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ENERGY RESEARCH

Impact of Limiting Solar and Wind Development in the ERCOT Market

April 16th, 2025

Prepared for Texas Association of Business

Context for this report

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- **This report, prepared for the Texas Association of Business (TAB), is an assessment of the role renewable generation (solar and wind) has played in the ERCOT market and the impact that restricting new solar and wind generation additions would have.**
- The purpose of this study is to provide independent analysis, informing policymakers on how restrictions to renewable energy deployment would impact the ERCOT market, including market pricing, reliability, and emissions.
- Aurora modeled three unique scenarios to evaluate the impact of different levels of renewables capacity additions:
  1. **Aurora's Central Case**, which assumes a continuation of existing policies at the state and federal levels and is the reference case
  2. **Limited Renewables Case**, which assumes a 50% long-term reduction in renewables additions beyond current late-stage projects
  3. **Fully Restricted Renewables Case**, which assumes no further renewables additions beyond current late-stage projects

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 using a 2013 weather year profile[1] to evaluate system performance 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.
- **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.

1) ERCOT uses a 2013 weather year to represent average conditions for planning purposes.

Sources: Aurora Energy Research, ERCOT

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I. Executive summary

II. Role of wind and solar generation in ERCOT

III. Impact of restricting renewables additions on price and reliability

1. Reliability outcomes
2. Pricing outcomes

IV. Appendix

Executive Summary

1 ERCOT's accelerating demand growth requires new generation from all technologies, with renewables and flexible technologies providing cheaper and reliable power

- ERCOT is expected to continue experiencing strong load growth, fueled by population growth, industrial and oil & gas activity, and emergent demand from data centers and bitcoin mining.
- The combination of renewables and flexible technologies like batteries have enabled ERCOT to meet peak demand and will remain essential in ensuring future grid flexibility and reliability.
- The increasing share of renewables in the technology mix, combined with their lower running costs, reduces electricity prices and effectively lower energy bills for consumers.

2 Restricting renewables additions would stifle ERCOT's ability to serve the expected additional load reliably, leading to capacity shortfalls and potential load shed

- Supply chain constraints have continued to induce delays to projects across all technologies, including some thermal projects that already had approved applications to the Texas Energy Fund.
- Under both the Limited Renewables and Fully Restricted Renewables scenarios, insufficient new capacity additions leads to capacity shortfalls and an estimated 1.8GW to 3.1GW of load shed under an extreme weather event, or between 360,000 and 620,000 homes without power.[1]
- Several datacenter and bitcoin projects selectively prioritize projects in Texas, due to the high presence of renewables generation that minimizes their operational emissions and environmental footprint.

3 Limiting renewables additions increases power prices by 14% in 2035, leading to a 10% increase in power costs for a residential consumer and +$6.3 million for an industrial consumer[1]

- In a "Fully Restricted Renewables" scenario, around-the-clock prices increase by 14% and all-in system costs rise by $5.2bn in 2035, as low-cost renewable generation is replaced by thermal powered energy
- For a 100MW baseload consumer, this translates to an increased cost of $6.3 million per year. For the average Texas household, yearly cost of electricity increases by $225, approximately 10%.

1) Representative of a 100MW baseload industrial consumer.

The combination of solar, wind and flexible natural gas and batteries is enabling ERCOT to meet its rapidly rising peak demand reliably

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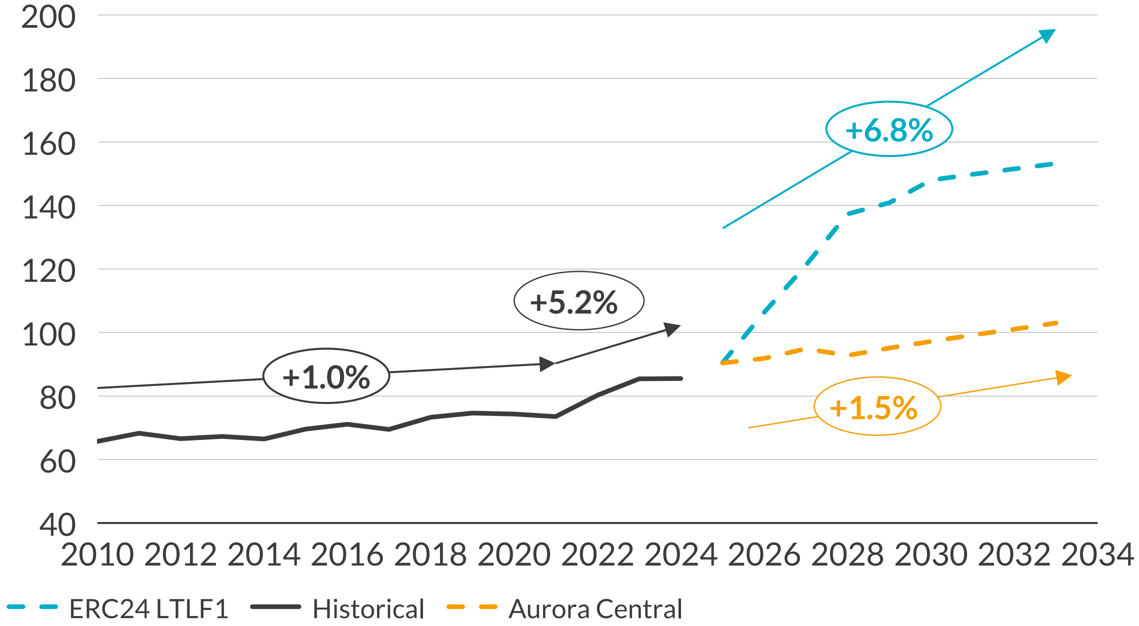
1 Data center and industrial load growth are driving a sharp increase in peak demand, regardless of the scenario considered

ERCOT Peak Load

GW

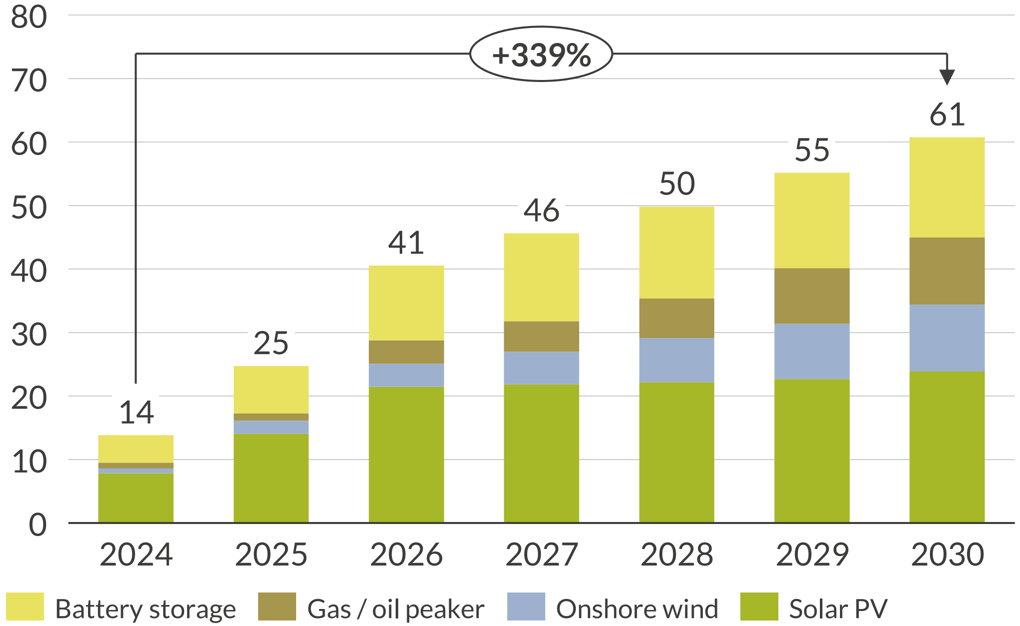


- In recent years, **heavy industrial electrification and demand from data centers and bitcoin mining** have driven a sharp demand growth from 2021-2024.
- The trend is expected to continue at an even faster rate in the ERCOT 2024 Long Term Load Forecast case due to higher data center and industrial load growth.

2 Renewables and flexible technologies' continued capacity growth is forecasted to meet future energy needs

Cumulative historical and forecasted new capacity in ERCOT (Aurora Central)

GW



- Historically, renewables combined with flexible dispatchable technologies have been making up a growing share of total installed capacity and contributing to meeting the accelerated demand growth.
- Continued capacity additions are necessary to provide the needed power and reliability to the grid.

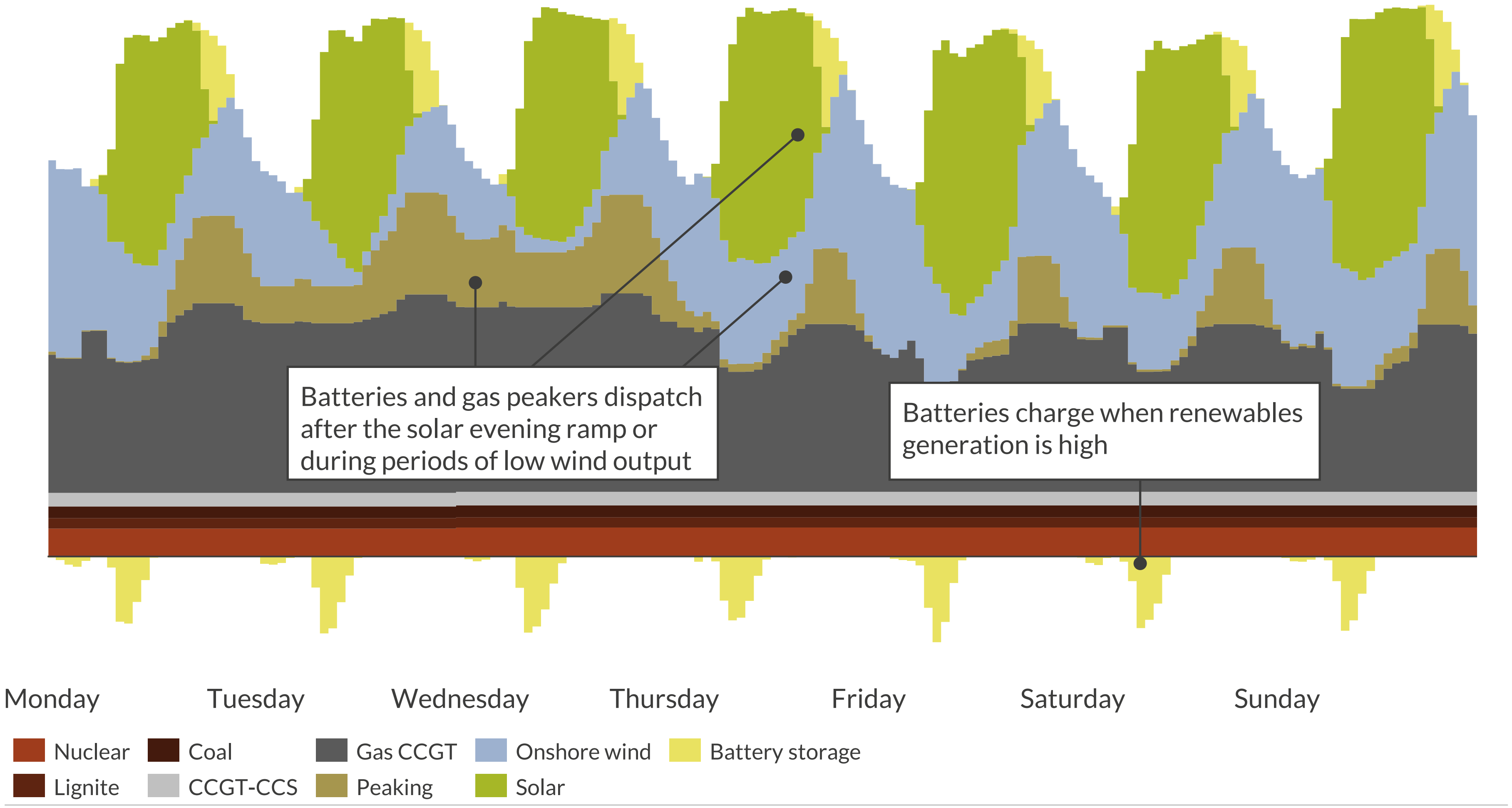
1) ERCOT Revised 2024 Long-Term Load Forecast.

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

Flexible dispatchable resources are paired with renewables to provide consistent energy during periods of low solar and wind output

Generation by technology in an example week
GW

Illustrative



- The combination of renewables and flexible dispatchable resources (e.g. batteries, gas peakers) offers an effective way to serve load consistently and reliably throughout the day.
- During the times when renewables are generating heavily on sunny/windy days, batteries can charge at cheap prices.
- When renewable generation is low on cloudy/windless days, flexible dispatchable technologies can fill in the gaps and ensure grid reliability.

From lower overall costs to reduced running costs, renewables contribute to lowering power prices

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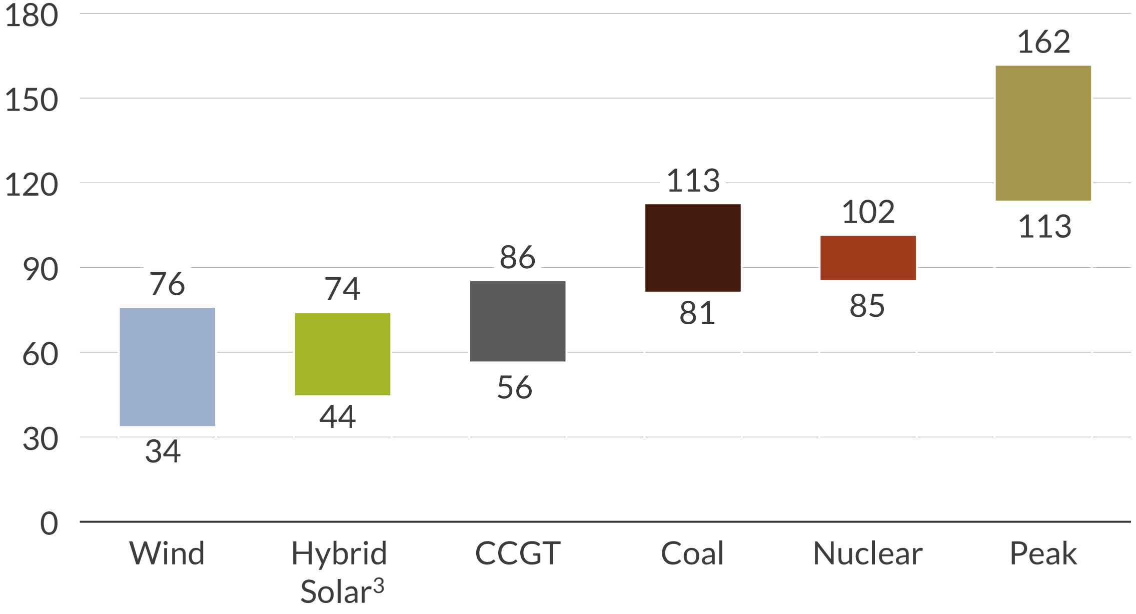
1 Renewables’ lower overall costs make them an economical addition to the generation mix

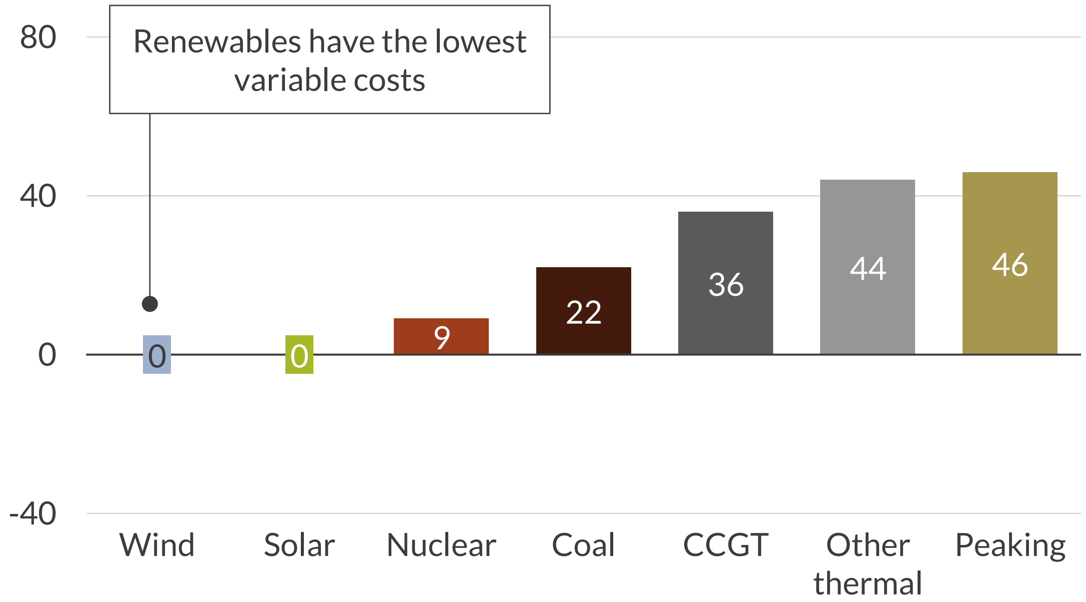
LCOE[1] by technology in Texas (excluding subsidies)[2]
$/MWh



- LCOE includes various costs throughout the asset’s lifetime, such as capital costs, operation and maintenance costs, financing costs, and running costs.
- Technological advancements and increasing demand for clean energy have driven down renewables’ costs significantly, making them an economical source of energy to meet the growing demand.

