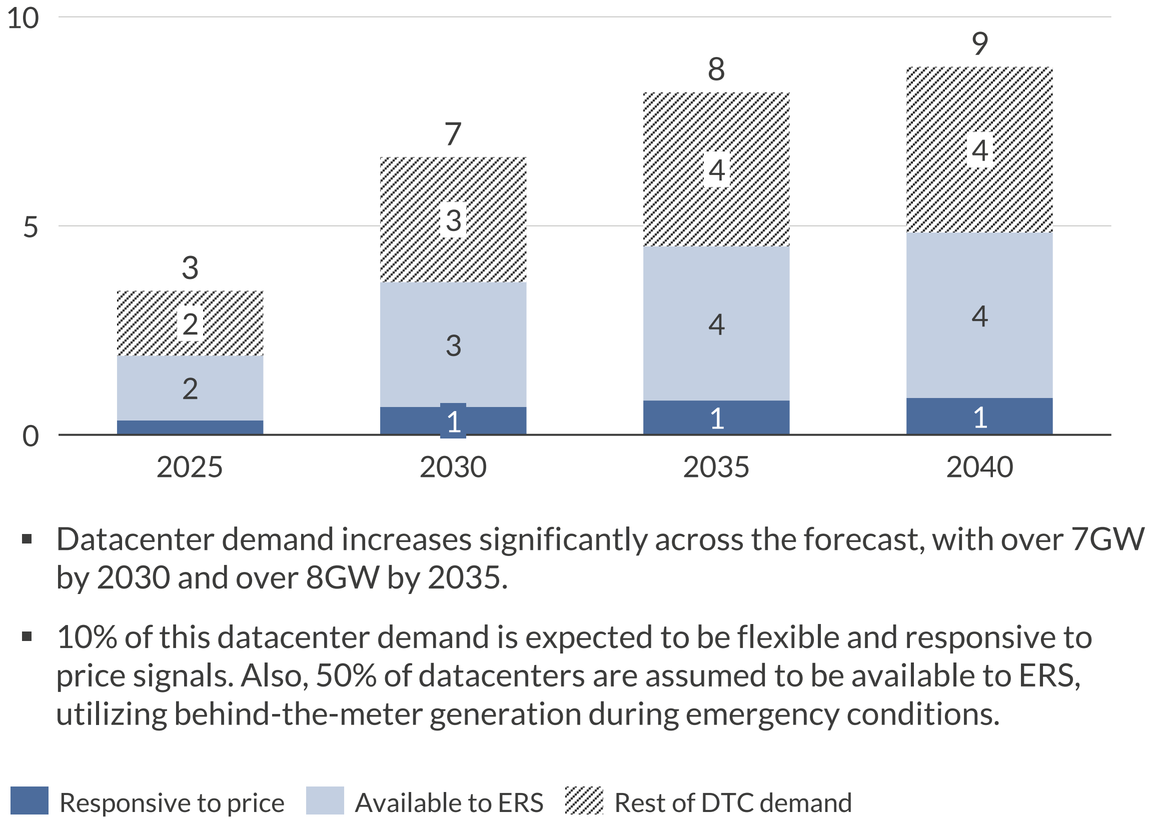
Central In the Central Demand Response scenario, Aurora models Demand Side Response programs in two main sectors:

Industrial assumes 10% of datacenter demand is responsive to price signals, and 50% of datacenter demand is available to ERS[1]

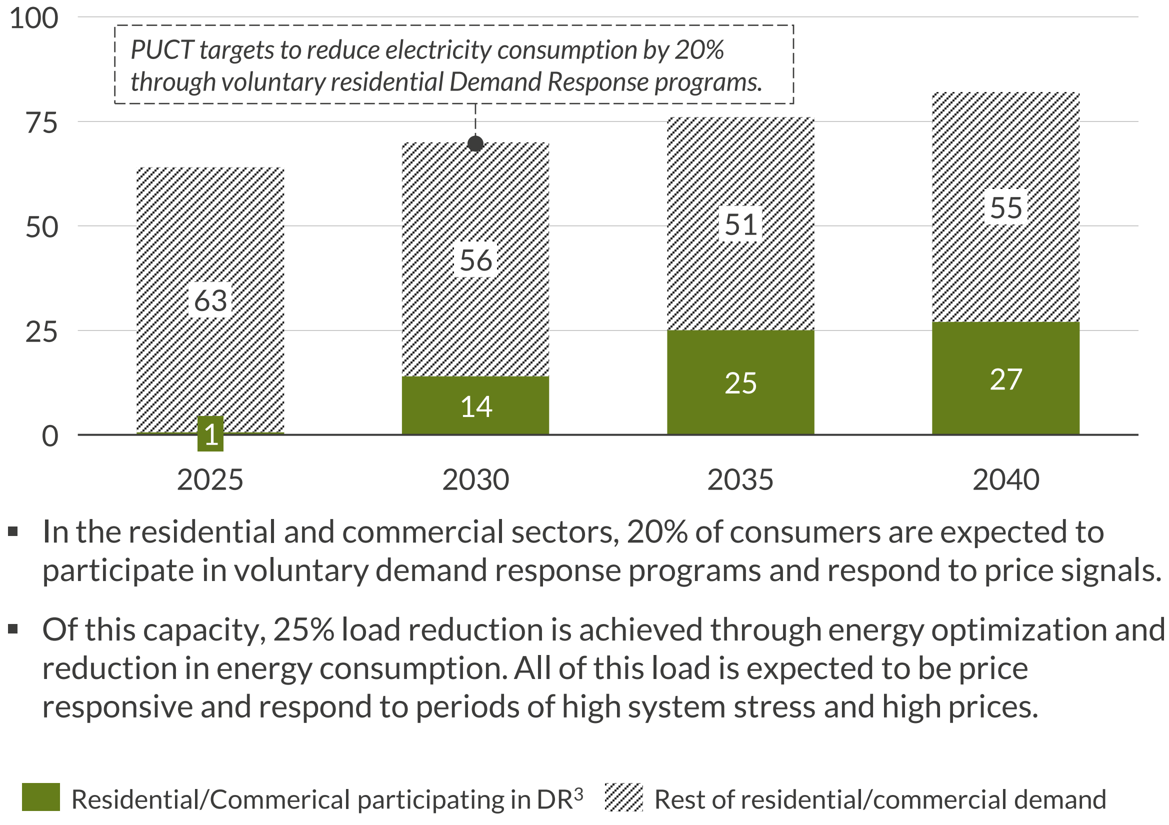
Aurora Central datacenter demand forecast
GW



- Datacenter demand increases significantly across the forecast, with over 7GW by 2030 and over 8GW by 2035.
- 10% of this datacenter demand is expected to be flexible and responsive to price signals. Also, 50% of datacenters are assumed to be available to ERS, utilizing behind-the-meter generation during emergency conditions.

Residential/Commercial assumes 20% residential/commercial Demand Response participation by 2030 with 25% load reduction to mimic impact of TDSP[2] programs

Aurora Central residential/commercial demand forecast
GW



- In the residential and commercial sectors, 20% of consumers are expected to participate in voluntary demand response programs and respond to price signals.
- Of this capacity, 25% load reduction is achieved through energy optimization and reduction in energy consumption. All of this load is expected to be price responsive and respond to periods of high system stress and high prices.

1) Emergency Response Service 2) Transmission Distribution Service Provider

Demand Response scenario | 7.7GW of Demand Response is integrated into the system by 2040, reducing the need for new generation by 1GW

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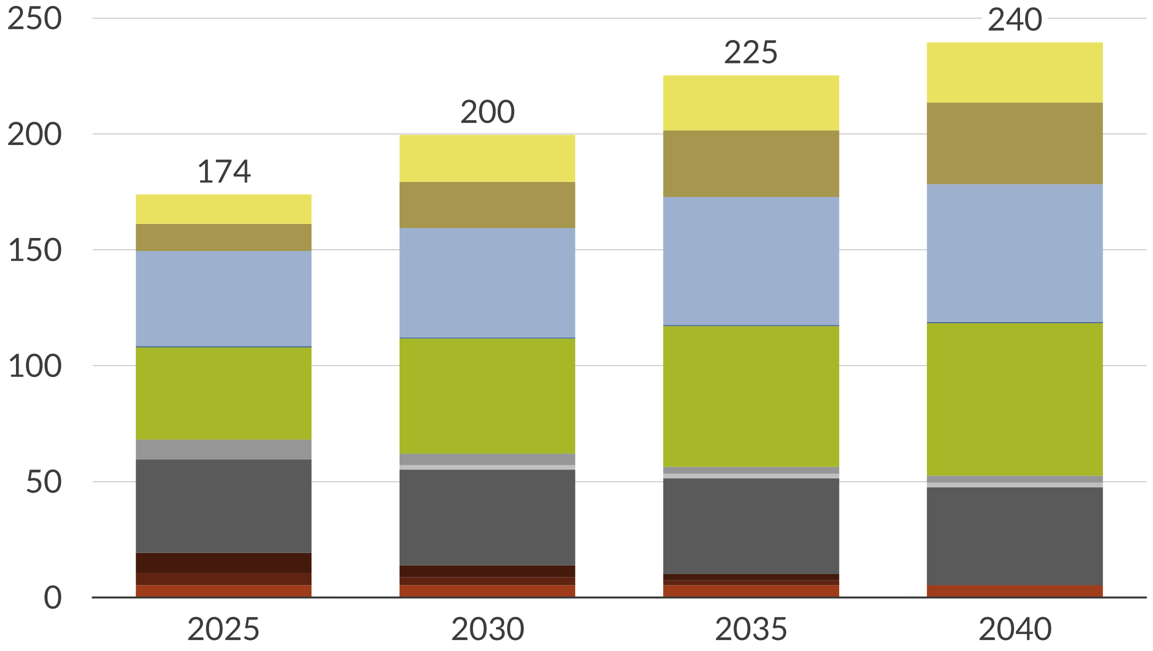
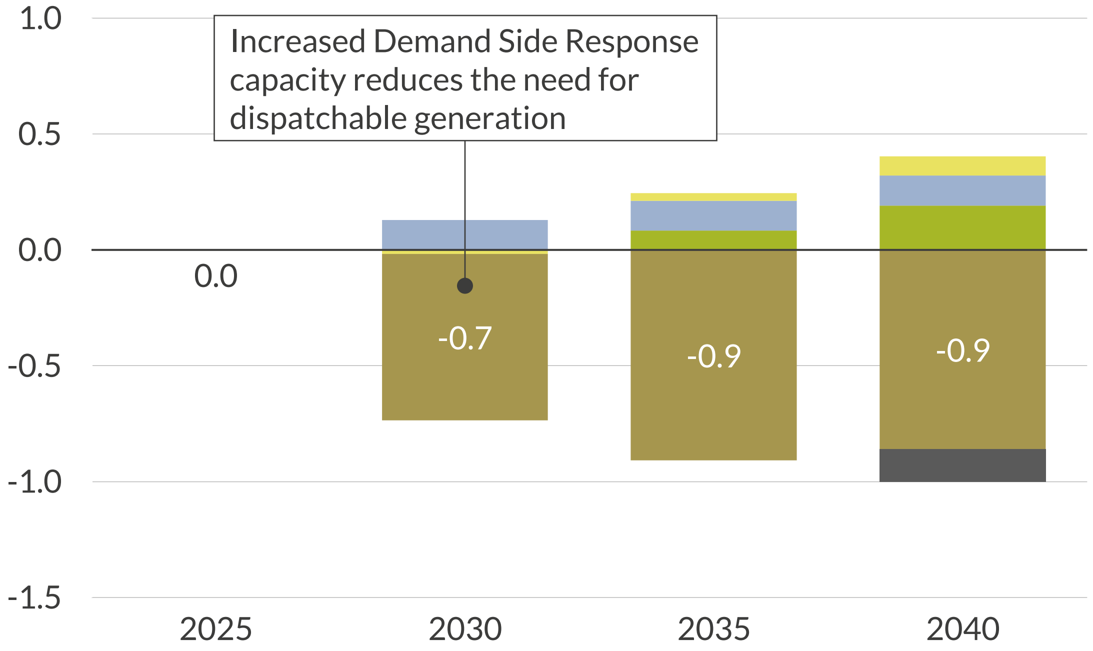
Aurora Central[1] "Status Quo" capacity stack
GW



- Installed capacity more than doubles across the horizon, driven by the growth of renewables, peaking, and battery capacities.
- Conventional capacity declines by 15.5GW from 2025 to 2040 as coal, lignite and steam gas turbine capacity retires with no new build replacement.