2 Renewables offer lower running costs than other types of generation, leading to reduced energy prices

Running cost [4] by technology (excluding subsidies)[5]
$/MWh (real 2023)



- Running costs measure the cost to produce a MWh of power and include components such as fuel, variable operations and the cost of starting.
- Since renewables don’t require fuel, they have **little to no running costs**, leading to reduced electricity generation prices and effectively lowering energy prices for consumers.

1) Levelized Cost of Energy is the average cost per unit of electricity generated over the lifetime of an energy-producing asset. 2) The LCOE figures shown exclude subsidies. Including applicable renewable subsidies like ITC/PTC would result in even lower prices. 3) Hybrid solar is a PV system coupled with battery storage. 4) Actual running costs (SRMC: Short Run Marginal Cost) will vary by plant. Assumes a $4/MMBtu natural gas price and a $3.5/MWh REC price. 5) Excludes Production Tax Credit and RECs.
Sources: Aurora Energy Research, National Weather Service, ERCOT, EIA

Restricting renewables build reduces wind and solar capacity additions by 14GW in the limited case and 27GW in the most restrictive case in 2035

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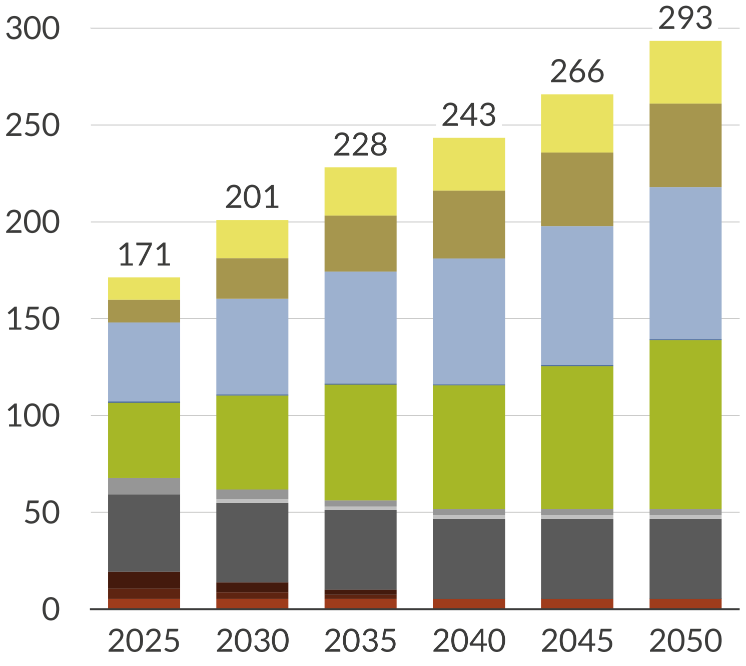
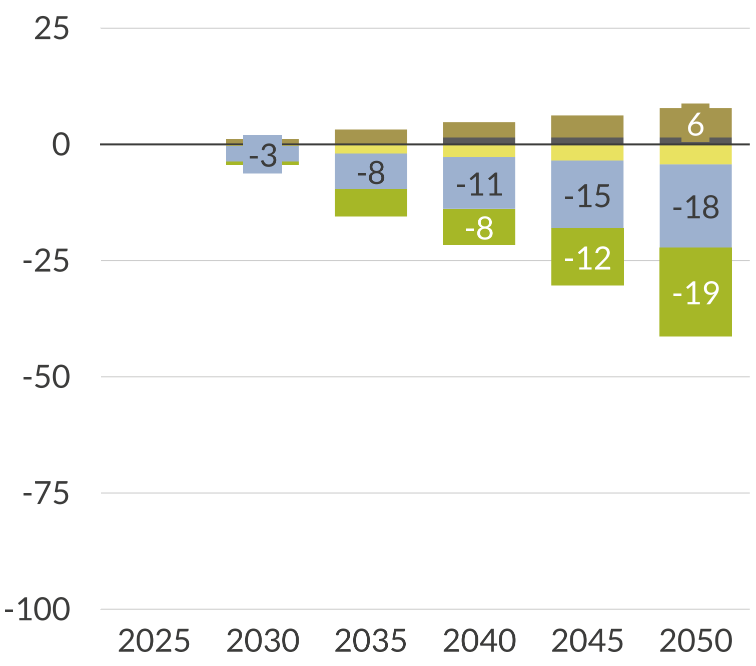
Aurora Central "Status Quo" capacity stack
GW



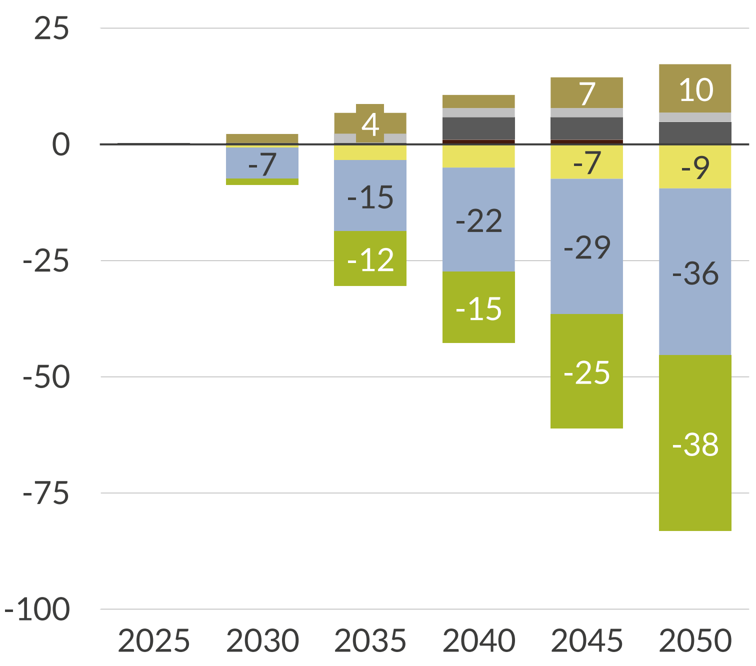
- Capacity grows in ERCOT to meet growing demand requirements.
- New entrants are primarily renewables and flexible generators such as batteries and peakers.

Capacity delta to Central (Limited Renewables)
GW



- Limiting renewables capacity by 50% equates to a reduction of nearly 40GW by 2050.
- 7.5GW of combined peaking and CCGT capacity is needed to replace renewables and batteries.

Capacity delta to Central (Fully Restricted Renewables)
GW



- Fully restricting renewables leads to 74GW less combined wind and solar by 2050. Battery economics worsen with fewer renewables, leading to a reduction of 9GW.
- 17 GW of combined peaking and CCGT capacity is needed to replace renewables and batteries.

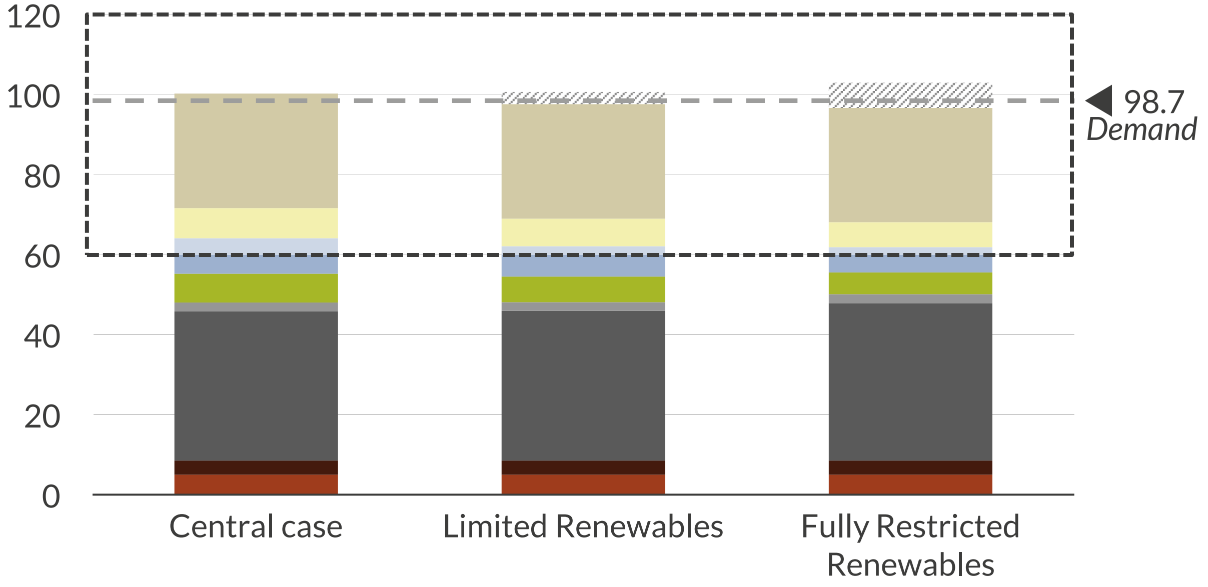
Nuclear | Lignite | Coal | Gas CCGT[1] | Gas CCS | Other thermal | Solar | Other RES[2] | Hydro | Onshore wind | Gas / oil peaker[3] | Battery storage

Sources: Aurora Energy Rresearch

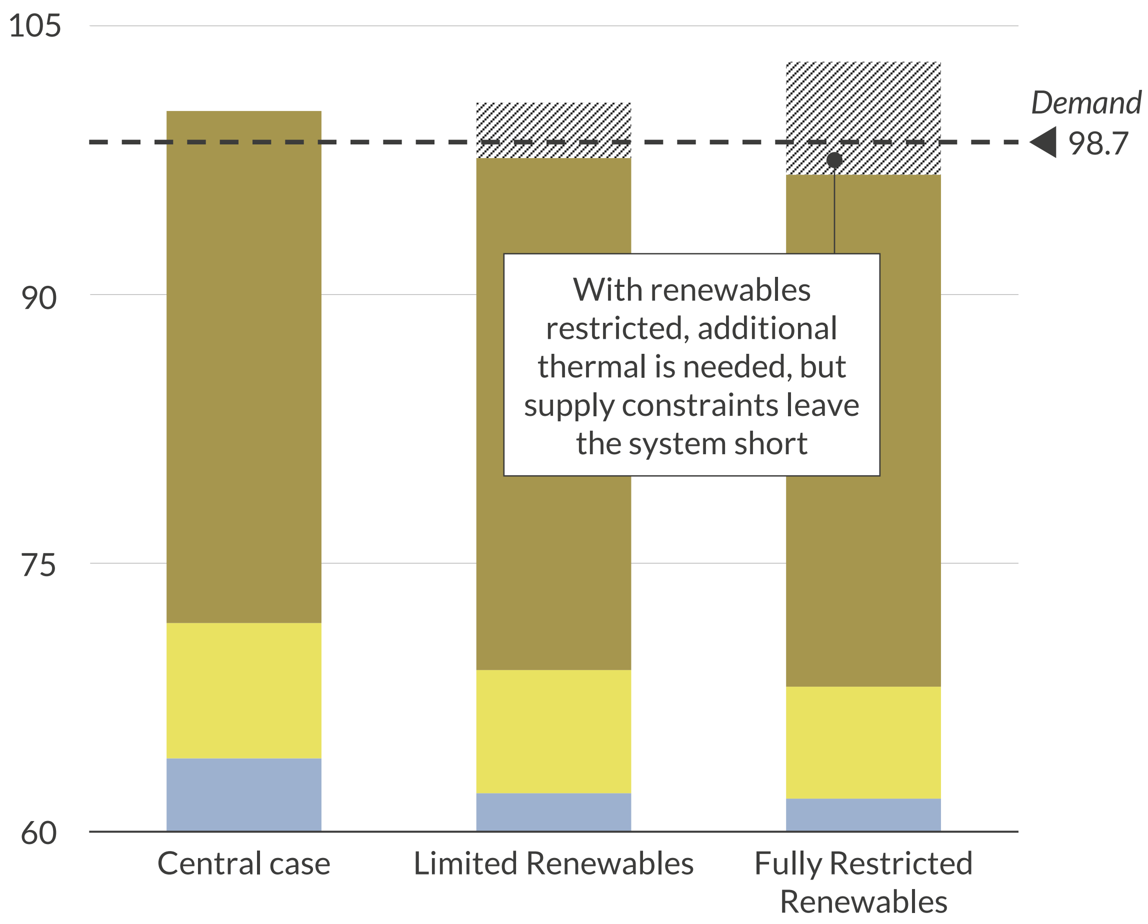
Restricting renewables while thermal supply chains are constrained leads to load shedding under summer heatwave conditions

- Restricting renewables build creates the need to build **additional thermal generation**.
- Supply chain constraints **are constraining the ability for new thermal capacity to build** to replace the generation lost from restricted renewables.
- Under summer heatwave conditions, **capacity shortfalls occur** in both the Limited Renewables and Fully Restricted Renewables scenarios.

Generation by technology during tightest system conditions (2035)[1]
GW



Supply shortfall
GW



Nuclear | Coal | Gas CCGT[1] | Other thermal | Solar | Onshore wind | Battery storage[3] | Gas / oil peaker | Supply constraints

1) Tightest system conditions occur in August. Generation by technology represents average hourly production across a 6-hour shortfall event.

Sources: Aurora Energy Research

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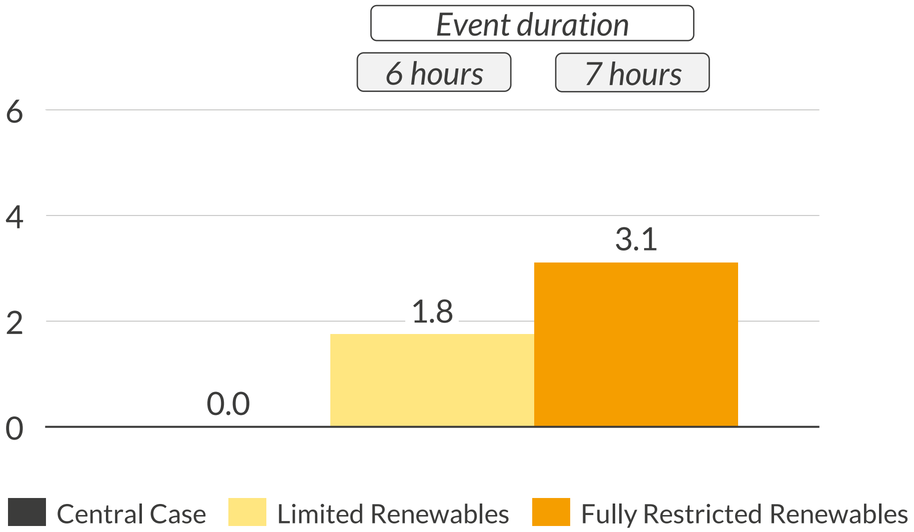
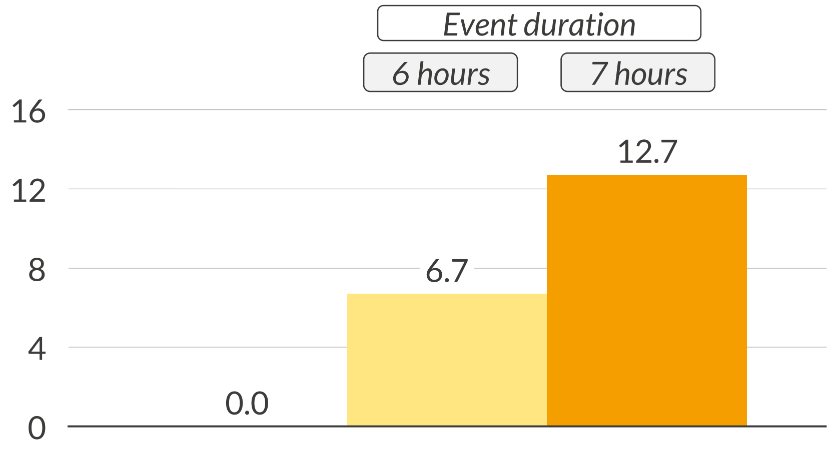
When accounting for thermal supply chain constraints, restricting renewables causes load shed between 1.8GW and 3.1GW across cases