Capacity delta to Central
GW



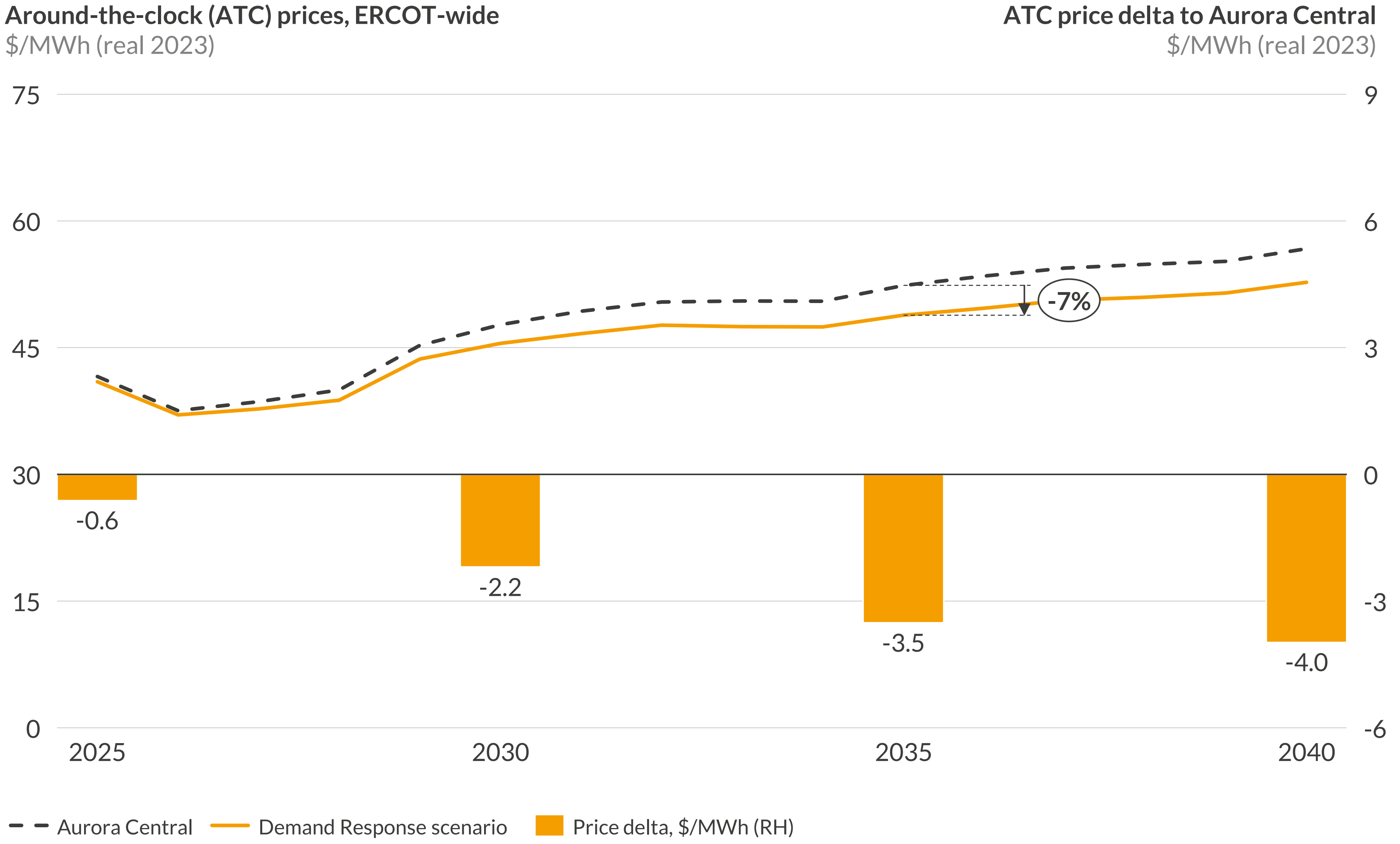
- In the Demand Response scenario, 7.7GW of demand side response capacity - including both residential and industrial consumers - is added to the system by 2040.
- Demand Response serves as a substitute for peaker generation, resulting in a 1GW reduction of gas-fired capacity built by 2040.

Nuclear | Lignite | Coal | Gas CCGT | Gas CCS | Other thermal | Solar | Other RES[2] | Hydro | Onshore wind | Gas / oil peaker[3] | Battery storage

1) Aurora Central 2025Q2. 2) Includes biomass 3) Gas / oil peaker includes CT and reciprocating engines.

Sources: Aurora Energy Rresearch

Demand Response scenario | Demand response programs reduce grid stress during peak hours and put downward pressure on prices



- Demand Response programs curtail load or shift usage in response to grid signals or price incentives, helping reduce demand during peak periods when prices are highest.
- This flexibility flattens the load curve and leads to lower wholesale prices – on average, ATC prices in the Demand Response scenario are $3/MWh lower than Aurora Central.

Sources: Aurora Energy Research

Demand Response scenario | Increased Demand Response participation can save industrial consumers $1.9M/yr and residential consumers $225 per year

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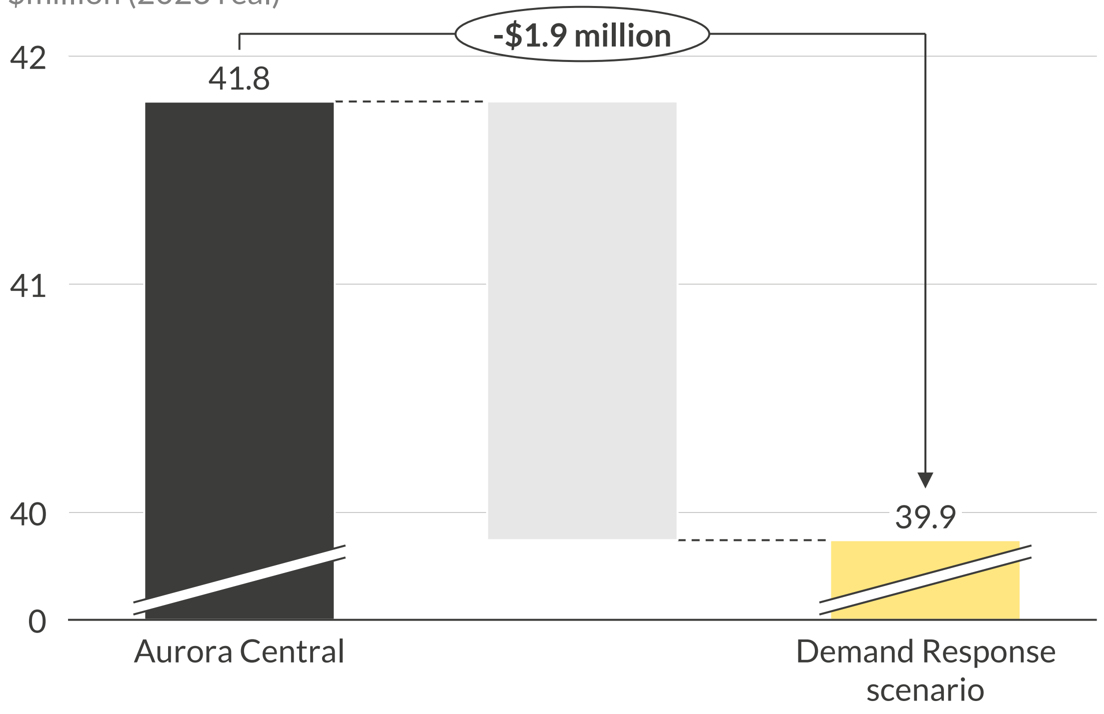
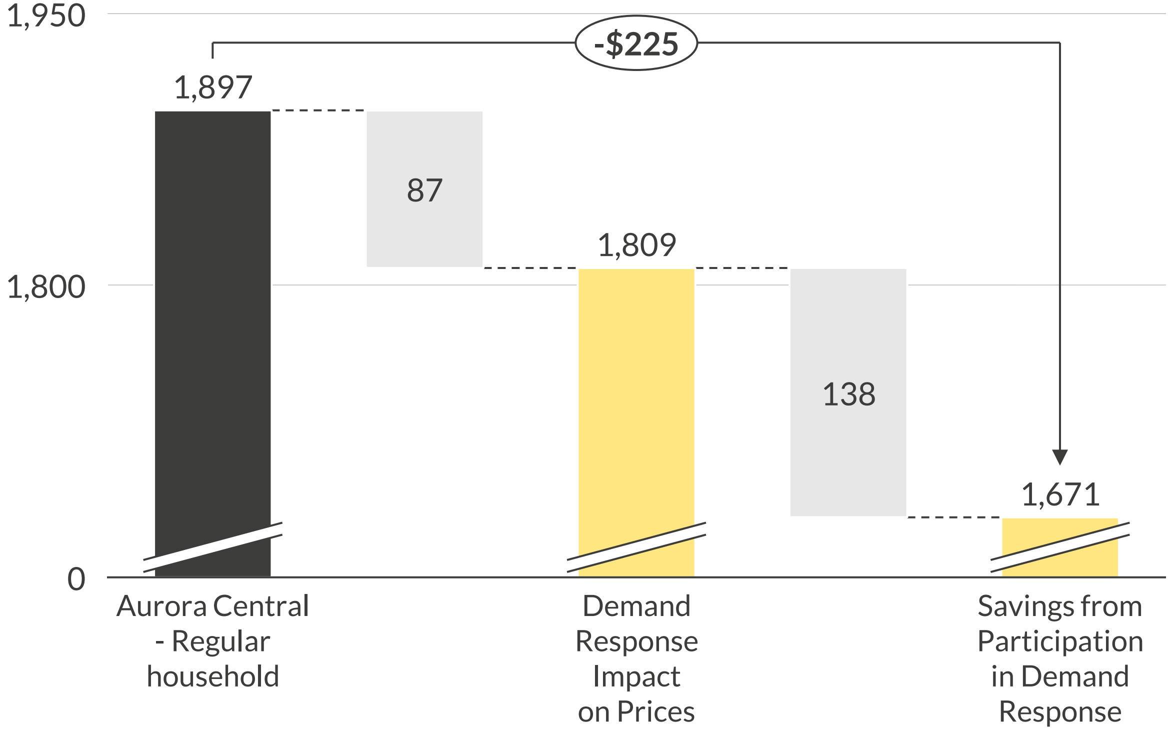
Electricity cost to an industrial consumer, 2030[1]
$million (2023 real)



Electricity cost to an average Texas household, 2030[2]
$ (2023 real)



- In the Demand Response scenario, as increased demand response programs help smooth demand and reduce prices during peak hours, wholesale electricity **costs decrease by $1.9M (-4.6%)** per year in 2030 for a 100MW baseload industrial customer.

- The addition of demand response programs lowers power prices across ERCOT, resulting in approximately $87 in annual electricity savings for an average Texas household, regardless of whether they participate in the programs. Households that do participate in demand response programs can expect to save an additional $138 per year due to reduced electricity consumption.

1) Includes wholesale costs for a 100MW industrial customer. Assumes exposure to ERCOT-wide average power prices. Does not include transmission costs. 2) Assumes a 75% retail markup to energy, and that the energy component makes up 60% of the total rate. Assumes the average household consumes 1,120kWh per month.

Sources: Aurora Energy Research, EIA, Energy Texas

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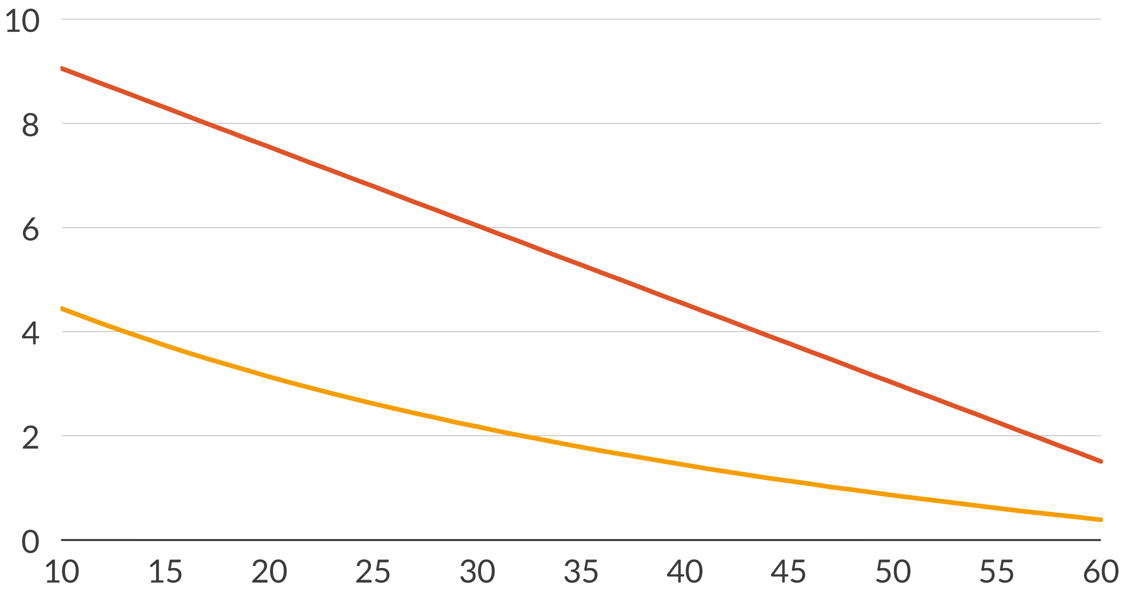
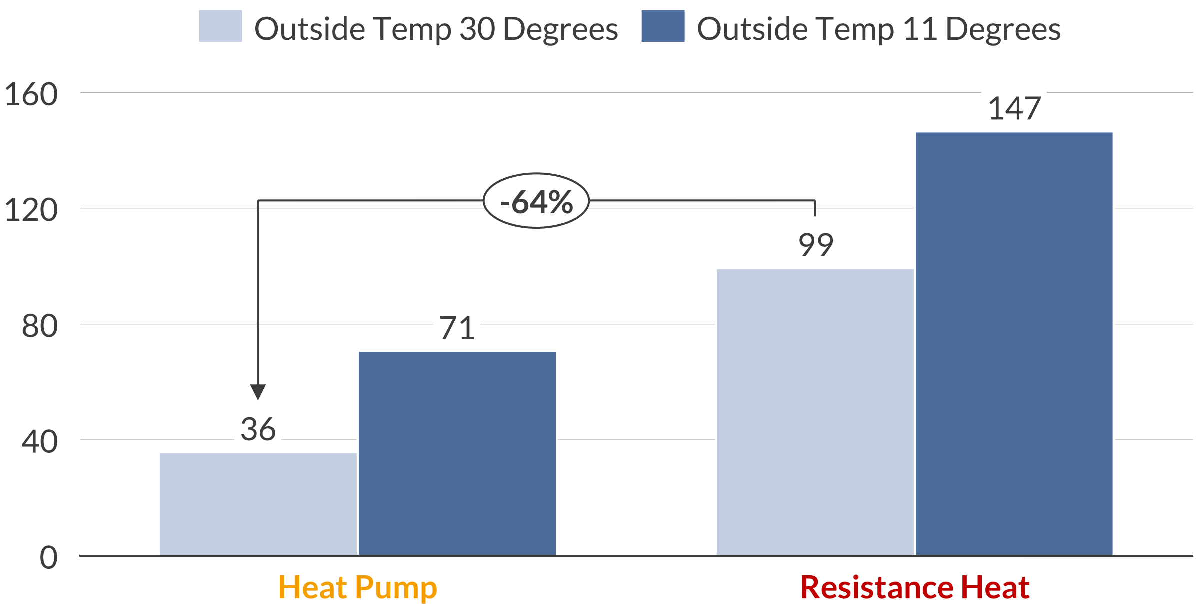
Heat Pump scenario | Heat pumps require 64% less energy to heat a home during the winter relative to traditional resistance heating