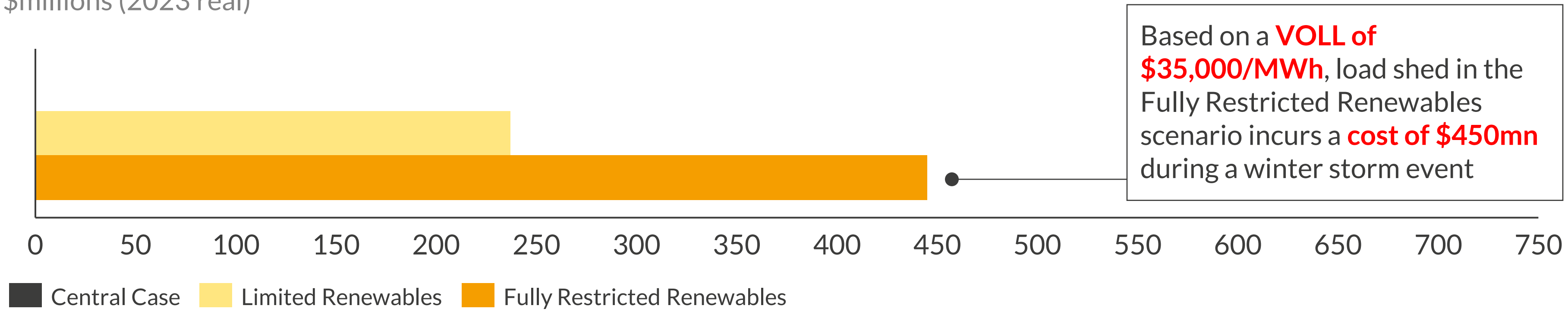
Max load shed, 2035
GW



Total load shed, 2035
GWh



Cost of lost load, 2035
$millions (2023 real)

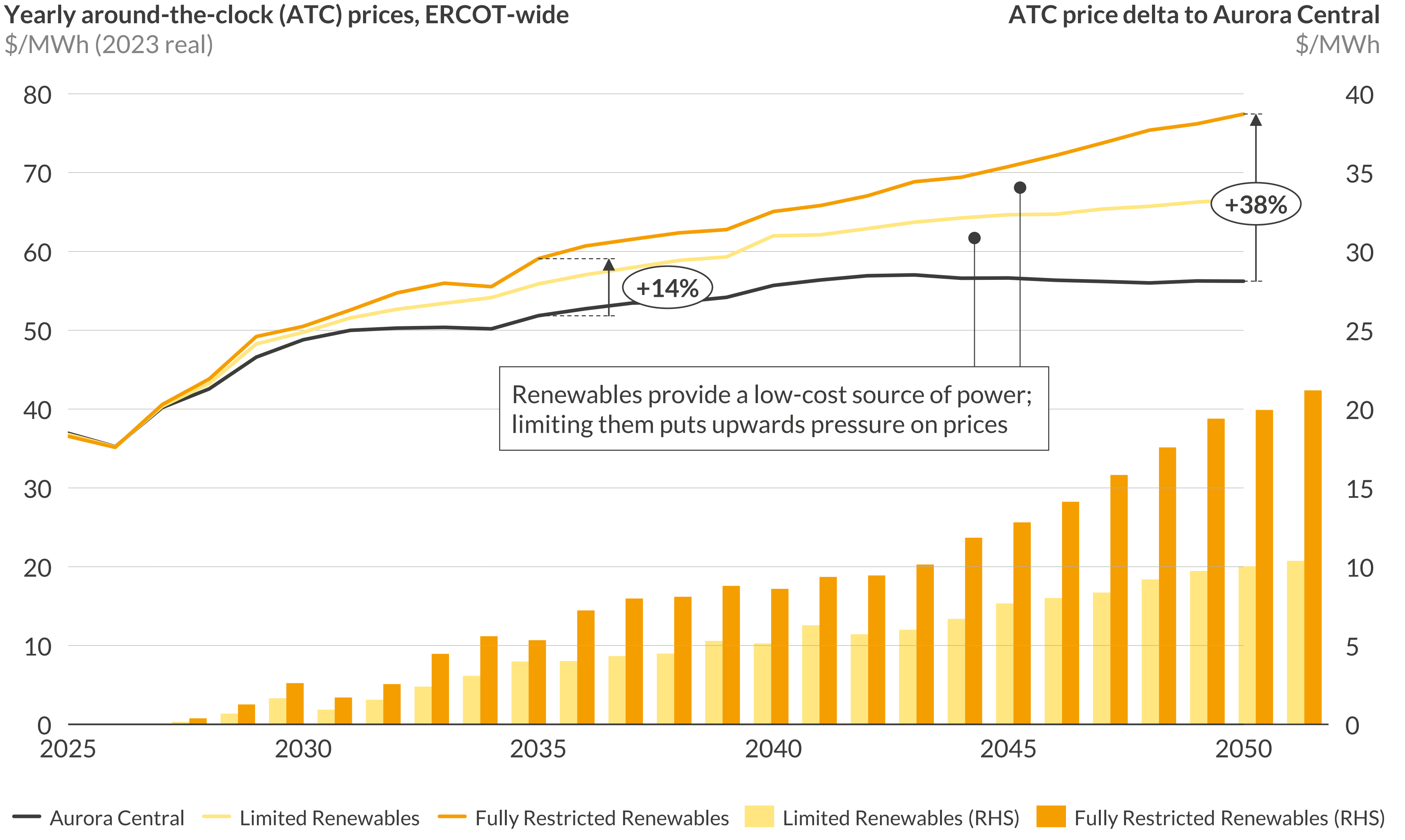


- Load shedding events occur under both the Limited Renewables and Fully Restricted Renewables cases.
- Fully restricting renewables build leads to the largest amount of load shed, with max load shed reaching 3.1GW.
- 1.8GW to 3.1GW of load shed represents between 360,000 and 620,000 homes without power.[1]
- Based on a $35,000/MWh value of lost load, total load shed costs range from $237mn to $445mn in the Limited Renewables and Fully Restricted Renewables scenarios, respectively.

1) 1 megawatt (MW) of electricity can power about 200 Texas homes during periods of peak demand.

Sources: Aurora Energy Research

Limiting renewables causes power prices to rise; prices in the Fully Restricted Renewables scenario increase by 38% by 2050

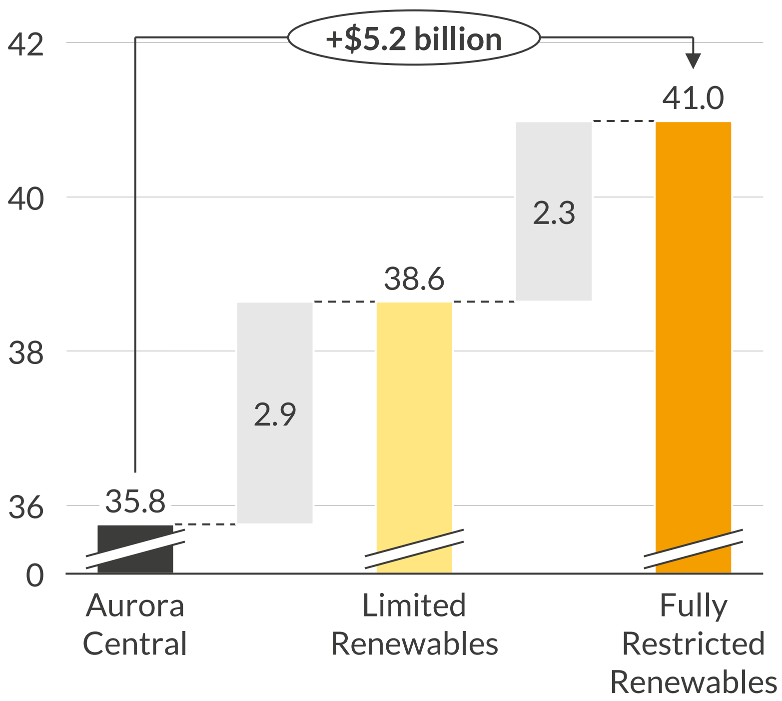


- Power prices in both the Limited Renewables and Fully Restricted Renewables cases rise in the mid to long-term as the system becomes more reliant on gas power generation, with prices in the Fully Restricted Renewables case reaching nearly $80/MWh by 2050., or a 38% increase compared to our Central case.
- Renewables generate at a very low cost, and depending on subsidies will often pay the system to run. Limiting or restricting their buildout forces the system to use more natural gas and coal to generate power. These fuel sources cost more and put upwards pressure on power prices.

Sources: Aurora Energy Research

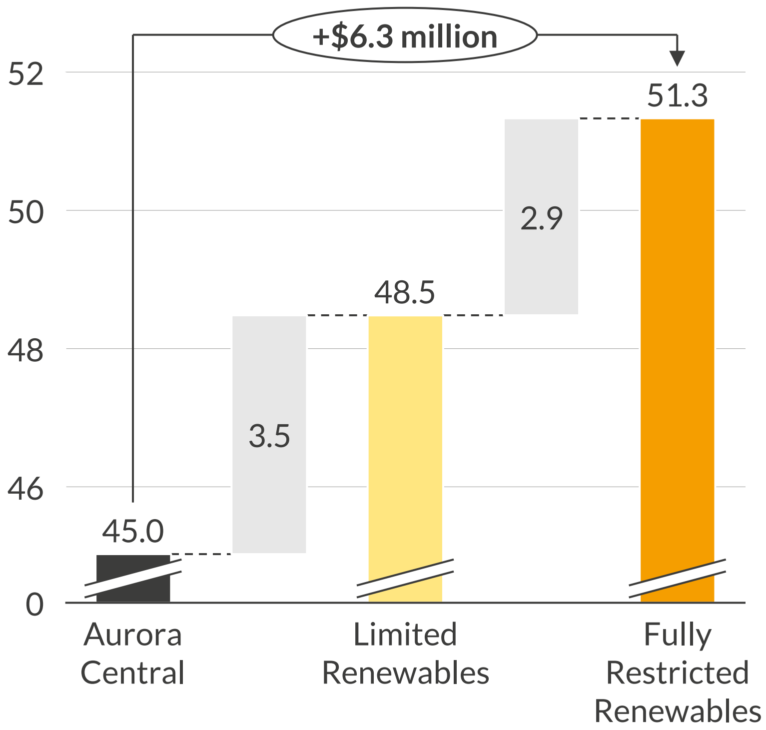
Higher prices translate to a system cost increase of $5.2bn in 2035, or +$6.3million/year for an industrial consumer and $225/year for a household

All-in system costs, 2035[1]
$billion (2023 real)



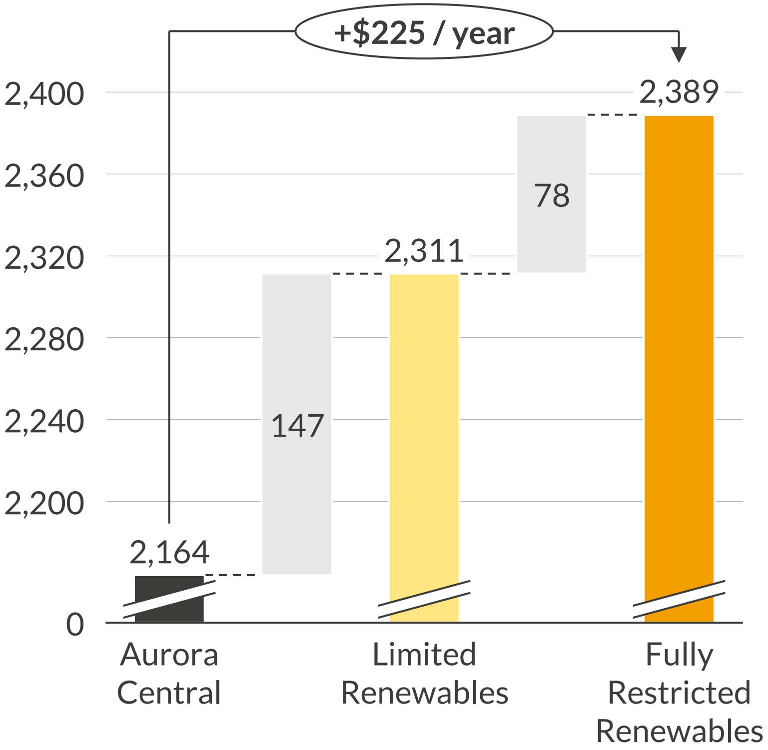
- In the Fully Restricted Renewables scenario, all-in **system costs rise by $5.2bn** per year in 2035, as low-cost renewable generation is replaced by thermal powered energy.

Cost to an industrial consumer, 2035[2]
$million (2023 real)



- For a 100MW baseload consumer, restricting renewables **increases costs by $6.3 million per year** in 2035 .

Cost to an average Texas household, 2035
$ (2023 real)



- For the average Texas household, restricting renewables would **increase the yearly cost of electricity by $225**, approximately 10%.

1) Includes wholesale and ancillary costs. 2) Assumes exposure to ERCOT North power prices. Does not include transmission costs. 3) 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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Renewables have been increasingly contributing to ERCOT's ability to meet its rising peak demand by providing more electricity during peak hours

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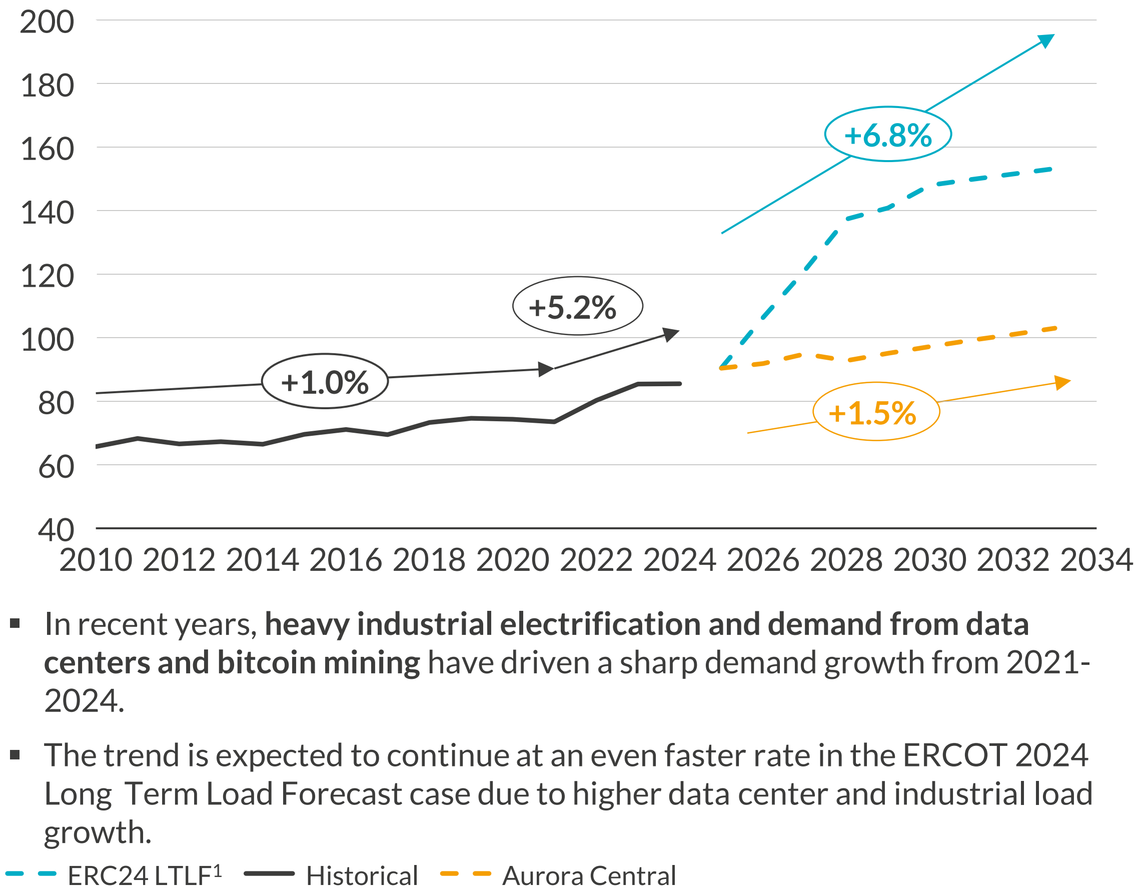
1 Data center and industrial load growth are driving a sharp increase in peak demand, regardless of the scenario considered

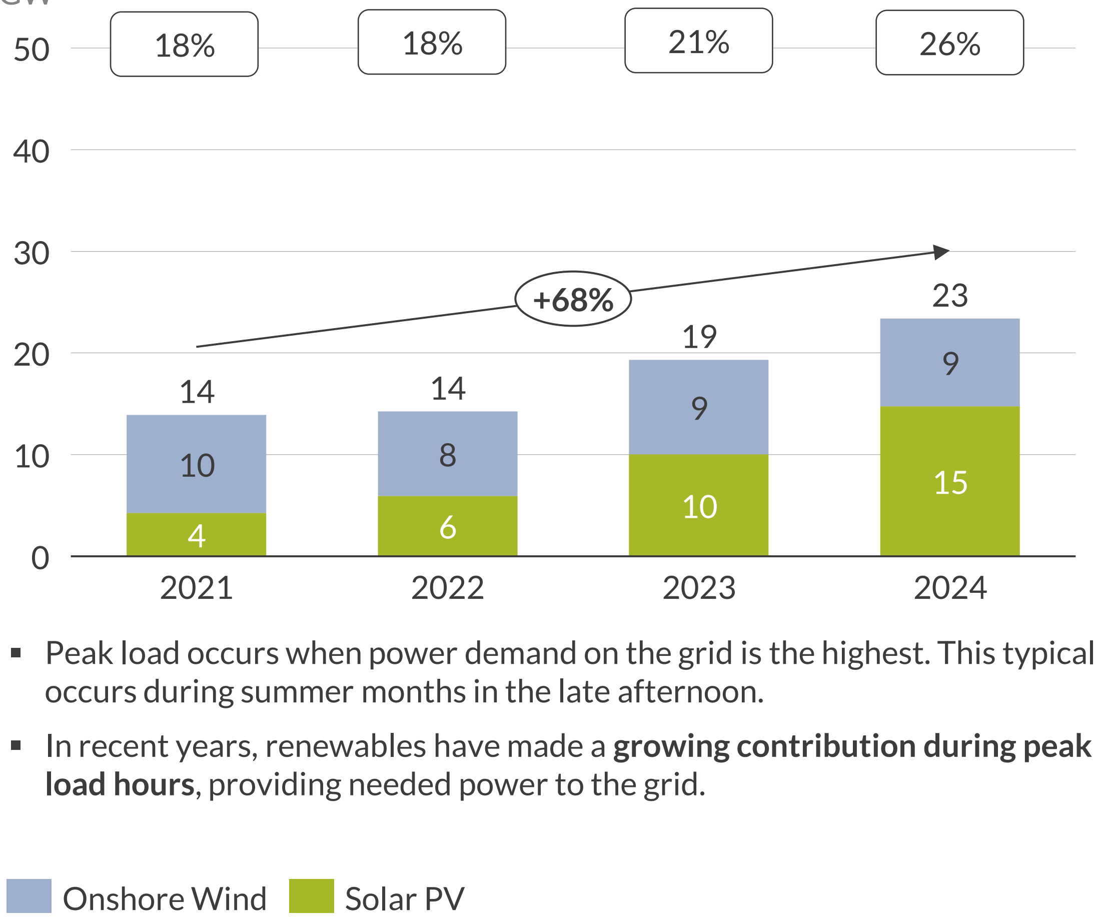
ERCOT Peak Load
GW



- In recent years, **heavy industrial electrification and demand from data centers and bitcoin mining** have driven a sharp demand growth from 2021-2024.
- The trend is expected to continue at an even faster rate in the ERCOT 2024 Long Term Load Forecast case due to higher data center and industrial load growth.

2 Renewables production during peak load hours, when demand on the system is highest, has increased steadily since 2021

Average generation during peak load hours[2]
GW



- Peak load occurs when power demand on the grid is the highest. This typically occurs during summer months in the late afternoon.
- In recent years, renewables have made a **growing contribution during peak load hours**, providing needed power to the grid.

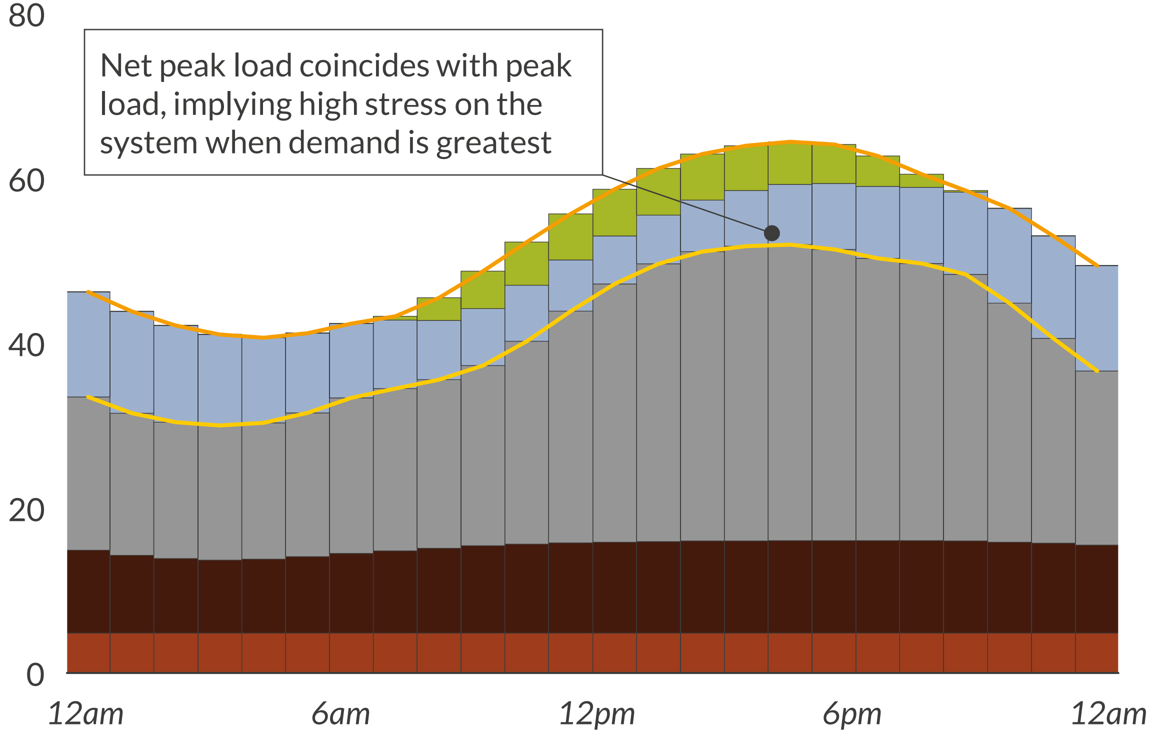
1) ERCOT Revised 2024 Long-Term Load Forecast. 2) Generation during August between 4pm and 6pm.

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

Between 2021 and 2024, renewables generation increased during peak summer demand, shifting peak net load to the evening

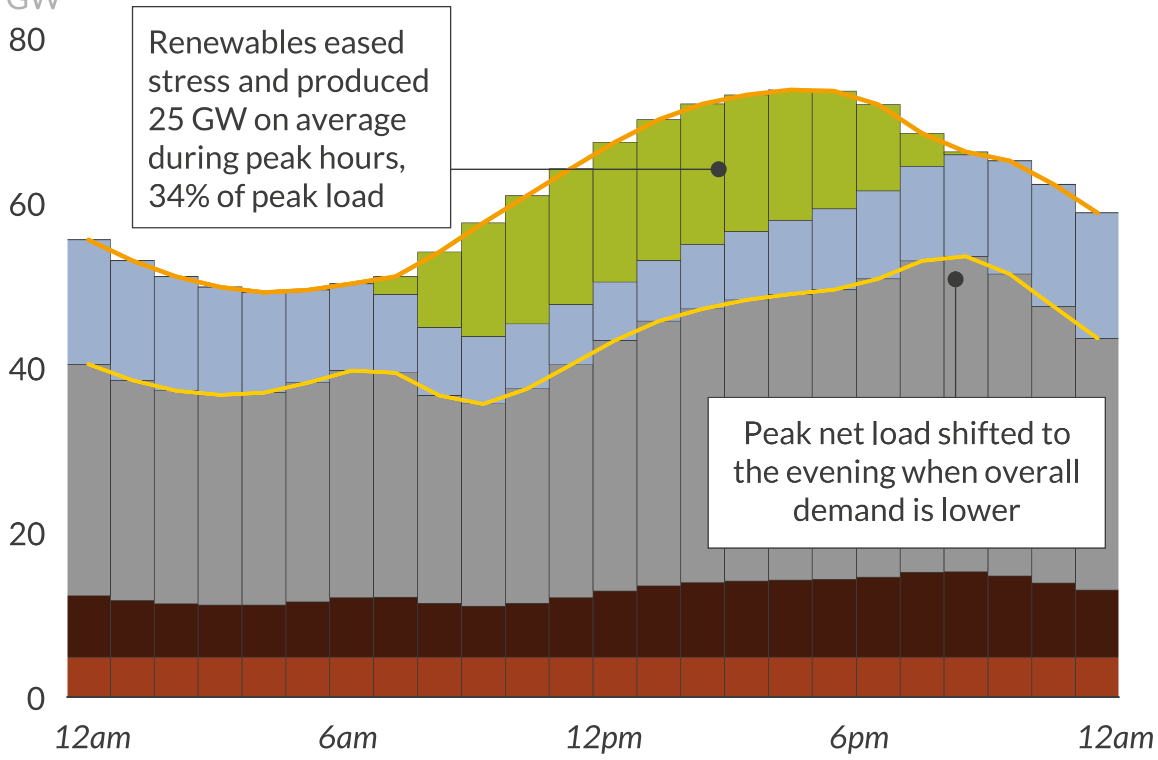
Generation on summer days in ERCOT[1] (2021)

GW



Generation on summer days in ERCOT[1] (2024)

GW



- In 2021 there were fewer renewables on the system, leaving the system with **tight margins and high reliance on thermal generators to meet demand**.
- In 2024, significant renewables generation during peak load hours **reduced net load and eased stress on the system**. Peak net load has shifted to the evening, and the ratio of peak net load to peak load **dropped to 73% from 81% in 2021**.

Nuclear | Coal | Gas + Peaking | Wind | Solar | Peak Load | Net Peak Load

1) Generation during August.

Sources: Aurora Energy Research, National Weather Service, ERCOT

Flexible dispatchable resources are paired with renewables to provide consistent energy during periods of low solar and wind output

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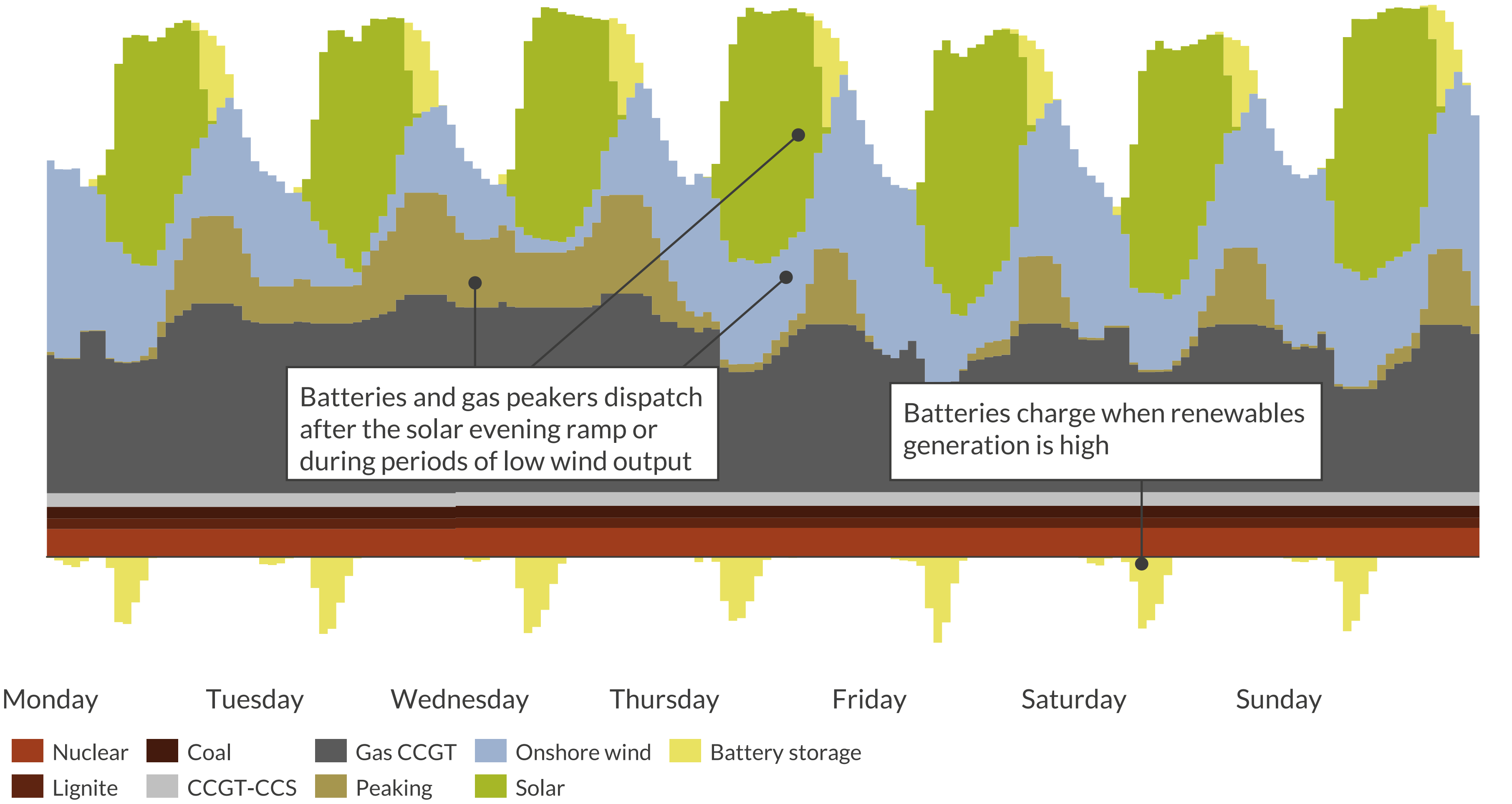
Generation by technology in an example week
GW

Illustrative



- The combination of renewables and flexible dispatchable resources (e.g. batteries, gas peakers) offers an effective way to serve load consistently and reliably throughout the day.
- During the times when renewables are generating heavily on sunny/windy days, batteries can charge at cheap prices.
- When renewable generation is low on cloudy/windless days, flexible dispatchable technologies can fill in the gaps and ensure grid reliability.

From lower overall costs to reduced running costs, renewables contribute to lowering power prices

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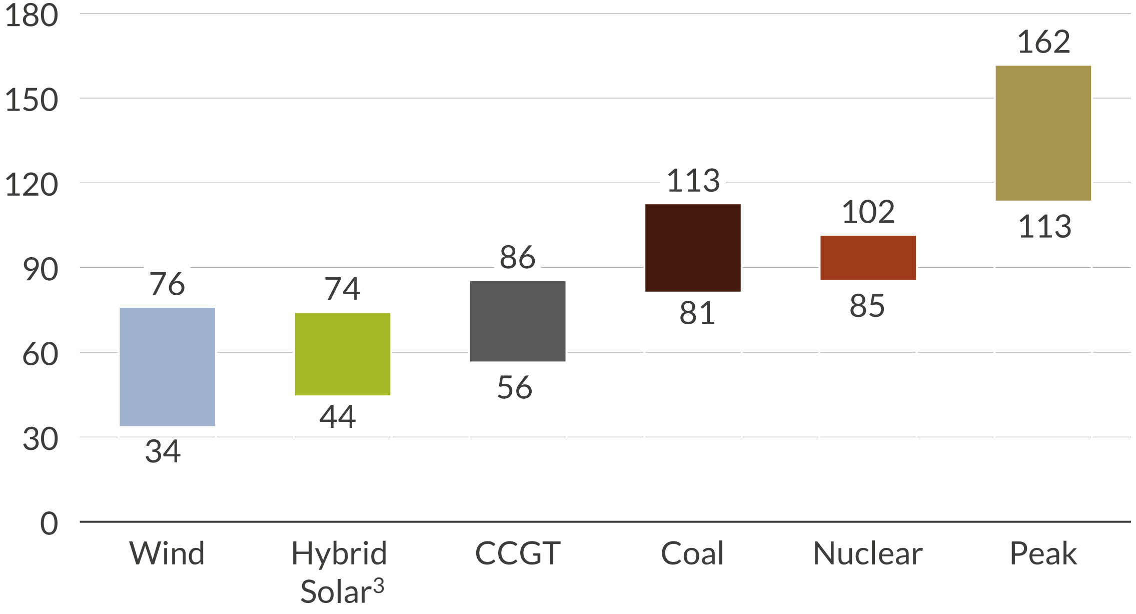
1 Renewables' lower overall costs make them an economical addition to the generation mix

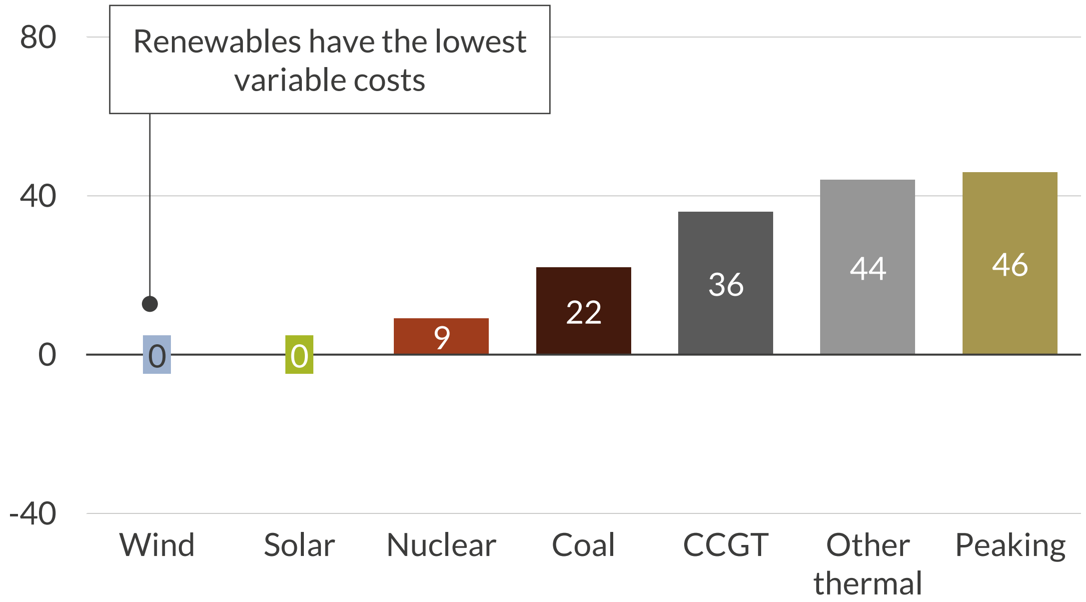
LCOE[1] by technology in Texas (excluding subsidies)[2]
$/MWh



- LCOE includes various costs throughout the asset's lifetime, such as capital costs, operation and maintenance costs, financing costs, and running costs.
- Technological advancements and increasing demand for clean energy have driven down renewables' costs significantly, making them an economical source of energy to meet the growing demand.