Electricity required to heat a home[1]
kW



Electricity required to heat a 50 building apartment[2]
kW



- **Resistance heat** converts electricity to thermal energy directly, while a heat pump works like an air conditioner in reverse. The **efficiency of resistance heat is limited to 100%,** while heat pumps can achieve much higher efficiencies across the normal range of operating temperatures.
- For houses that use heat pumps, this translates to lower household electricity use in wintertime, which **helps lower residential electricity bills and reduces strain on the electricity grid** during winter storms.

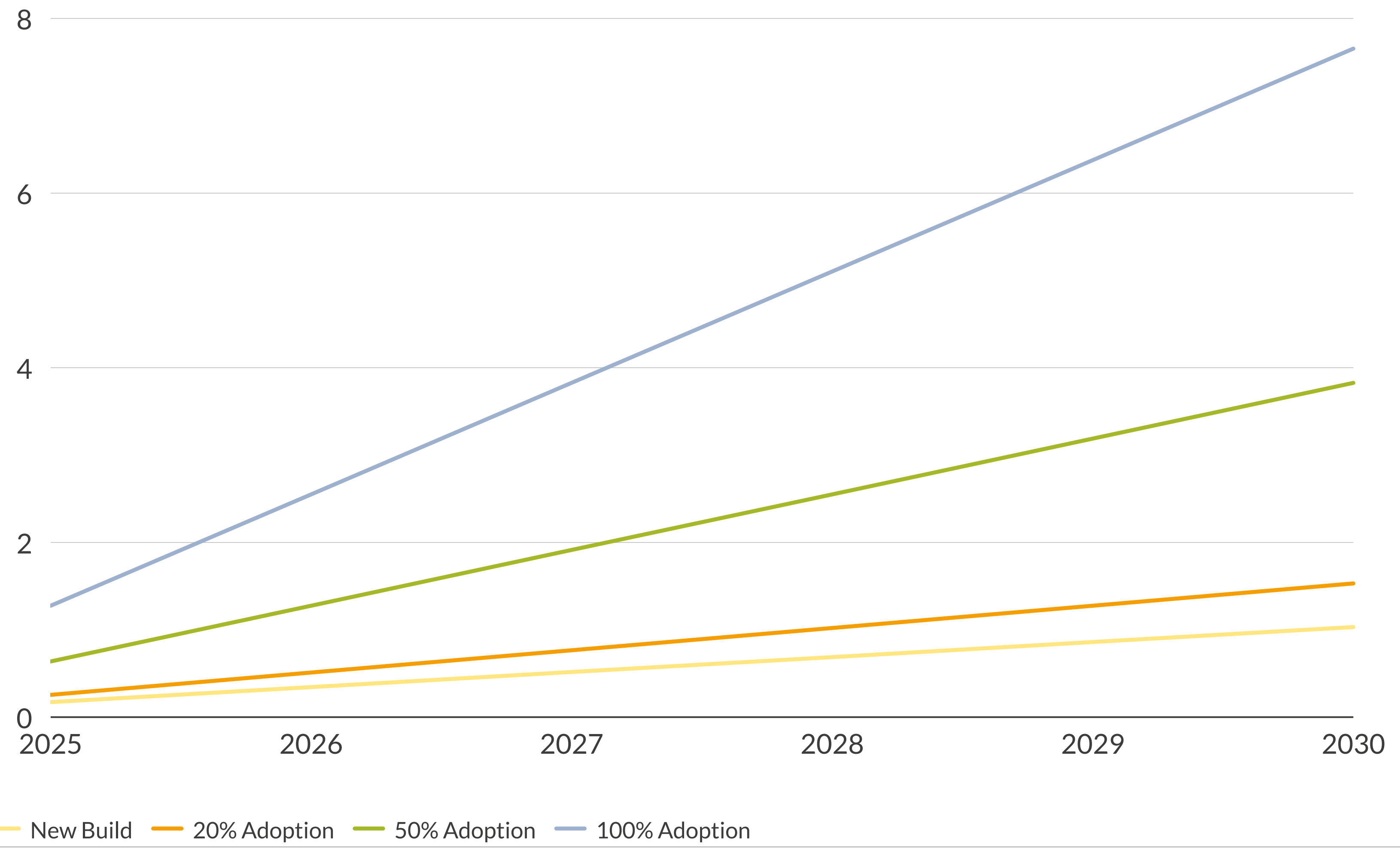
- Due to the lower up-front installation cost and pass-through of electricity costs to tenants, **resistance heating is a popular choice for multi-family construction, such as apartment buildings**.
- While the overall heat loss per housing unit is lower for a large apartment complex, the high number of units translates to a large consumption of electricity from resistance heat when temperatures are cold, with **177% more electricity required to heat a 50-unit apartment complex** using resistance heat at an outside temperature of 30 degrees Fahrenheit.

1) Assumes an 1800 square foot house and average air source heat pump ratings with a thermostat setting of 70 degrees F. 2) Assumes a 5-story building with 900 square foot units.

Sources: Aurora Energy Research, EIA, Energy Texas

Heat Pump scenario | Aurora modeled four levels of heat pump adoption to test the impact on market pricing and reliability

Additional heat pumps (new and retrofit) relative to Aurora Central
Millions



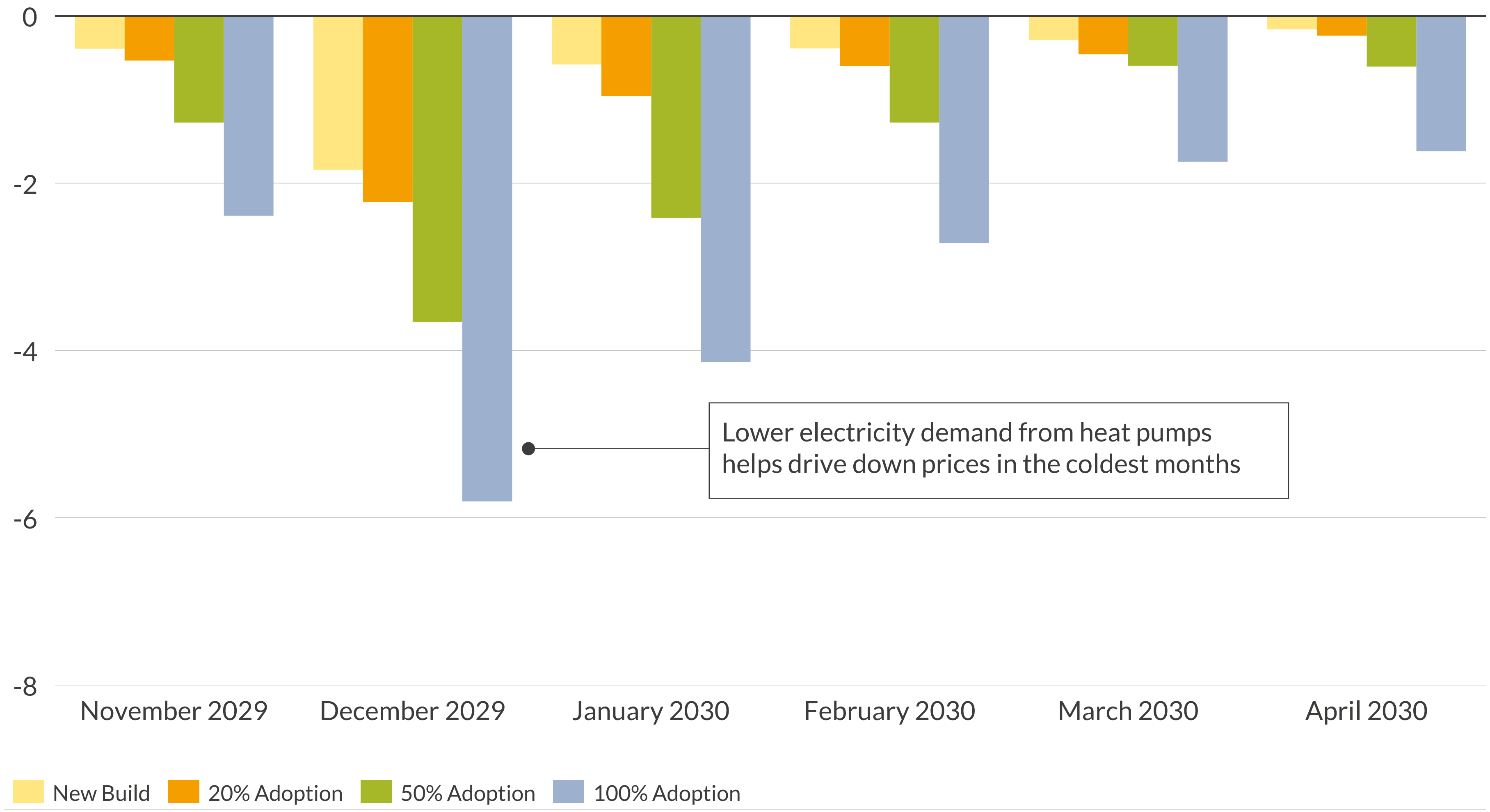
1) The New Build scenario assumes ~172,000 new heat pumps per year based on 10-year average of new private housing unit permits and the historical percentage of houses with central air-conditioning systems.
Sources: Aurora Energy Research, EIA, FRED economic data

Methodology

- The **Aurora Central** scenario assumes that electricity use patterns continues at the status quo, with no net increase in the proportion of heat pumps across Texas.
- The **New Build**[1] scenario assumes that **all new construction requires heat pumps**, and no other retrofits occur. This reflects a scenario where building codes require heat pumps in all new houses.
- The **Adoption** scenarios assume that in addition to new build heat pumps, existing homes retrofit to achieve target levels of total adoption by 2030 (20%, 50%, and 100% adoption across ERCOT).

Heat Pump scenario | Increased heat pump adoption lowers electricity prices during winter months when heat pump benefits are highest

Monthly wholesale electricity price delta to Aurora Central, ERCOT-wide, Winter 2029/2030
$/MWh (2023 real)



- As heating demand increases in winter months, the impact of increased heat pump adoption across Texas becomes apparent through lower around-the-clock electricity prices.
- In the New Build scenario, electricity prices fall by an average of $0.6/MWh (-1.5%) from November to April.
- In a scenario with 100% heat pump adoption by 2030, electricity prices fall by $5.8/MWh (-13%) in December 2029.