2 Renewables offer lower running costs than other types of generation, leading to reduced energy prices

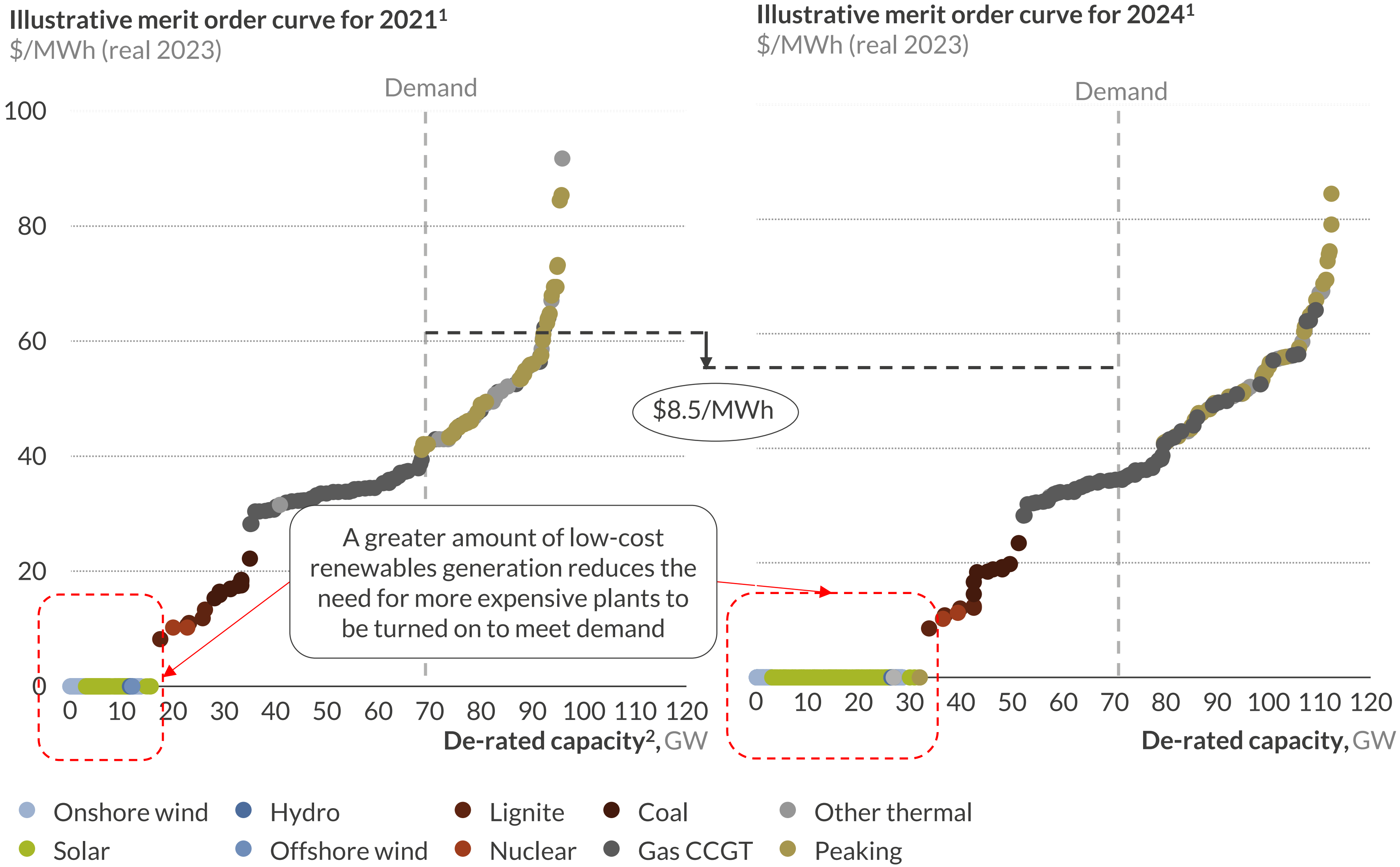
Running cost [4] by technology (excluding subsidies)[5]
$/MWh (real 2023)



- Running costs measure the cost to produce a MWh of power and include components such as fuel, variable operations and the cost of starting.
- Since renewables don't require fuel, they have **little to no running costs**, leading to reduced electricity generation prices and effectively lowering energy prices for consumers.

1) Levelized Cost of Energy is the average cost per unit of electricity generated over the lifetime of an energy-producing asset. 2) The LCOE figures shown exclude subsidies. Including applicable renewable subsidies like ITC/PTC would result in even lower prices. 3) Hybrid solar is a PV system coupled with battery storage. 4) Actual running costs (SRMC: Short Run Marginal Cost) will vary by plant. Assumes a $4/MMBtu natural gas price and a $3.5/MWh REC price. 5) Excludes Production Tax Credit and RECs.
Sources: Aurora Energy Research, National Weather Service, ERCOT, EIA

Increasing low-cost solar and wind generation reduces the need to turn on more expensive generators, lowering power prices



1) The illustrative curve is made based on the assumptions of $3.5/MMBtu gas price and 70GW demand. The curve also excludes subsidies. Including applicable renewable subsidies like ITC/PTC would result in even lower prices. 2) Assumed 75% of rated solar capacity and 15% of rated wind capacity, thermal remains the same as the rated capacity.
Sources: Aurora Energy Research, ERCOT

Several key trends:

- Power supply in ERCOT is dispatched with an aim to minimize system cost, clearing in preference of:
  - Low-marginal cost assets such as onshore wind and solar
  - Thermal baseload assets such as natural gas and coal
  - Peaking natural gas assets and energy storage
- The supply stack evolves with increasing penetration of renewables and other technologies.
- The rapid growth in renewables results in low-cost renewable assets fulfilling a greater portion of demand, removing the need for the market to dispatch inefficient and expensive plants to meet demand and lowering energy prices.

Texas has nearly tripled its renewables installed capacity due to its fast interconnection process and abundant natural resources

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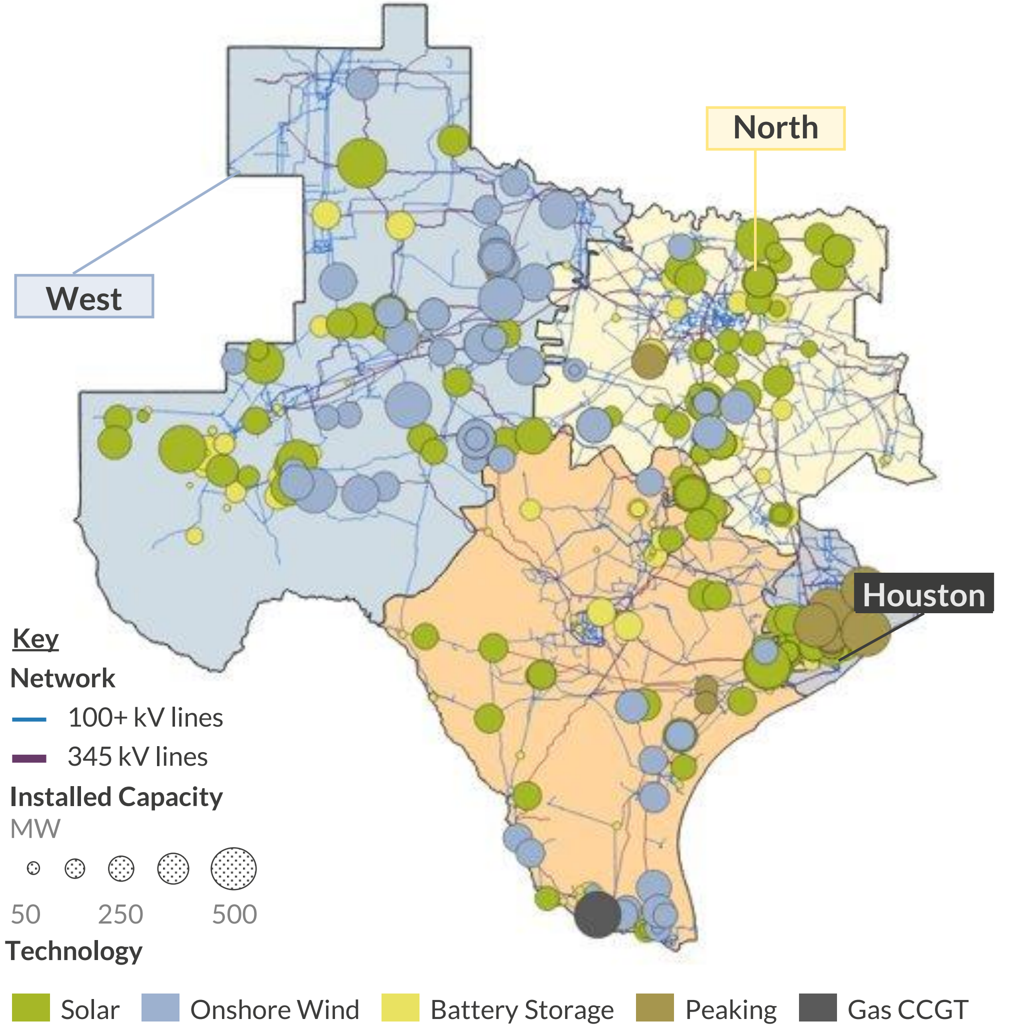
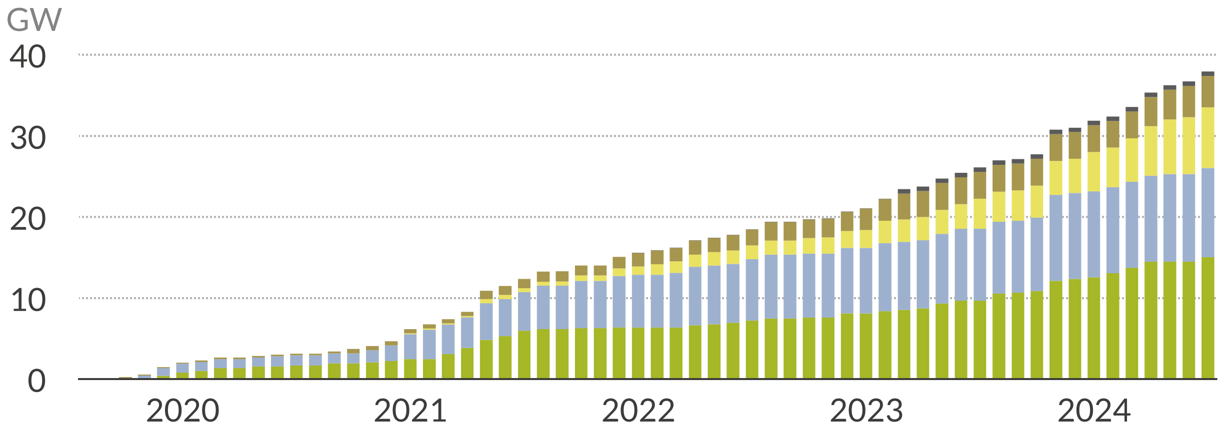
COD[1] capacity[2] in ERCOT 2020-24



"Connect and Manage" Interconnection

- Unlike other US grid operators that require lengthy system impact studies and network upgrades before a project can connect, ERCOT allows projects to connect first and manage congestion later, allowing renewables to start operating quickly.
- ERCOT also prioritizes grid management rather than delaying connections for transmission upgrades from developers, leading to a faster interconnection process.

Cumulative COD[1] capacity[2] monthly in ERCOT 2020-24,



- Texas has natural resources ideal for renewables, such as strong and consistent wind in the Panhandle and West Texas, and high solar irradiance across the state. Combined with abundant land resources, renewable projects are highly efficient and cost-effective.
- The increasing renewables also reduced emissions by lowering the carbon intensity of electricity generation from 416 gCO_2/kWh in 2021 to 389 gCO_2/kWh in 2022[3].

1) Commercial operation date, i.e., considering assets that began producing power for the grid in the month listed. 2) Locations are approximate, and some projects are overlapping. Doesn't include repowers of existing assets. 3) ERCOT emission data is limited and assumed to be 90% of total electric power sector emissions of Texas.
Sources: Aurora Energy Research, ERCOT, EIA

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Aurora modeled the impact of different levels of renewables adoption on power prices and reliability across three different scenarios

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As per *Central* scenario unless otherwise indicated		Aurora Central	Limited Renewables	Fully Restricted Renewables
Technology	**Renewables**	Late-stage development projects are assumed to reach commercialization. Long-term, renewables build in the based on economic signals.	Late-stage development projects are assumed to reach commercialization. Long-term, economics-based renewables build is reduced by 50% relative to Aurora Central.	Late-stage development projects are assumed to reach commercialization. Long-term, renewables do not build.
Policy	**Intended objective**	Continue the status quo. Renewables receive federal tax credits but do not receive state level subsidies.	Limit the development and growth of renewables.	Fully disallow the development of renewables beyond projects which are already late-stage.
	Pollution standards	Plants face increasing costs at end of lifetime (like EPA NOx allowances) but are not mandated to close		
	Reliability	New entry determined by market economics		
	Renewables incentives	Inflation Reduction Act provisions for wind, solar and battery out to 2035. 40% ITC available to batteries. Beyond this point Tax Credit support is kept at final year values. 45Q available to new build and refurbishing Gas CCGT CCS plants		
	Transmission upgrades	Strengthening of network increases transmission capacity between most regions by ~50% by 2050		
Demand	**Underlying demand**	+234TWh to 2060 driven by population and industrial growth		
	EVs	2m EVs by 2030 and 24m by 2060		
	Bitcoin mining	3GW of mining load held constant through the horizon, price of bitcoin at $60,000 through horizon		
	Hydrogen electrolysis	Demand for hydrogen electrolysis begins in 2028, reaches 5GW by 2050		
Commodities	**Gas price**	Prices increase to $3.7/MMBtu in 2030 and $4.3 in 2050		
	Coal price	Stable coal price across forecast horizon		

Sources: Aurora Energy Research

Restricting renewables build reduces wind and solar capacity additions by 14GW in the limited case and 27GW in the most restrictive case in 2035