Sources: Aurora Energy Research

Heat Pump scenario | 20% heat pump adoption saves $424/yr in household power costs, indirectly decreasing cost for an industrial customer by $0.4 million

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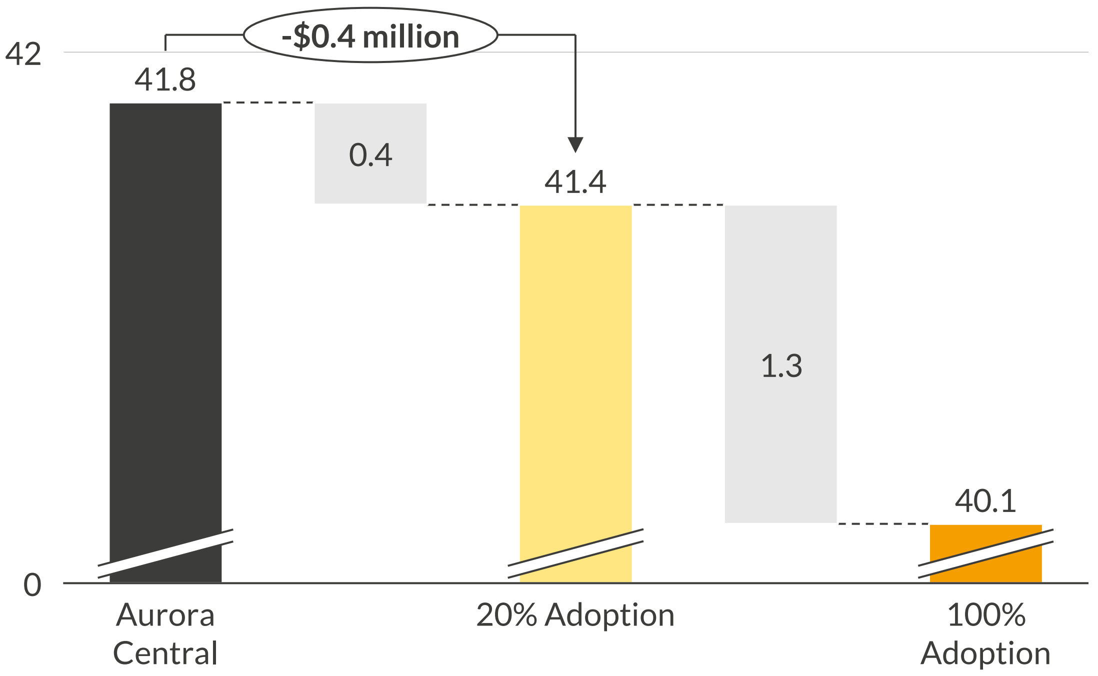
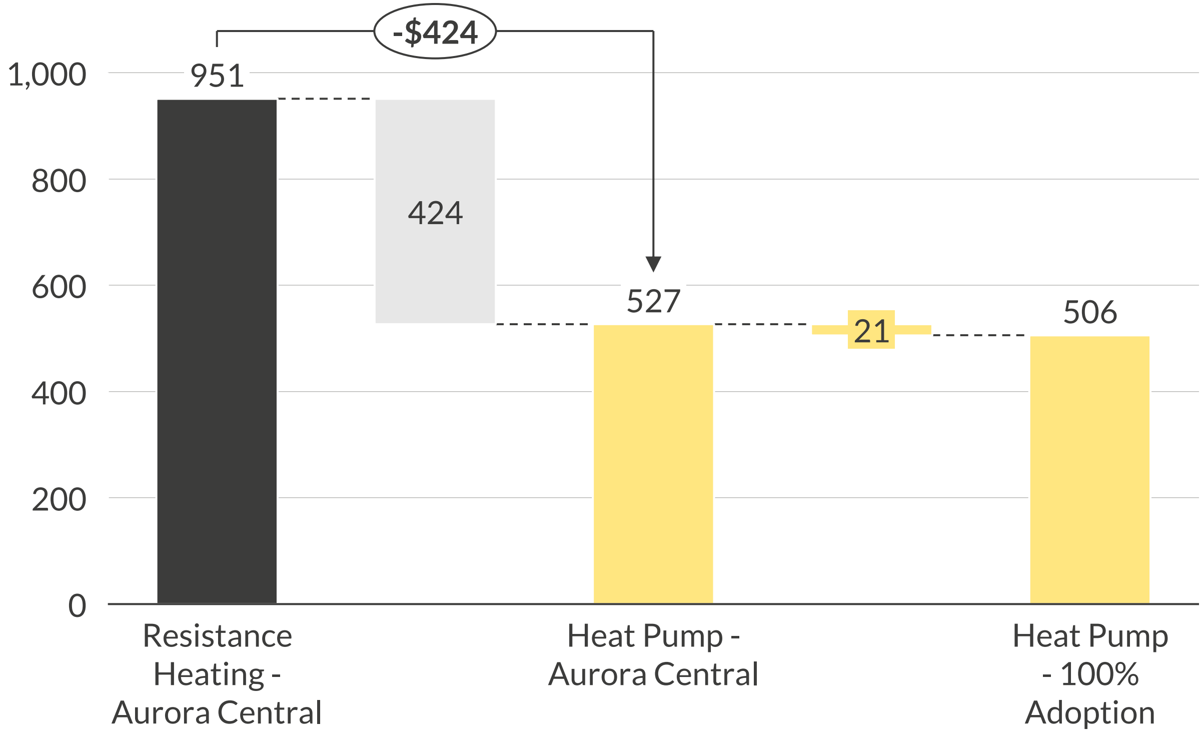
Electricity cost to an industrial consumer, 2030[1]
$million (2023 real)



Heating electricity cost to an average Texas household, 2030[2]
$ (2023 real)



- In the 100% adoption scenario, wholesale electricity **costs decrease by $1.3M (-3%)** per year in 2030 for a 100MW baseload industrial customer, as increased heat pump adoption lowers demand and drives down prices in the wintertime.

- For the average Texas household, converting to a heat pump instead of resistance heat can **decrease the yearly cost of electricity by $424**, approximately 45%.
- Increased heat pump adoption across ERCOT lowers electricity prices, and an additional $21/year can be saved in the 100% adoption scenario.

1) Includes wholesale electricity costs (ERCOT-wide average) for a 100MW industrial customer. 2) Assumes a 75% retail markup to energy, and that the energy component makes up 60% of the total rate.

Sources: Aurora Energy Research, EIA, Energy Texas

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To assess system reliability, Aurora modeled the impact of a historic weather event using future (2030) supply and demand assumptions

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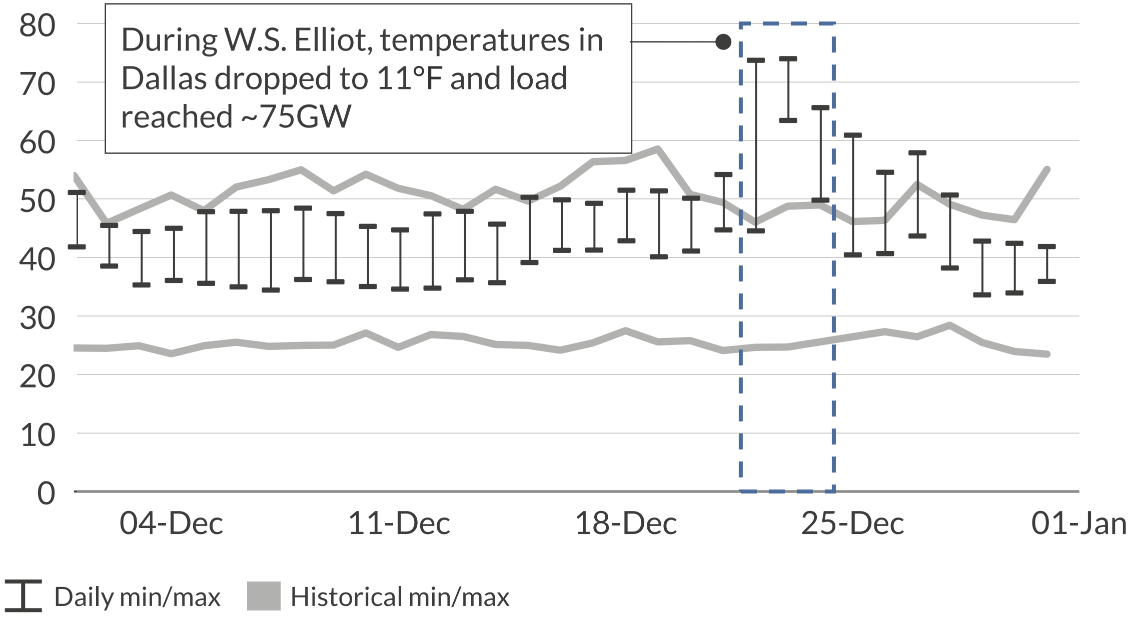
2022 Weather Year (Winter Storm Elliot)

Total ERCOT load, December 2022[1]

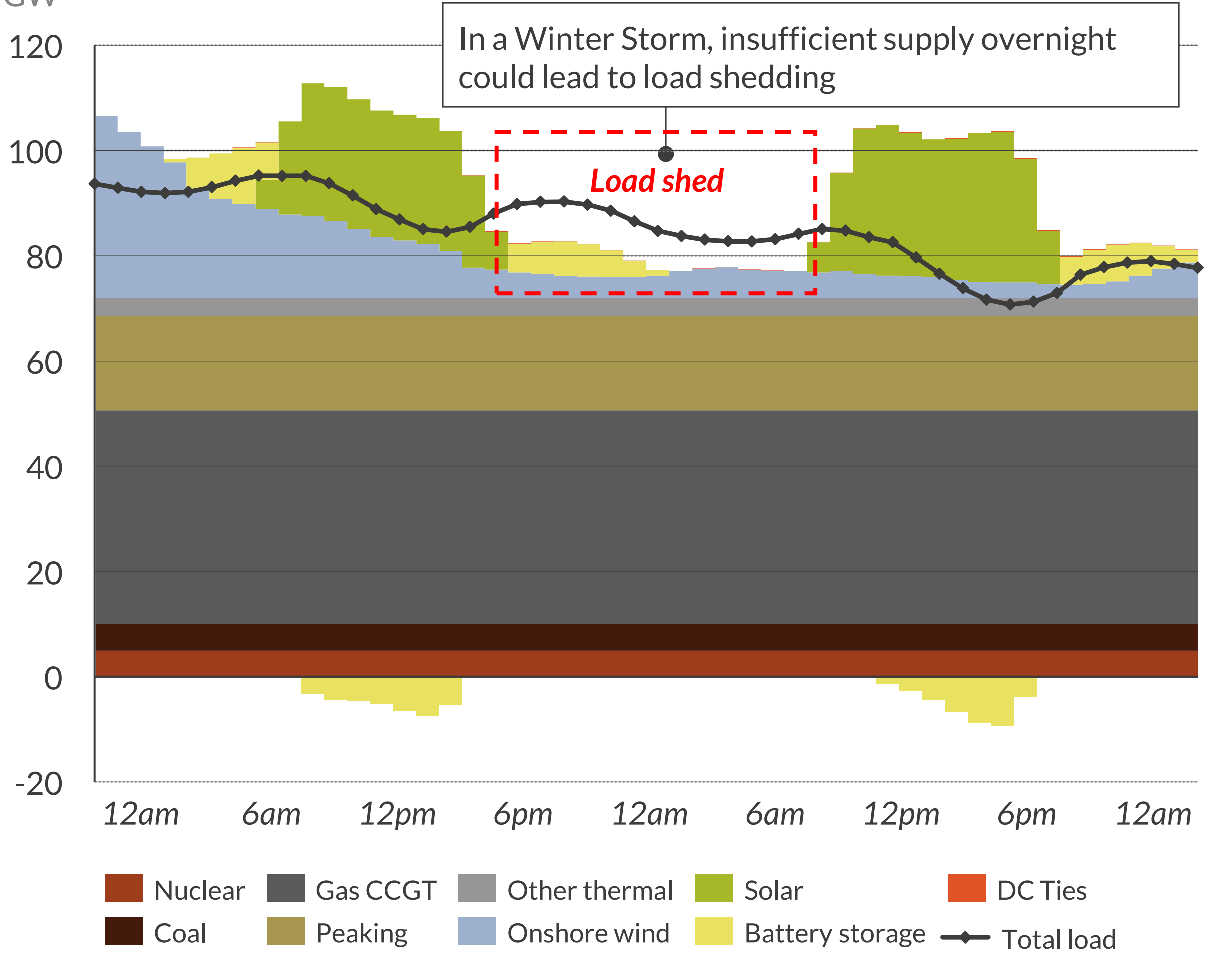
GW



Production by technology and total load, ERCOT

Illustrative

GW



- In 2022, W.S Elliot brought **extreme cold weather, which has only been matched once since** (W.S. Heather in January 2024).
- However, temperatures were **not as extreme as during W.S. Uri**, (February 2021) nor were outage levels, largely due to new weatherization standards.
- Aurora uses demand, renewables generation and outage profiles to recreate the effect of W.S. Elliot **under 2030 supply and demand assumptions.**

1) Including years since 2010.

Sources: Aurora Energy Research, National Weather Service, ERCOT

Demand Response scenario | For the winter storm analysis, Aurora modeled Demand Response (DR) programs under two separate cases

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Winter Aurora modeled two cases with differing demand response profiles to illustrate the incremental impacts:

Case A

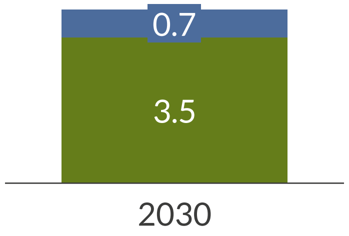
Price Responsive

+ 20% Residential/Commercial Load

  ➢ Of which 25% of load reduced

+ 10% Industrial (datacenters)

  ➢ Of which 100% of load reduced



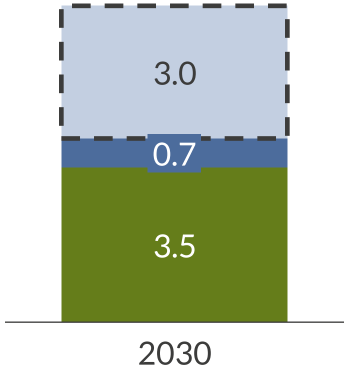
Case B

Price Responsive

➢ Same as Case A

Emergency Response Service

+ 50% Industrial (datacenters) load available to ERS



Industrial Demand in ERS | Industrial Demand responsive to prices | Residential/Commercial Demand Response

- **In Case A,** Aurora assumes all consumers that participate in demand response are **price responsive**.
- **20% of residential/commercial power consumers** are assumed to participate and of the total load, **25% load reduction is achieved** to mimic impact of TDSP[2] programs.
- **10% of industrial (datacenter) demand** is expected to be flexible and **responsive to price signals**, reducing load completely during high priced hours.
- **In Case B,** the same proportion of price responsive demand and load reduction achieved in Case A are assumed.
- An additional 50% of datacenter load (3GW) is assumed to be **available to ERS**, utilizing behind-the-meter generation during **emergency conditions** to alleviate system stress.

1) Emergency Response Service 2) Transmission Distribution Service Provider 3) Assuming 25% load reduction of those who participate in residential/commercial Demand Response (14 GW)

Sources: Aurora Energy Research, PUCT, ERCOT

Demand Response scenario | Increased Demand Response participation can effectively avoid load shedding in a winter storm event

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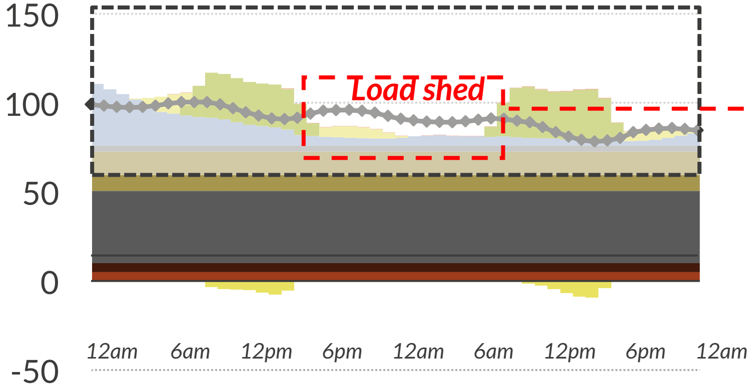
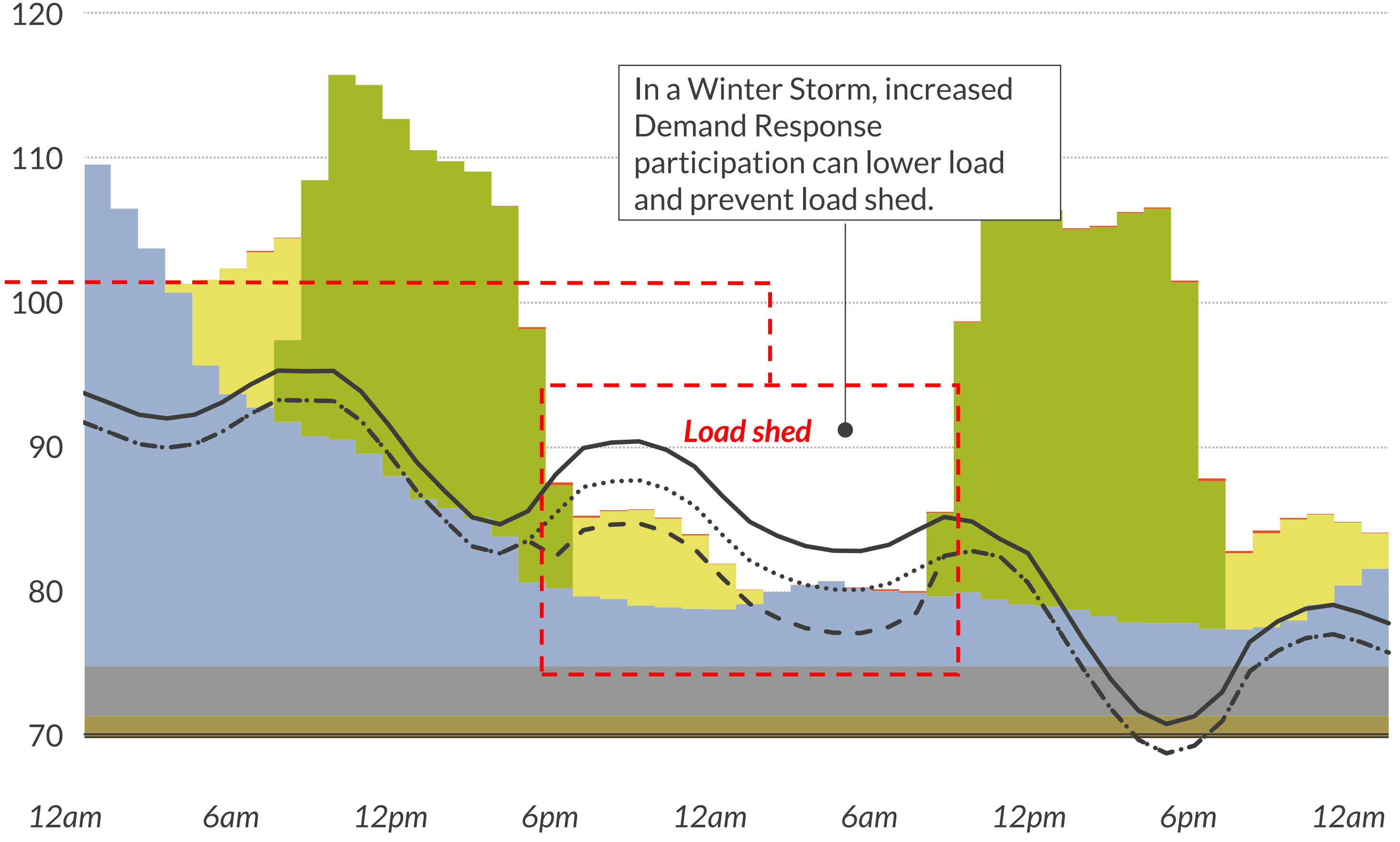
2030 December winter storm (Winter Storm Elliot-style event)
GW

- Load shed in Aurora base 2022 Weather Year case is driven by a lack of generation due to the mismatch in flexible generation coverage during periods of low renewables generation.
- By 2030, max load shed of approximately 5.9GW occurs during the tightest periods of the winter.
- Increased Demand Response participation can effectively reduce the supply gap, and a scenario with 50% industrial Demand Response actively engaged in ERS completely avoids load shedding.



Nuclear | Peaking | Solar
Coal | Other thermal | Battery storage
Gas CCGT | Onshore wind | DC Ties

Production by technology and total load, ERCOT
GW



Total load ····· Case A: Residential/Commercial DR + 10% Industrial DR – – Case B: Case A + 50% industrial DR in ERS Active

Sources: Aurora Energy Research

Demand Response scenario | Assuming 50% industrial Demand Response participation in ERS, load shed can be entirely avoided

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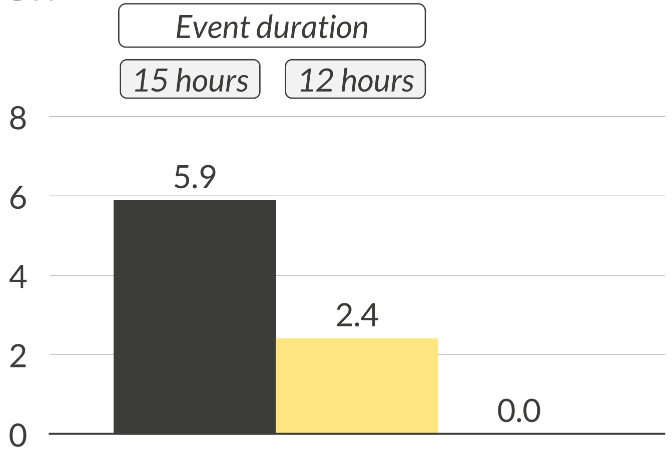
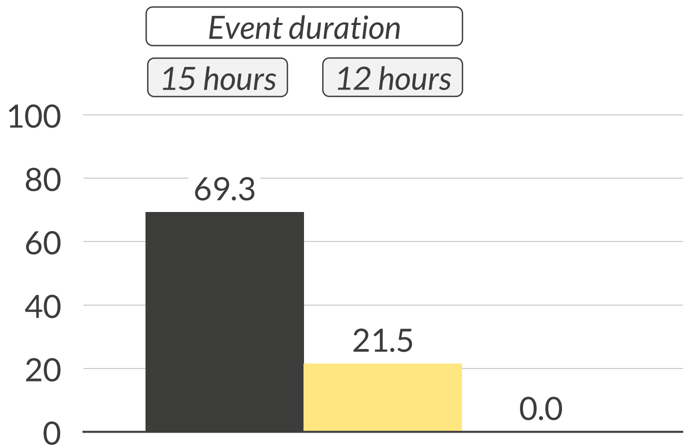
Max load shed, Winter 2030
GW



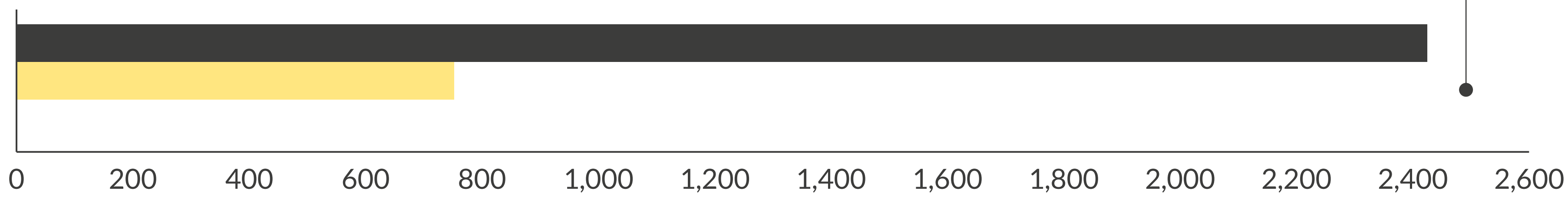
Total load shed, Winter 2030
GWh



Central Case | Case A: Residential/Commercial DR + 10% Industrial DR | Case B: Case A + 50% industrial DR in ERS Active

Cost of lost load, Winter 2030
$millions (2023 real)

Based on a **VOLL of $35,000/MWh**[1], Case A Demand Response reduces load shed **costs by $1.7bn** during a winter storm event in 2030.



Central Case | Case A: Residential/Commercial DR + 10% Industrial DR | Case B: Case A + 50% Industrial DR in ERS Active

- Load shedding events occur in the Central scenario under Winter Storm conditions in 2030.
- With 20% residential and commercial demand (3.5GW) + 10% industrial demand (0.7GW) participation in Demand Response programs during the winter storm, total load shed could effectively reduce by 47GWh (-70%).
- With 50% industrial demand response participation in ERS, **load shed would be entirely avoided** in Winter Storm conditions.