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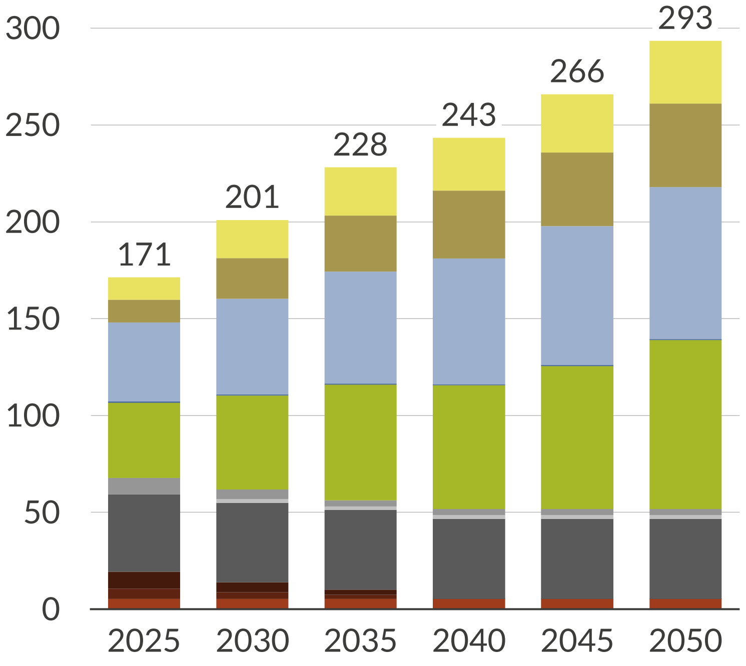
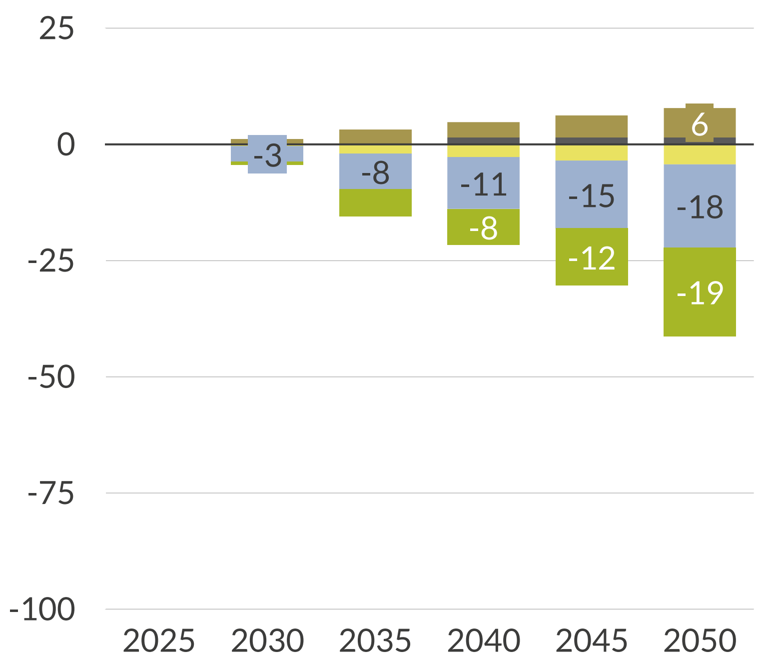
Aurora Central "Status Quo" capacity stack
GW



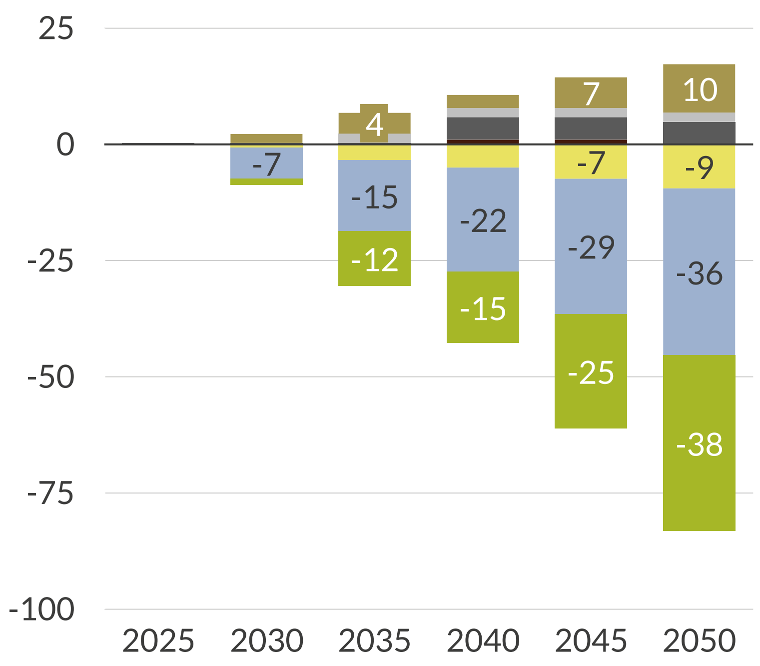
- Capacity grows in ERCOT to meet growing demand requirements.
- New entrants are primarily renewables and flexible generators such as batteries and peakers.

Capacity delta to Central (Limited Renewables)
GW



- Limiting renewables capacity by 50% equates to a reduction of nearly 40GW by 2050.
- 7.5GW of combined peaking and CCGT capacity is needed to replace renewables and batteries.

Capacity delta to Central (Fully Restricted Renewables)
GW



- Fully restricting renewables leads to 74GW less combined wind and solar by 2050. Battery economics worsen with fewer renewables, leading to a reduction of 9GW.
- 17 GW of combined peaking and CCGT capacity is needed to replace renewables and batteries

Nuclear | Lignite | Coal | Gas CCGT[1] | Gas CCS | Other thermal | Solar | Other RES[2] | Hydro | Onshore wind | Gas / oil peaker[3] | Battery storage

Sources: Aurora Energy Rresearch

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AURORA

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2. Pricing outcomes

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Total load is forecasted to grow rapidly and will require significant capacity additions to ensure reliability

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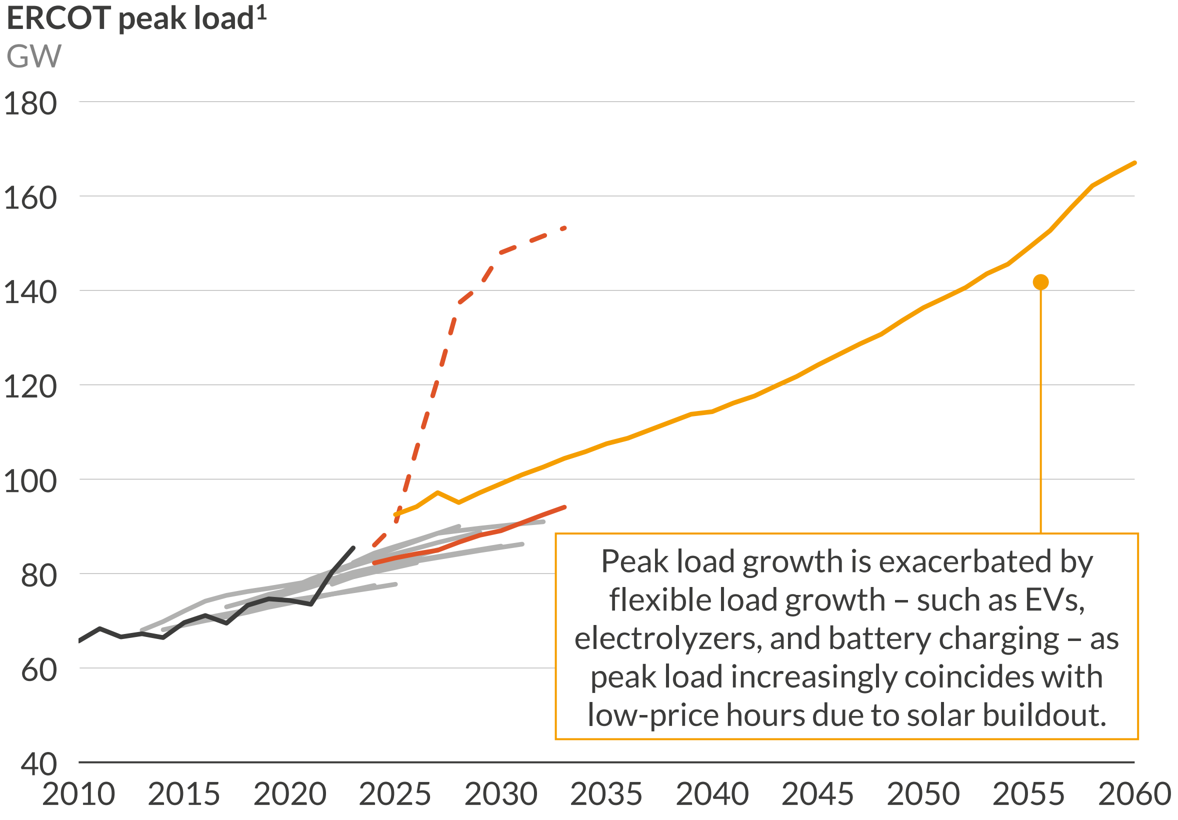
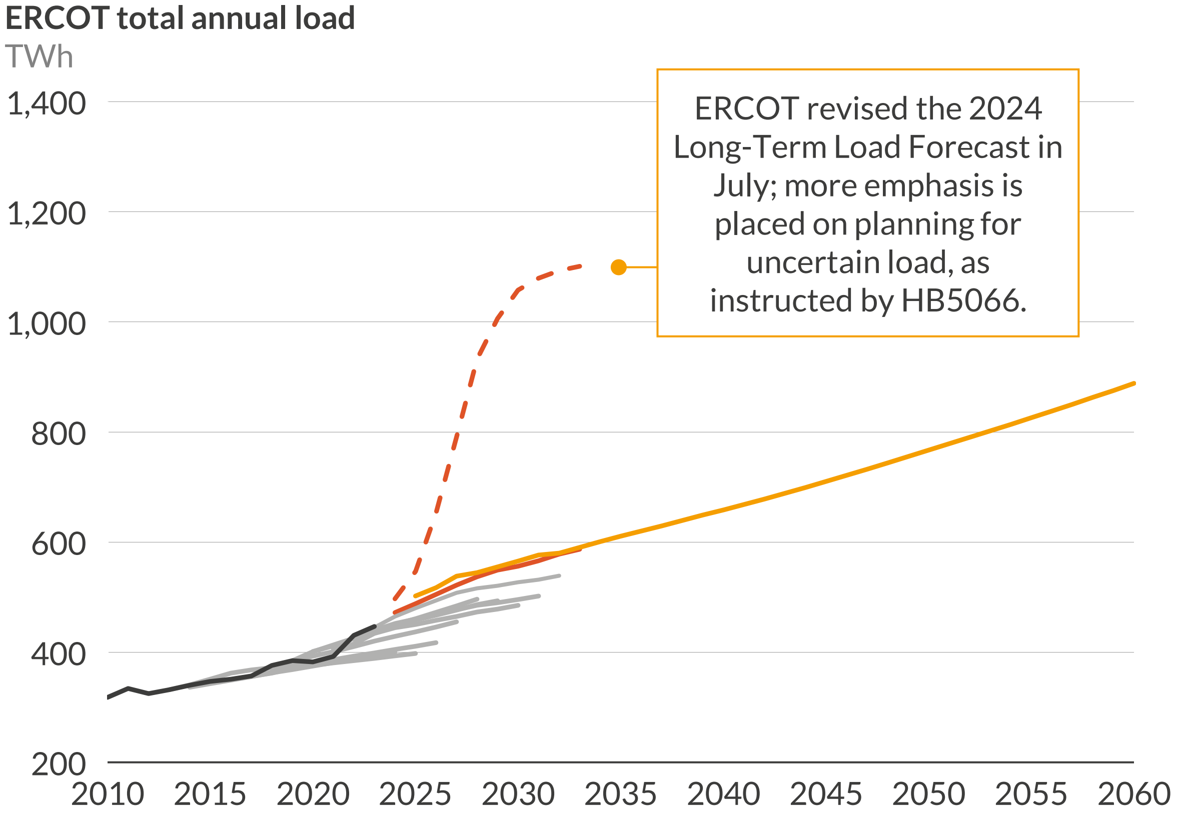


- Future peak and annual demand growth are driven by economic growth, datacenter, industrial development, and HVAC.
- Peak load is forecasted to reach 99GW by 2030.



- Annual energy demand is set to increase in line with peak demand and reaches 538TWh in 2027 and 566TWh by 2030. Beyond 2030, demand continues to increase as population increase, industrial and datacenter demand growth, electrification of transport, and onset of hydrogen electrolyzers offset efficiency improvements.

1) Summer peak demand. 2) 2024 Long-Term Load Forecast, released January 2024. 3) Revised 2024 Long-Term Load Forecast, released July 2024.

Sources: Aurora Energy Research, ERCOT

Thermal supply chain constraints could prevent additional gas plants from being built to backfill for restricted renewables

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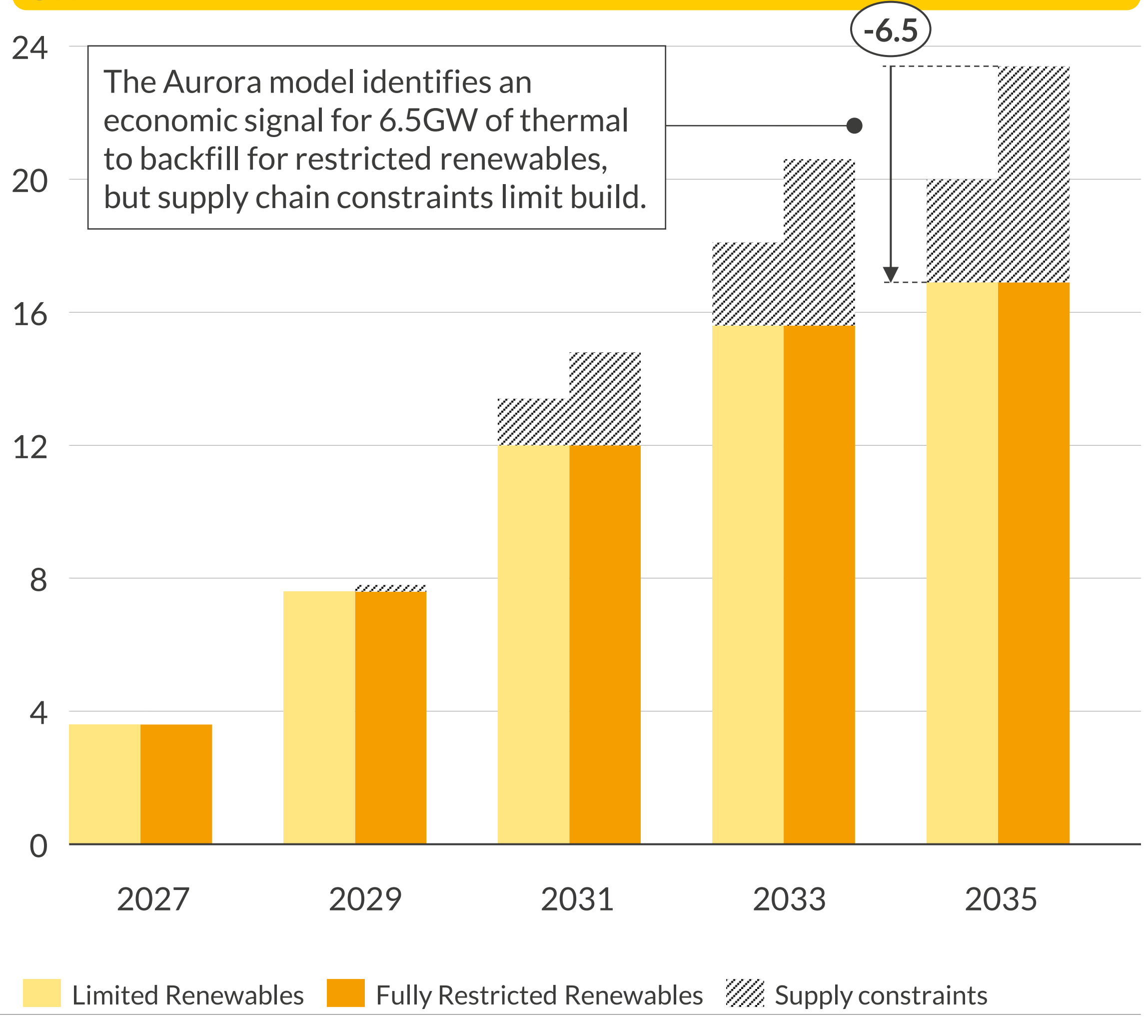
Overview of thermal supply chain challenges and recent impacts

- 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 induced delays**.
- Why does it matter?
  - The reliability of the grid is dependent on having sufficient supply to meet demand. If renewables are restricted and gas turbine supply chains limit thermal capacity, the grid is at **an increased risk of a capacity shortfall**, which could lead to forceable load shed and power outages.

Capturing the impact of supply chain constraints – modeling methodology

- To quantify this impact, Aurora **limited thermal build across scenarios to that of the Central case**, assuming supply chain constraints would prevent any further thermal capacity expansion.
- Using the updated supply stack, Aurora then measured the impact on reliability, with a focus on forecast periods when the system is at its tightest.