1) PUCT approved Value of Lost Load

Sources: Aurora Energy Research, PUCT

Demand Response scenario | In a more volatile weather year, the average Texas household can save over $485 per year by participating in DSR programs

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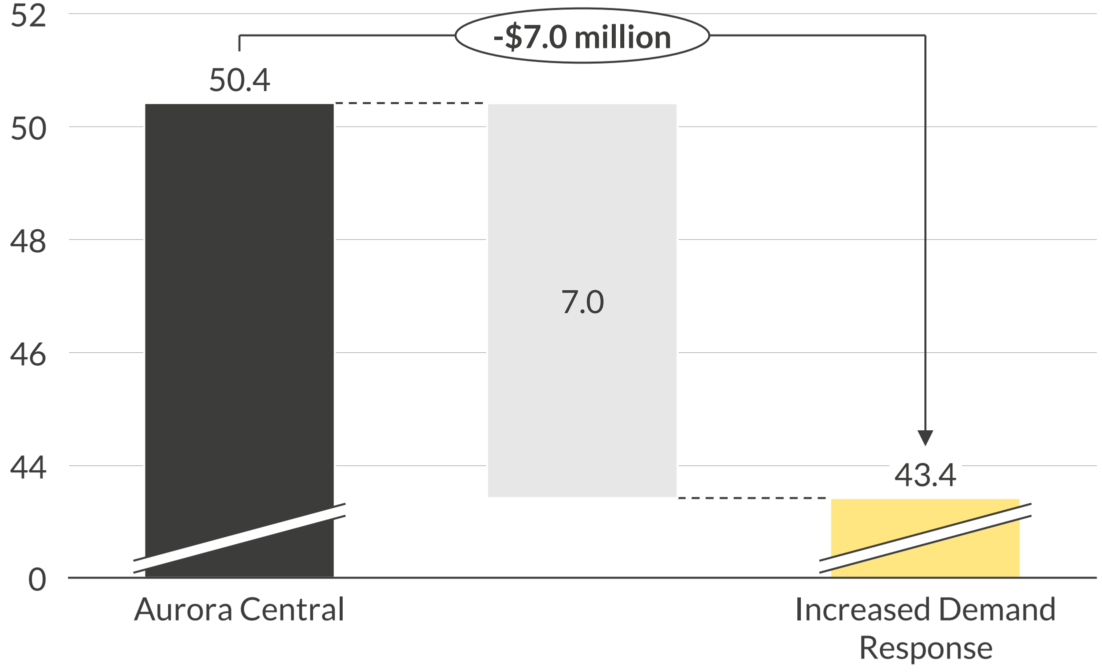
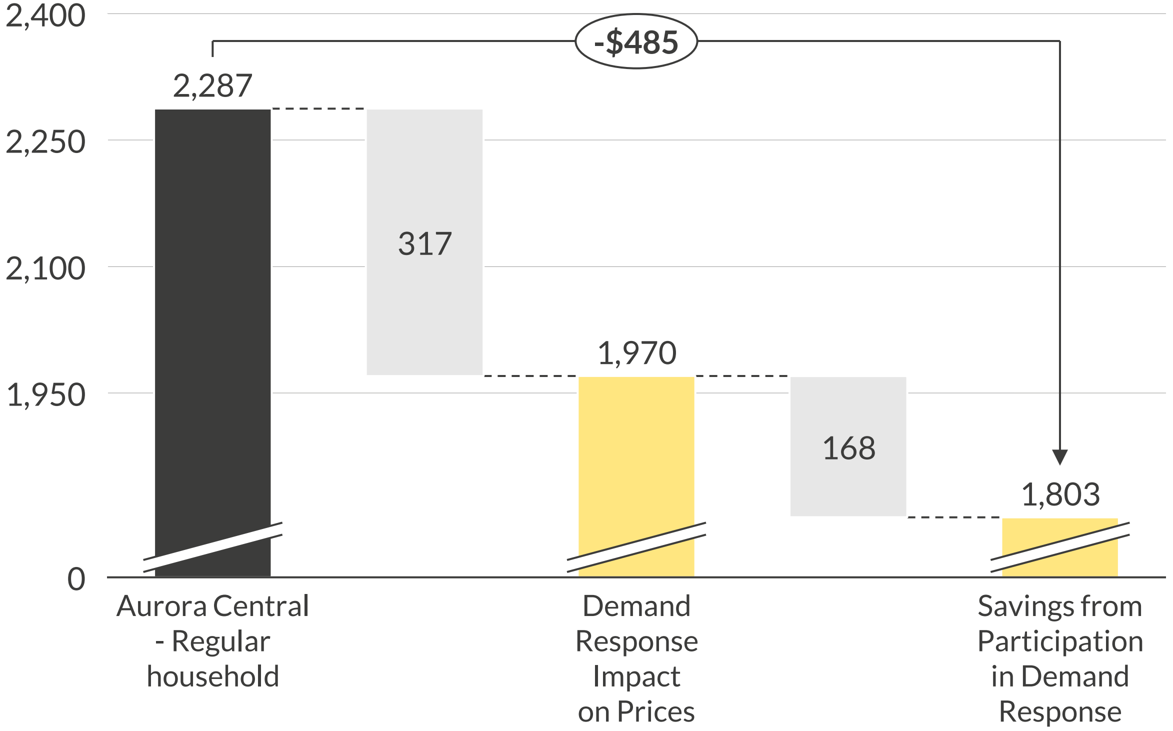
Electricity cost to an industrial consumer, 2030[1]
$million (2023 real)



Electricity cost to an average Texas household, 2030[2]
$ (2023 real)



- High-volatility weather amplifies the impact of demand response on consumer cost savings. Industrial consumers experience cost reductions of nearly 15%, resulting in savings of approximately $7 million per year for a 100 MW baseload consumer.

- Demand response has an even greater impact on cost savings during an extreme weather year by mitigating large price spikes in the wholesale market, which translates through to lower costs for retail customers.
- For the average Texas household, this translates to a **decrease in yearly cost of electricity of $485/yr** under 2022 weather year conditions.

1) Includes wholesale costs for a 100MW industrial customer. Assumes exposure to ERCOT-wide average power prices. Does not include transmission costs. 2) Assumes a 75% retail markup to energy, and that the energy component makes up 60% of the total rate. Assumes the average household consumes 1,120kWh per month.
Sources: Aurora Energy Research, EIA, Energy Texas

Agenda

I. Executive summary

II. Role of demand side management in ERCOT

III. Market outcomes under average weather conditions

   1. Demand response
   2. Heat pump adoption

IV. Winter storm analysis

   1. Demand response
   2. Heat pump adoption

V. Appendix

HP scenario | In 2030, load shedding from winter storm conditions (Storm Elliot-style event) can be avoided with 50% heat pump adoption

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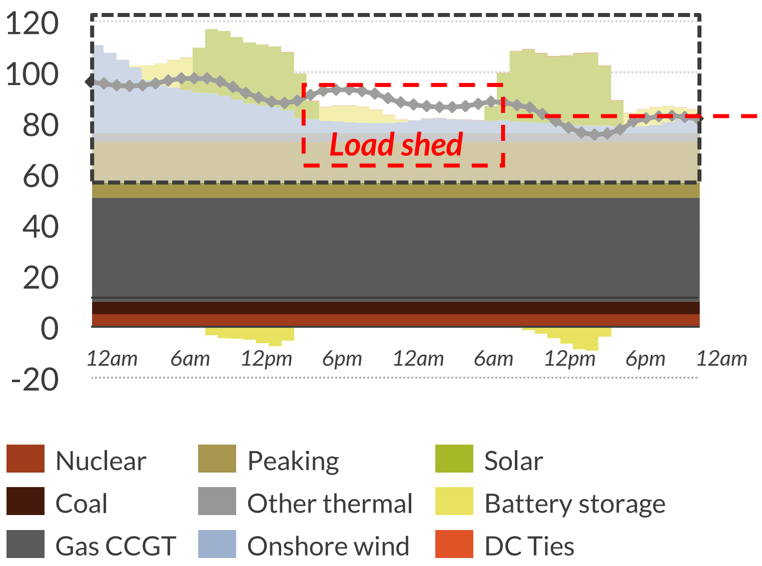
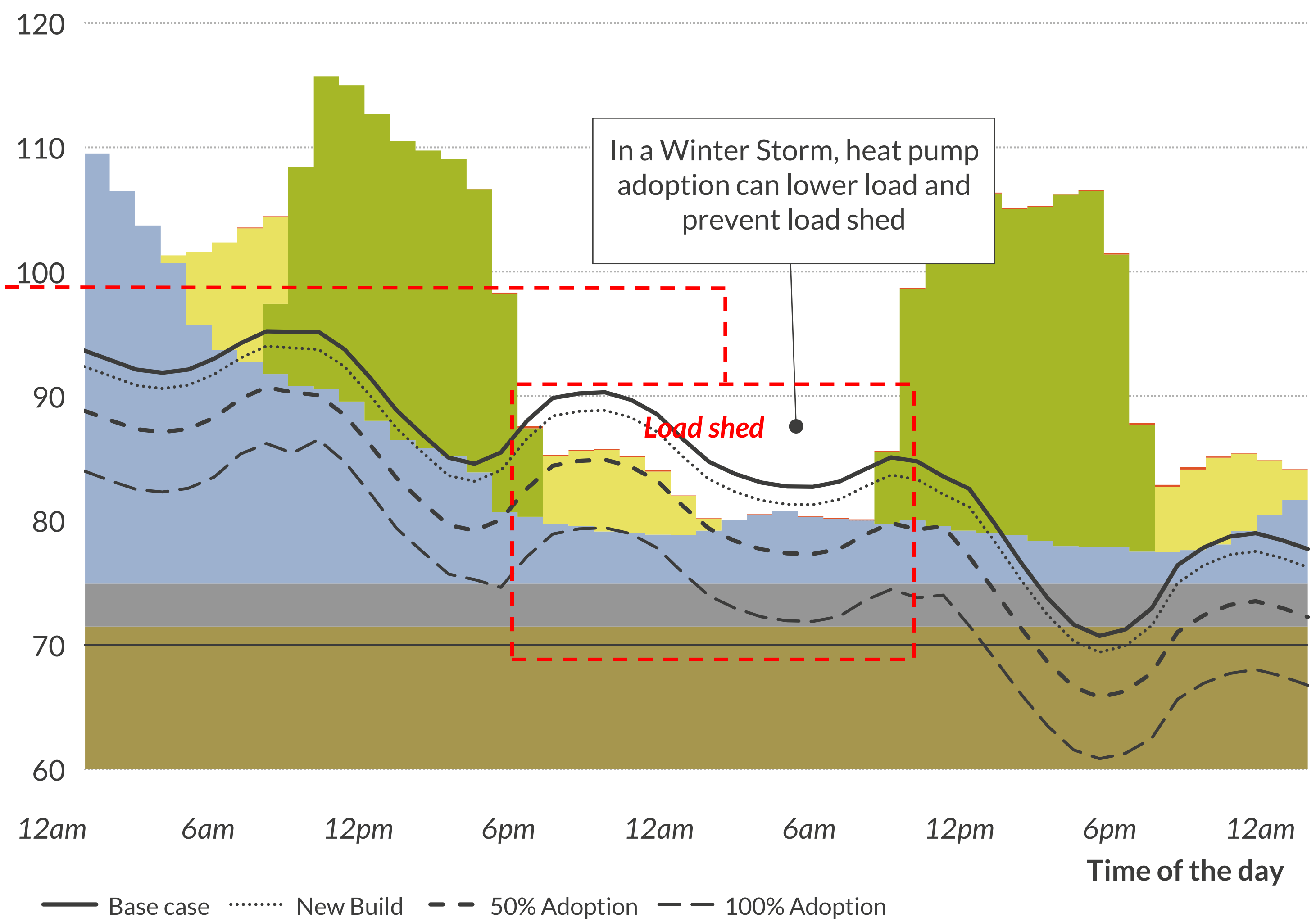
2030 December winter storm (Winter Storm Elliot-style event)
GW

- Load shed in the 2022 Weather Year case is driven by a lack of generation due to the mismatch in flexible generation coverage during periods of low renewables generation. By 2030, max load shed of approximately 5.9GW occurs during the tightest periods of the winter.
- Increased heat pump adoption lower the supply gap, and a scenario with 100% heat pump adoption by 2030 completely avoids load shed.



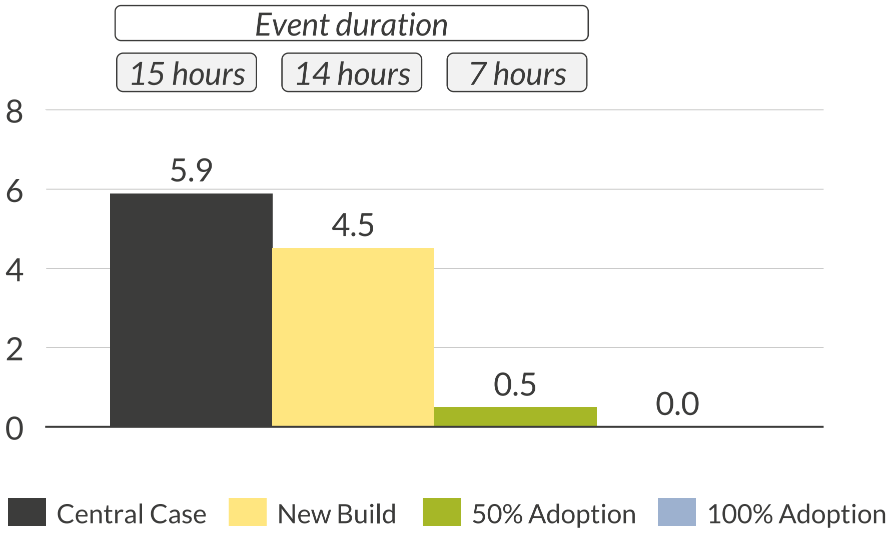
Production by technology and total load, ERCOT
GW



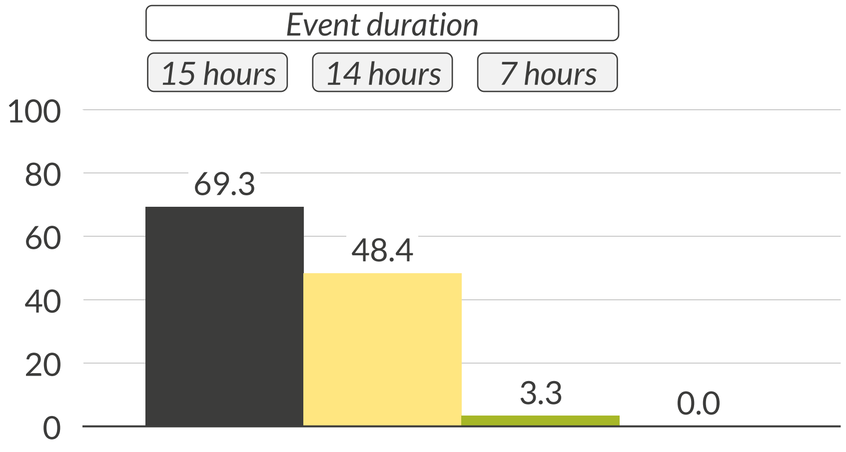
Sources: Aurora Energy Research

HP scenario | Load shed is prevented in the scenario with 50% heat pump adoption by 2030

Max load shed, Winter 2030
GW

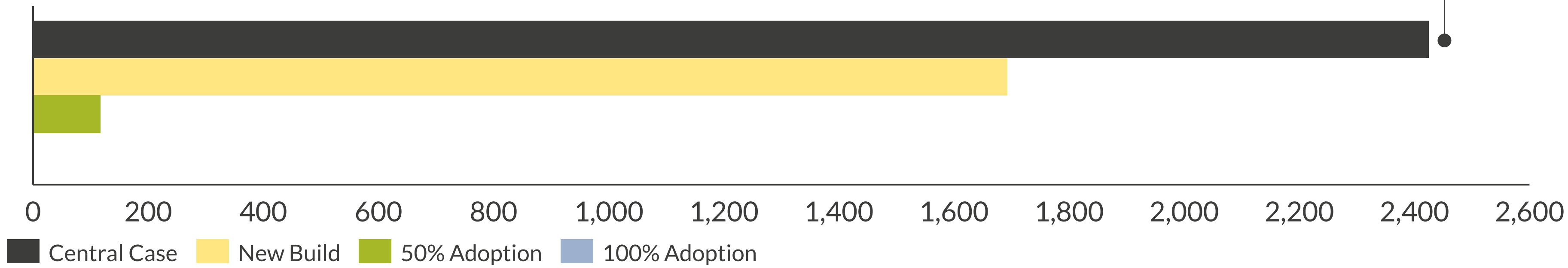


Total load shed, Winter 2030
GWh



Based on a **VOLL of $35,000/MWh**[2], 50% heat pump adoption by 2030 reduces load shed **costs by $2.3bn** during a winter storm event.

Cost of lost load, Winter 2030
$millions (2023 real)



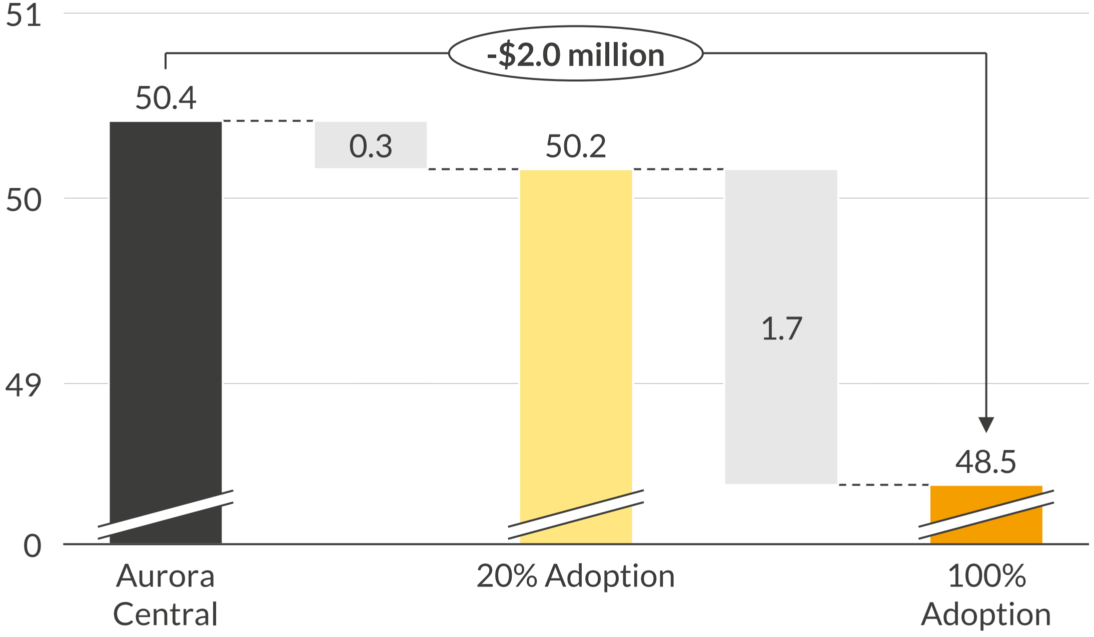
- Load shedding events occur in the Central scenario under Winter Storm conditions in 2030.
- Requiring all new-build construction to require heat pumps would reduce the total load shed in this Winter Storm event by 12GWh (-82%).
- **5.9GW of load shed represents around 1.18 million homes** without power[1]. If 50% of housing units adopted heat pumps by 2030, this would reduce this to ~100,000 homes in the same event.
- In the scenario where 100% of housing units adopt heat pumps by 2030, **load shed is entirely avoided** in Winter Storm conditions.

1) 1 megawatt (MW) of electricity can power about 200 Texas homes during periods of peak demand. 2) PUCT approved Value of Lost Load

Sources: Aurora Energy Research

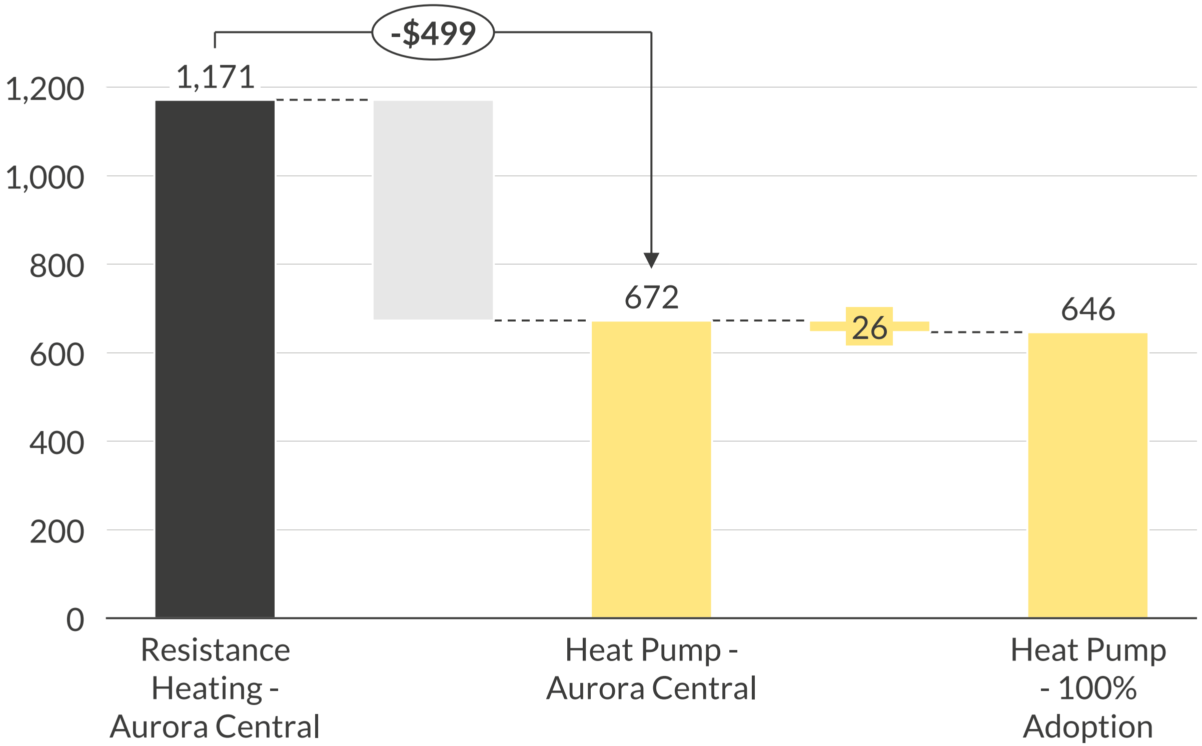
HP scenario | In a more volatile weather year, potential savings from switching to a heat pump for a residential customer increases to $499/year

Electricity cost to an industrial consumer, 2030[1]
$million (2023 real)



- In the 100% adoption scenario, wholesale electricity **costs decrease by $2.0M (-3%)** per year in 2030 for a 100MW baseload industrial customer, as increased heat pump adoption lowers demand and drives down prices in the wintertime.

Heating electricity cost to an average Texas household, 2030[2]
$ (2023 real)



- In a higher volatility weather year, electricity use will rise on average and increase the potential for cost savings for a consumer who switches to a heat pump. For the average Texas household, converting to a heat pump instead of resistance heat can **decrease the yearly cost of electricity by $499** under 2022 weather year conditions.

1) Includes wholesale electricity costs (ERCOT-wide average) for a 100MW industrial customer. 2) Assumes a 75% retail markup to energy, and that the energy component makes up 60% of the total rate.

Sources: Aurora Energy Research, EIA, Energy Texas

Agenda

There are currently five main types of Demand Response products available in the ERCOT Region

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Demand Response properties	Load Resource Participation in ERCOT Ancillary Services		Aggregate Distributed Energy Resource (ADER) Pilot Project	Emergency Response Service (ERS)	TDSP Load Management Programs	4-Coincident Peak (4-CP) Load Reduction and Price-Responsive Demand Response
Description and purpose	Load Resources can participate in ancillary services, serving as a backup or reserve power resource that can be used in case of an outage or other disruption to the main power grid. **Non-Controllable Load Resources (NCLRs)** LRs controlled by a high-set Under-Frequency Relay, can perform manual deployments with a slower response and ramp time, usually between 15 and 30min.	**Controllable Load Resources (CLRs)** LRs that use fast-acting control systems to respond to primary frequency deviations, can follow SCED basepoints and Load Frequency Control Dispatch Instructions	▪ An ADER is a Resource consisting of multiple individually metered sites/Premises connected at the distribution system level that has the ability in aggregate to respond to ERCOT Dispatch Instructions. ▪ The ADER Pilot Project aims to explore and assess the integration of diverse, distributed energy resources into the ERCOT wholesale market.	▪ The ERS program engages commercial and industrial customers to reduce their electricity usage during grid emergencies on short notice to mitigate rolling blackouts. ▪ During a grid emergency, ERCOT alerts ERS customers to reduce energy use within 10 or 30 minutes. ▪ Electricity generators that participate in ERS may be called on to provide a certain number of megawatts to prevent load-shedding.	▪ The TDSP Load Management Program refers to any program created pursuant to Public Utility Regulatory Act, TEXAS UTILITIES CODE §§ 36.204 and 39.905 and 16 TAC § 25.181. ▪ In these programs, end-use customers agree to receive payment from a TDSP in exchange for reducing peak demand for a specified duration upon request by the TDSP.	▪ In ERCOT, the requirement to pay for the transmission system is set on the four system-wide peak intervals in June, July, August, and September. ▪ ERCOT uses the 4CP method to determine demand charges for commercial properties. ▪ By practicing 4CP load reduction, retail customers can lower their electricity bills and reduce stress on the grid during the highest peak demand hours of the year.
Current market size[1]	▪ Responsive Reserve (RRS): 2,300-3,178MW (~50% reserved for load) ▪ Non-spinning Reserve (Non-spin): 1,430-4,482MW ▪ ERCOT Contingency Reserve Service (ECRS): 889-3,007MW		23.5 MW registered capacity	▪ Maximum annual spend limit for the 2024 program year was $75 million ▪ There are four ERS procurement periods during the year (Dec – Mar, Apr – May, Jun – Sept, and Oct – Nov).	N/A	N/A

1) Ancillary service values for 2024, minimum and maximum hourly procurement volumes. Some of the products are not that easily quantifiable as they are not directly administered by ERCOT.