Cumulative thermal additions, ERCOT-wide
GW



Sources: Aurora Energy Research, Heatmap

Restricting renewables while thermal supply chains are constrained leads to load shedding under summer heatwave conditions

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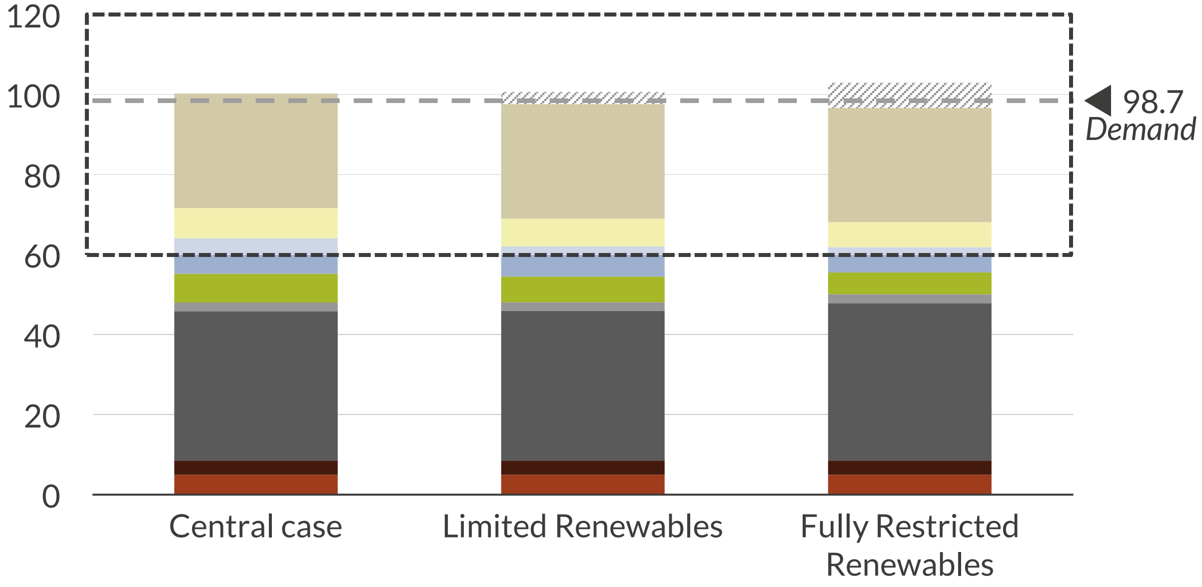
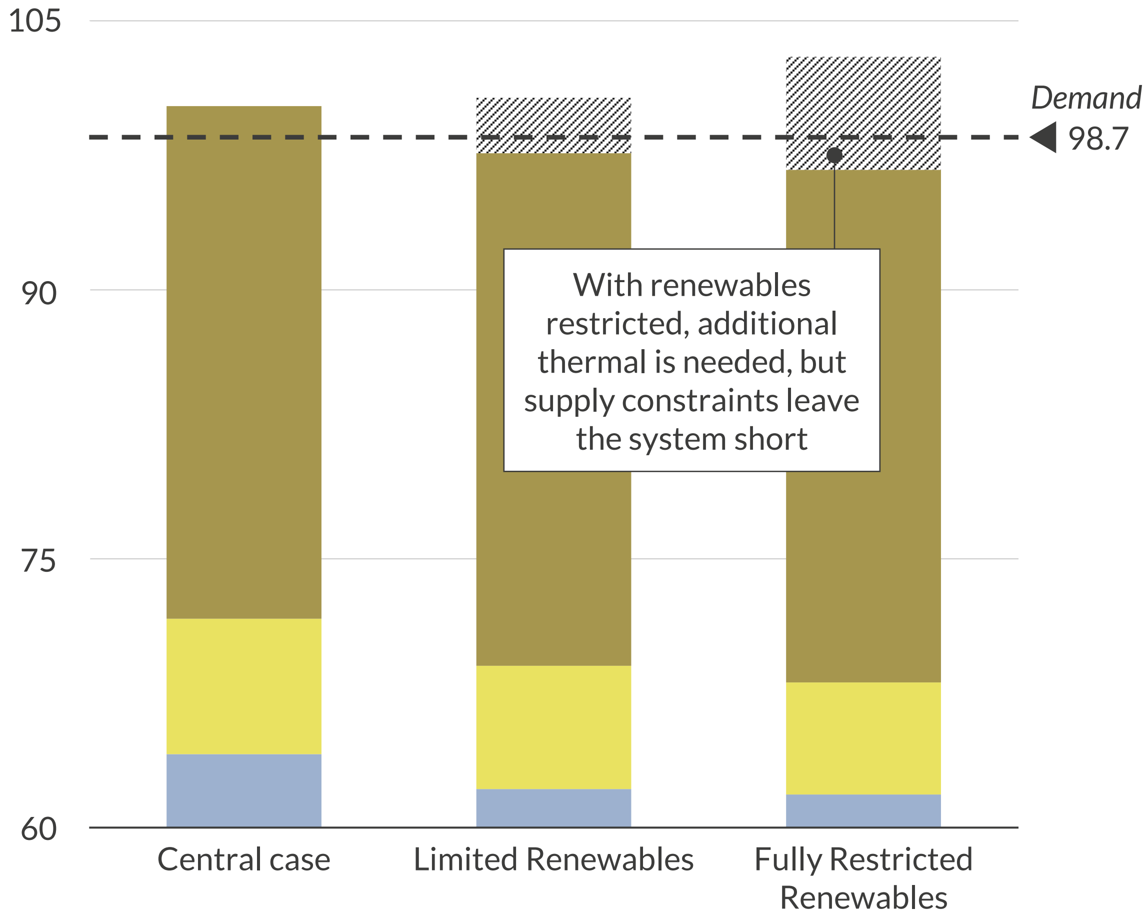
- Restricting renewables build creates the need to build **additional thermal generation**.
- Supply chain constraints **are constraining the ability for new thermal capacity to build** to replace the generation lost from restricted renewables.
- Under summer heatwave conditions, **capacity shortfalls occur** in both the Limited Renewables and Fully Restricted Renewables scenarios.

Generation by technology during tightest system conditions (2035)[1]
GW



Supply shortfall
GW



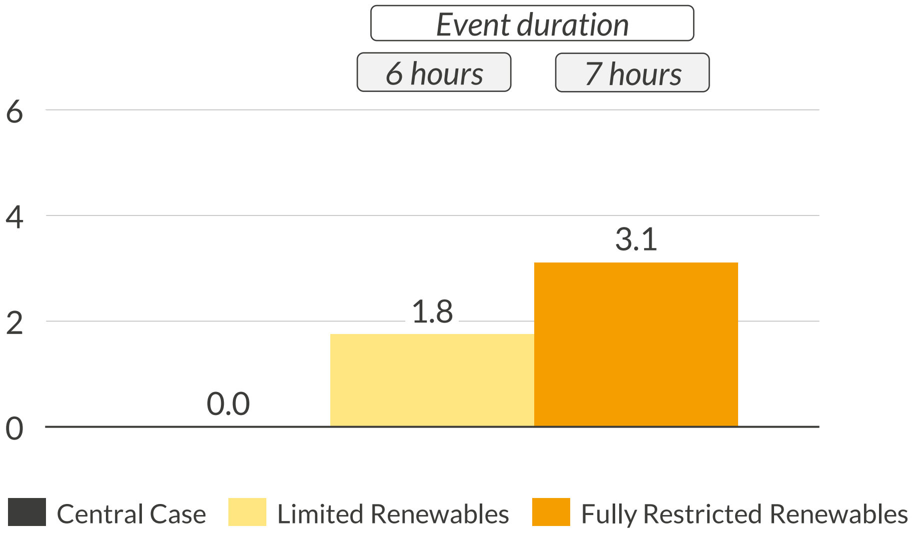
Nuclear | Coal | Gas CCGT[1] | Other thermal | Solar | Onshore wind | Battery storage[3] | Gas / oil peaker | Supply constraints

1) Tightest system conditions occur in August. Generation by technology represents average hourly production across a 6-hour shortfall event.

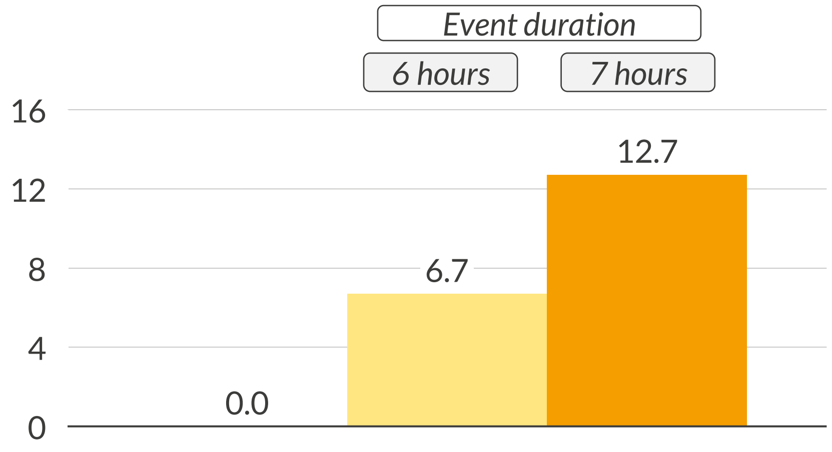
Sources: Aurora Energy Research

When accounting for thermal supply chain constraints, restricting renewables causes load shed between 1.8GW and 3.1GW across cases

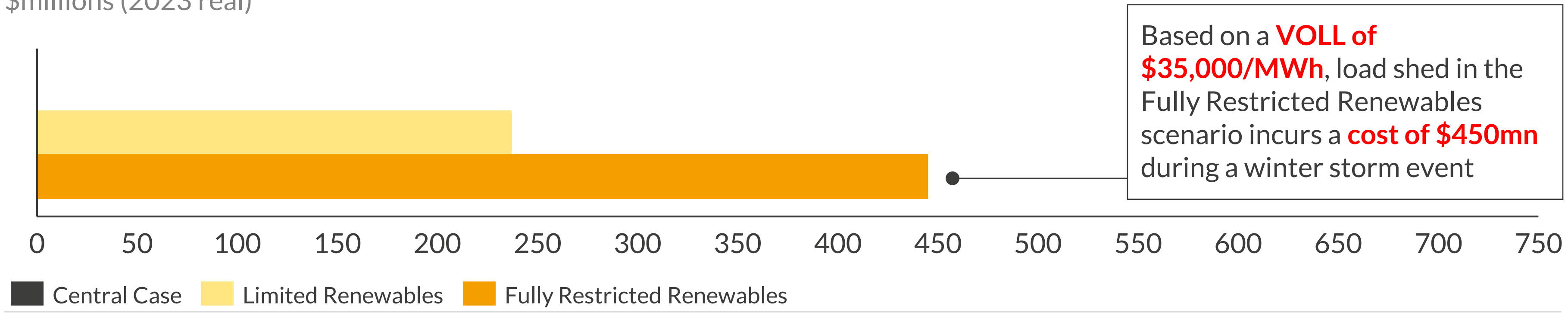
Max load shed, 2035
GW



Total load shed, 2035
GWh



Cost of lost load, 2035
$millions (2023 real)



- Load shedding events occur under both the Limited Renewables and Fully Restricted Renewables cases.
- Fully restricting renewables build leads to the largest amount of load shed, with max load shed reaching 3.1GW.
- 1.8GW to 3.1GW of load shed represents between 360,000 and 620,000 homes without power.[1]
- Based on a $35,000/MWh value of lost load, total load shed costs range from $237mn to $445mn in the Limited Renewables and Fully Restricted Renewables scenarios, respectively.

1) 1 megawatt (MW) of electricity can power about 200 Texas homes during periods of peak demand.

Sources: Aurora Energy Research

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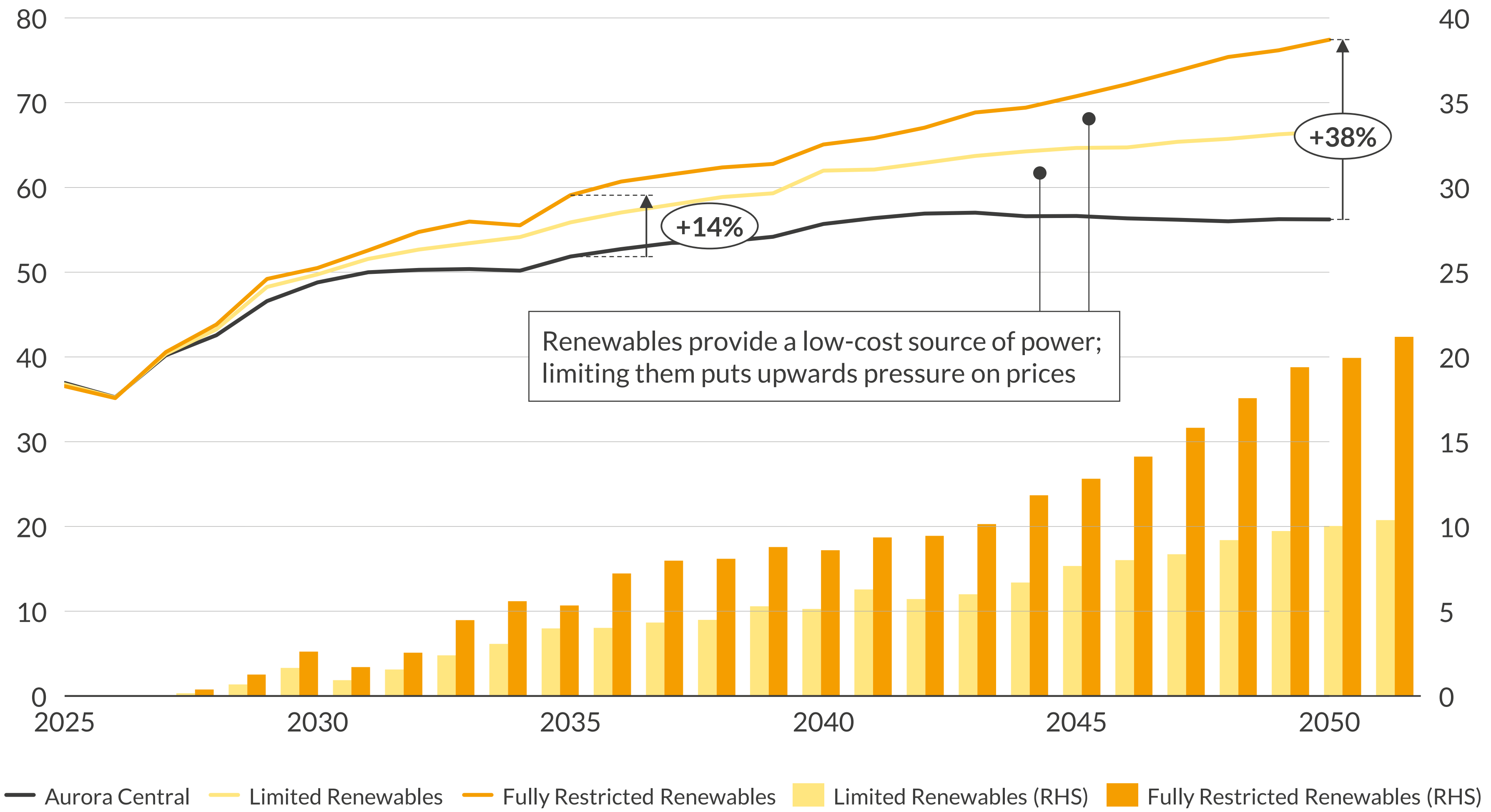
Limiting renewables causes power prices to rise; prices in the Fully Restricted Renewables scenario increase by 38% by 2050

Yearly around-the-clock (ATC) prices, ERCOT-wide
$/MWh (2023 real)

ATC price delta to Aurora Central
$/MWh



Sources: Aurora Energy Research

- Power prices in both the Limited Renewables and Fully Restricted Renewables cases rise in the mid to long-term as the system becomes more reliant on gas power generation, with prices in the Fully Restricted Renewables case reaching nearly $80/MWh by 2050., or a 38% increase compared to our Central case.
- Renewables generate at a very low cost, and depending on subsidies will often pay the system to run. Limiting or restricting their buildout forces the system to use more natural gas and coal to generate power. These fuel sources cost more and put upwards pressure on power prices.