Sources: ERCOT, PCI Energy Solutions, Foreman

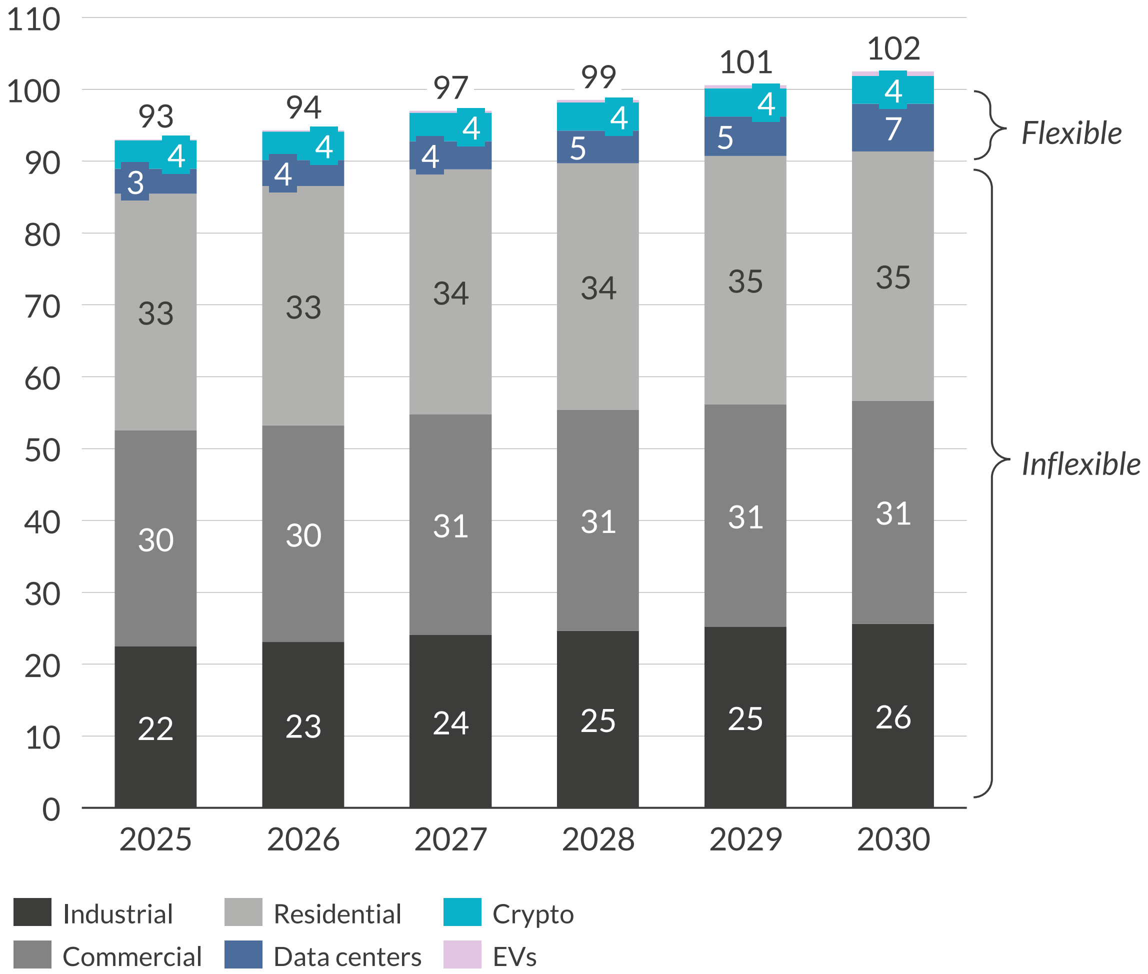
Aurora's demand forecast is built bottom up; demand is classified by its sector and flexibility

Aurora's demand methodology

- Aurora builds its demand forecast from the **bottom up**, taking a view on key demand drivers such as population growth, industrial growth and electric vehicle uptake.
- Demand fed into the Aurora model can be classified as either **flexible or inflexible,** each of which have **different impacts on grid reliability and power prices.**
  - Flexible demand puts downwards pressure on power prices, turning off when prices render power consumption uneconomic.
  - Due to its price responsiveness flexible demand indirectly supports grid reliability, as high prices coincide with periods of system stress.

Inflexible "base" demand	Flexible demand (price responsive)
▪ Residential	▪ Electric vehicles[1]
▪ Commercial	▪ Data centers
▪ Inflexible industrial	▪ Crypto mines
	▪ Hydrogen electrolyzers

Central case peak load forecast by demand sector
GW



1) Not all electric vehicles are considered flexible. Aurora classifies EVs as "Smart", "Time-of-use-tariff", and "Dumb", with "Dumb" EVs being fully inflexible. As the forecast progresses, the ratio of flexible EVs increases with the expectation of higher rates of smart charging.
Sources: Aurora Energy Research

Aurora's analysis is based on proprietary, in-house modeling with integrated energy, ancillary, and capacity expansion modeling

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5 Integrated Models

Global Commodities (AER-GLO)

Hydrogen (AER-HY)

Gas (AER-GAS)

Power markets (AER-ES)

INPUTS

- Technology
- Policy
- Demand
- Commodity prices[1]
- Weather patterns

Dispatch model

- Hourly or sub-hourly
- Iterative modeling
- Dynamic dispatch of plant
- Ancillary services modeled endogenously

Continuous iteration until an equilibrium is reached

Investment decisions module

- Capacity market modeling (where applicable)
- Capacity build / exit / mothballing
- IRR / NPV driven
- Detailed technology assessments

OUTPUTS

- Capacity mix
- Generation mix
- Wholesale & imbalance prices
- Capacity market prices
- Profit / Loss and NPV
- Electric vehicle charging

Up to 70
specifications modeled for each plant

c. 85k
investment hours on modeling capabilities

~15k
model runs per week

50+
strength of modeling team globally

Quarterly updates
through subscription research

1) Gas, coal, oil and carbon prices fundamentally modeled in-house with fully integrated commodities and gas market model.

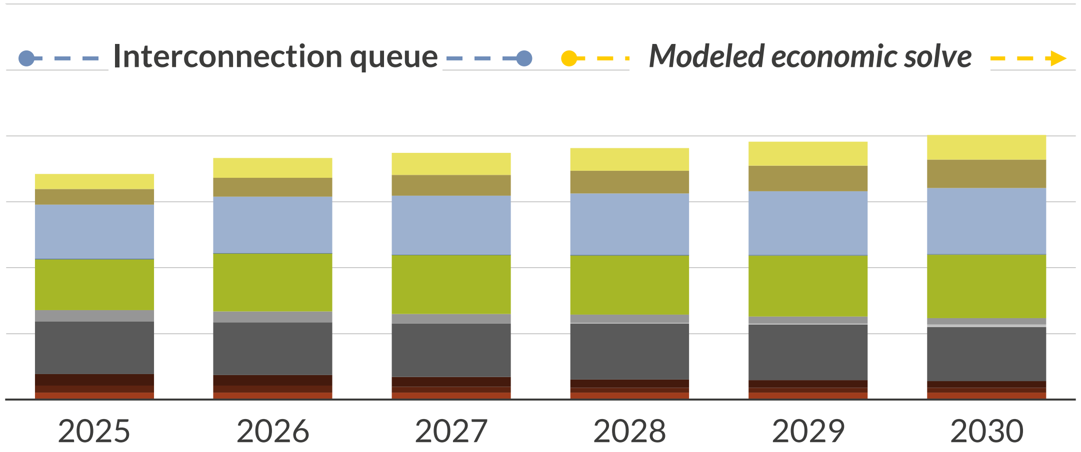
Source: Aurora Energy Research

Aurora utilizes both the interconnection queue and an economics-based model solve to forecast future capacity

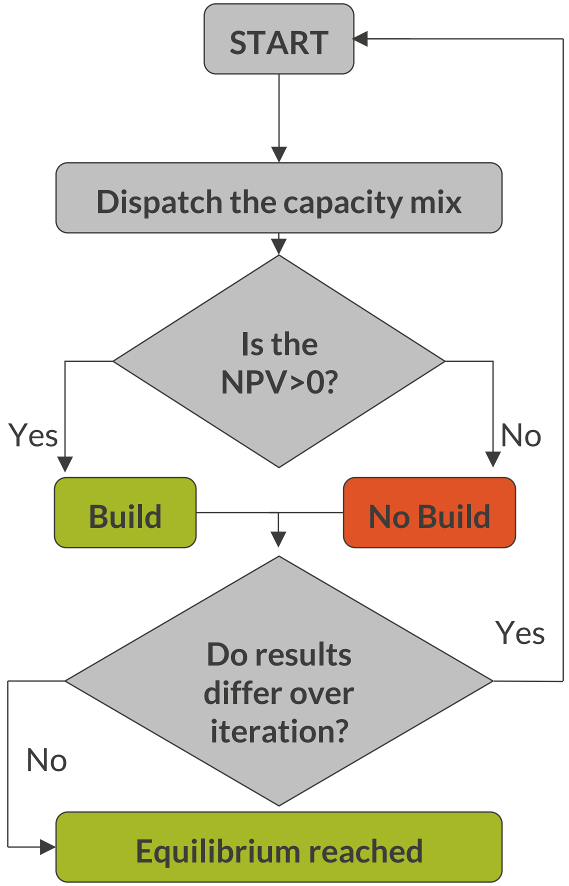
Inclusion of capacity from the ERCOT Interconnection Queue

- Aurora's near-term capacity additions are based off the ERCOT interconnection queue.
- Aurora evaluates completion rates of projects in the existing interconnection queue with historical success rates in determining the timeline of their market entry.
- Plants included in the forecast must have already signed an interconnection agreement.
- **Capacity additions are updated by Aurora on a quarterly basis.**

Forecasted capacity stack



Aurora AER-ES Model Internal Capacity Expansion



- In the mid to long-term, Aurora forecasts capacity additions based on an economic model solve.
- Plants in Aurora's model choose to either build or retire based off a NPV calculation.
- Existing plants have the ability to close or continue operating based on unit economics for the plant.
- The Aurora methodology **minimizes total system cost over the model lifetime** through a process of algorithmic iteration until lowest system cost is achieved.

1) Refers to evaluation of December 2024 ERCOT GIS report.

Aurora provides market leading forecasts & data-driven intelligence for the global energy transition

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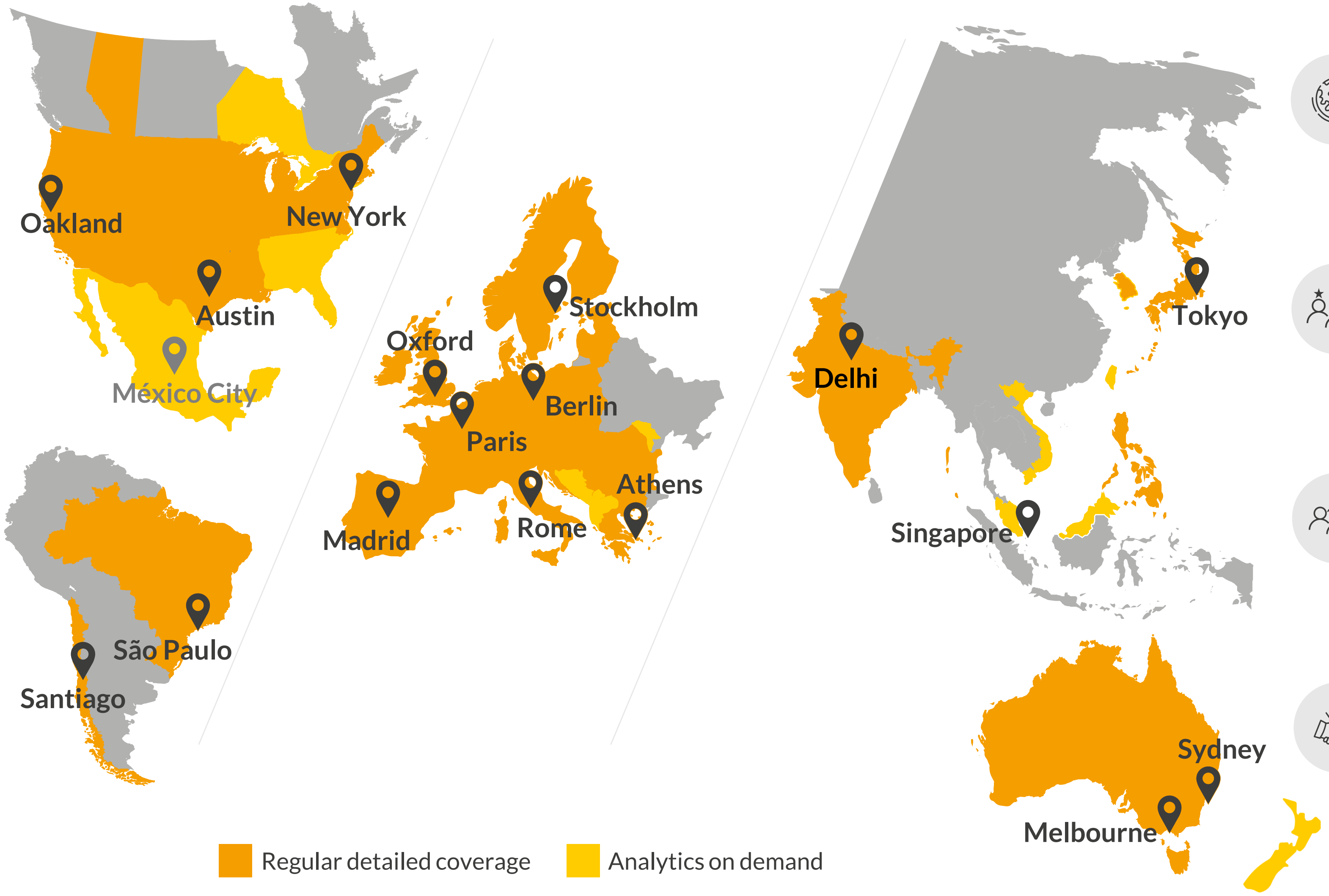
- Power markets
- Renewables & PPAs
- Storage
- Grid & Congestion
- Electric vehicles
- Hydrogen H_2
- Carbon CO_2
- Natural gas



17 offices

1000+ market experts

950+ subscribing companies

150+ transactions supported in 2024

Source: Aurora Energy Research

Details and disclaimer

Date: May 1st, 2025

This report was commissioned by the Texas Association of Business (TAB) and South-central Partnership for Energy Efficiency (SPEER) as a Resource . All analysis and findings are the independent work and opinion of Aurora Energy Research.

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