Higher prices translate to a system cost increase of $5.2bn in 2035, or +$6.3million/year for an industrial consumer and $225/year for a household

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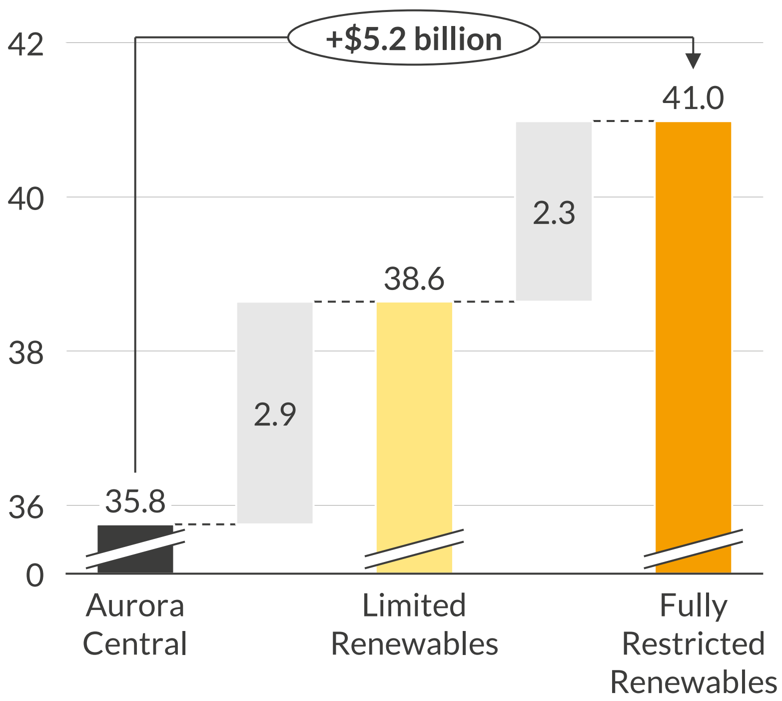
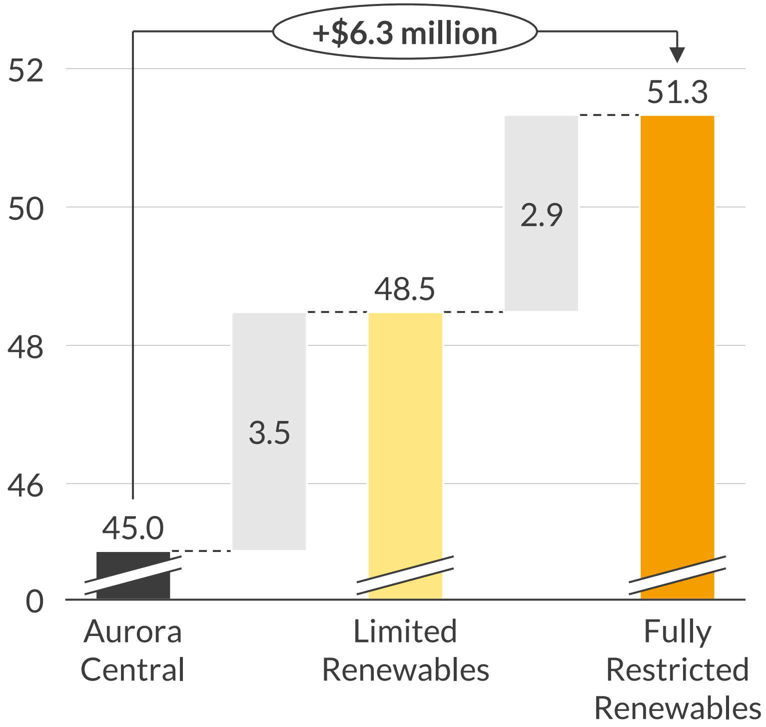
All-in system costs, 2035[1]
$billion (2023 real)



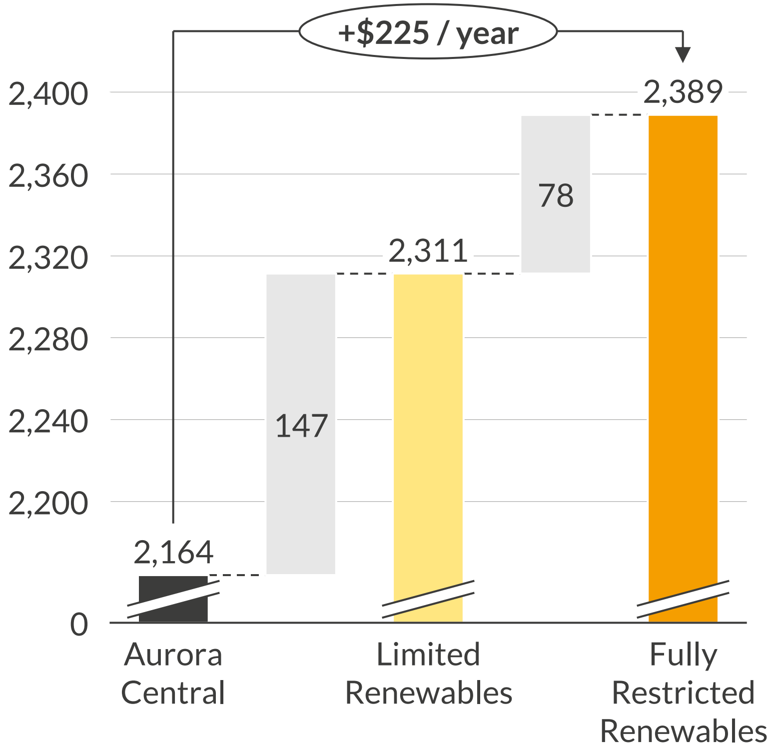
- In the Fully Restricted Renewables scenario, all-in **system costs rise by $5.2bn** per year in 2035, as low-cost renewable generation is replaced by thermal powered energy.

Cost to an industrial consumer, 2035[2]
$million (2023 real)



- For a 100MW baseload consumer, restricting renewables **increases costs by $6.3 million per year** in 2035 .

Cost to an average Texas household, 2035
$ (2023 real)



- For the average Texas household, restricting renewables would **increase the yearly cost of electricity by $225**, approximately 10%.

1) Includes wholesale and ancillary costs. 2) Assumes exposure to ERCOT North power prices. Does not include transmission costs. 3) 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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Aurora's demand forecast is built bottom up; demand is classified by its sector and flexibility

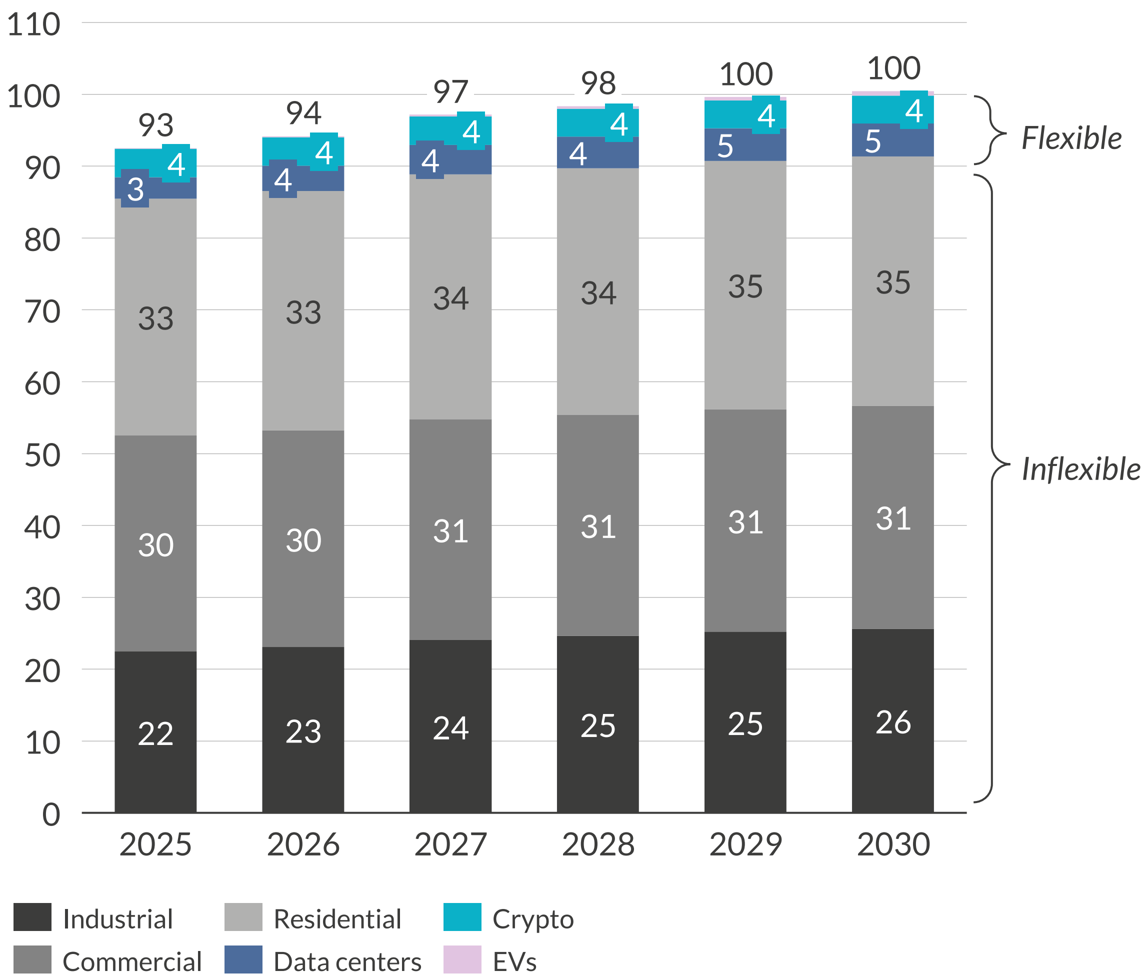
Aurora's demand methodology

- 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

Studies show a wide range of electricity demand growth outcomes from the AI revolution and US data centers by 2030

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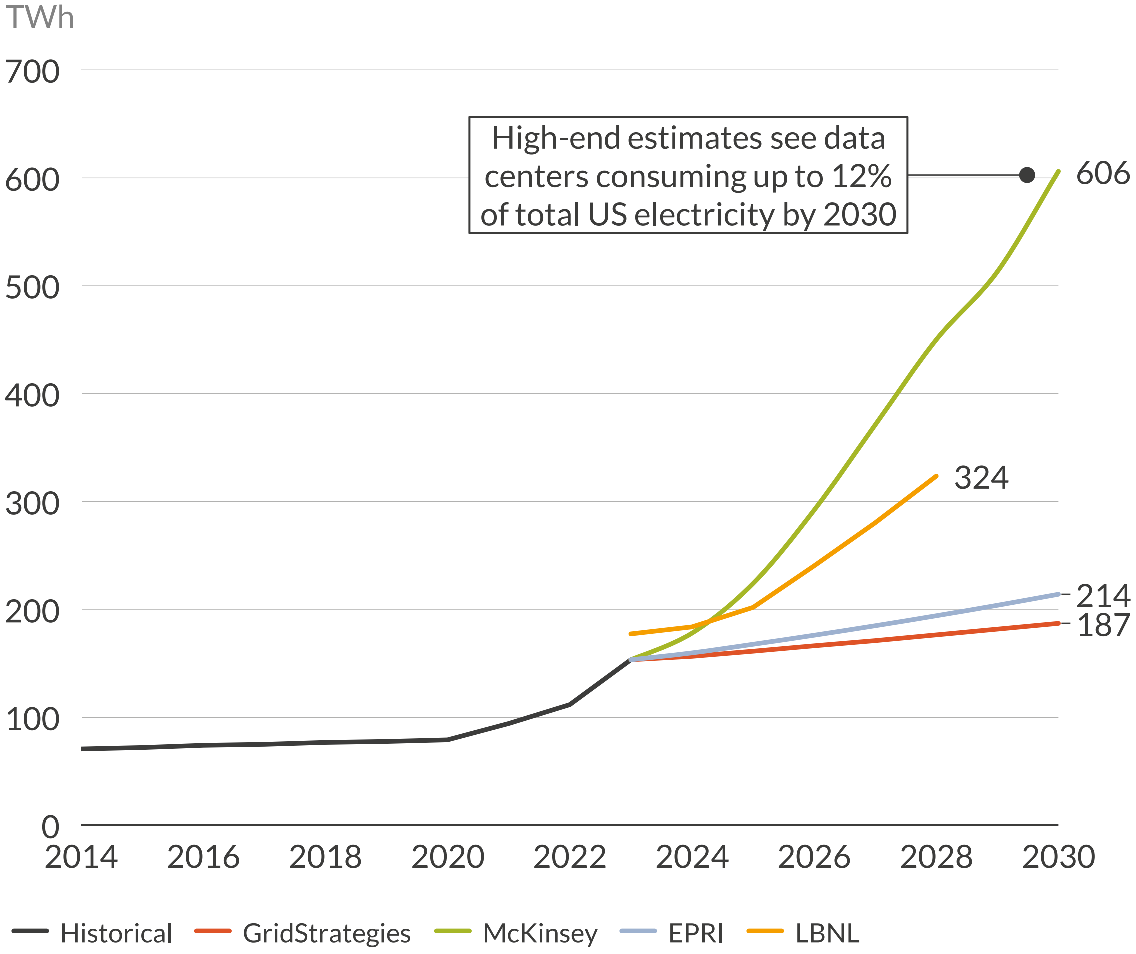
Several studies have been published analyzing the growth trajectory of data center load. These highlight the ambitious investment tech firms are making into AI, but also the real-world challenges of meeting that demand.

Tech companies' need for data center space poses challenges to electrical grids:

- With compute requirements and electricity consumption to train new AI models spiraling upwards, tech firms are seeking to build ever-larger data centers.
- While most hyperscale assets currently measure around 30-50MW, firms are constructing numerous data centers with capacities upwards of 100MW.
- Efficiency improvements were sufficient to keep data center electricity consumption flat through the 2010s despite increased build. However, new AI-focused chips have reversed that trend, consuming more power than previous models and creating uncertainty around the scale of future demand.
- Bringing as much as 1GW of load online in a single location poses transmission challenges, and long interconnection queues are forcing firms to consider all options for bringing those projects to market as fast as possible.
- Some studies foresee up to 70GW of additional data center load by 2030. FERC's more conservative estimate, released in its 2024 Summer Long-Term Reliability Report estimated the market would reach 35GW of capacity in total by 2030. This would still necessitate many GW more baseload demand.

Historical and forecasted U.S. installed data center capacity



Sources: Aurora Energy Research, FERC, Lawrence Berkeley National Laboratory, EPRI, CBRE, GridStrategies, IEA, McKinsey

Auorora incorporates both announced retirements as well as modeled economic retirements into its capacity expansion methodology

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Thermal retirement assumptions between 2025 and 2030[1]

Year	Plant	Size (MW)	Technology/ fuel	Hub
2027	Coleto Creek	655	Coal	South
2027	Martin Lake	893	Lignite	North
2027	Mountain Creek	808	STG[2]	North
2027	Sim Gideon	140	STG	South
2028	J K Spruce	922	Coal	South
2028	Martin Lake	893	Lignite	North
2028	Graham	629	STG	West
2028	O W Sommers	445	STG	South
2029	J K Spruce	560	Coal	South
2029	W A Parish (STG)	863	STG	Houston
2030	W A Parish (coal unit)	734	Coal	Houston
2030	O W Sommers	434	STG	South

Aurora's plant retirement methodology

- **Announced retirements**
  - Announced retirements are incorporated into Aurora's capacity expansion model based on the ERCOT Capacity Demand and Reserves report.
  - This includes full and partial retirements across all technology types.
- **Model based economic retirements**
  - Aurora's capacity expansion model can choose to retire a plant's capacity if its future revenues are insufficient to cover its costs, yielding it present value negative.
  - Additionally, plants built within the model will be retired when they reach the end of their technical lifetime, even if they are present value positive.
  - Aurora's model allows thermal plants to mothball at a yearly granularity, if favorable, as a means to avoid economic retirement.
  - Costs factored into retirement decisions are based on Aurora's in-house research and include values for fuel, as well as fixed and variable operations.

1) Includes full and partial, announced and model based retirements. 2) Steam turbine generator.

Sources: Aurora Energy Research

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

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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 modelling
- Dynamic dispatch of plant
- Ancillary services modelled endogenously

Continuous iteration until an equilibrium is reached

Investment decisions module

- Capacity market modelling (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 modelled for each plant

c. 85k investment hours on modelling capabilities

~15k model runs per week

50+ strength of modelling team globally

Quarterly updates through subscription research

1) Gas, coal, oil and carbon prices fundamentally modelled 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

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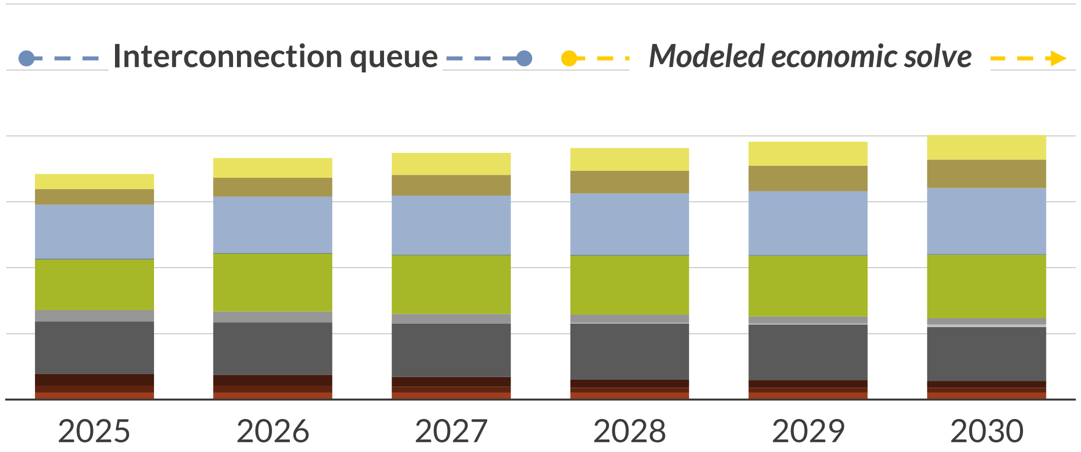
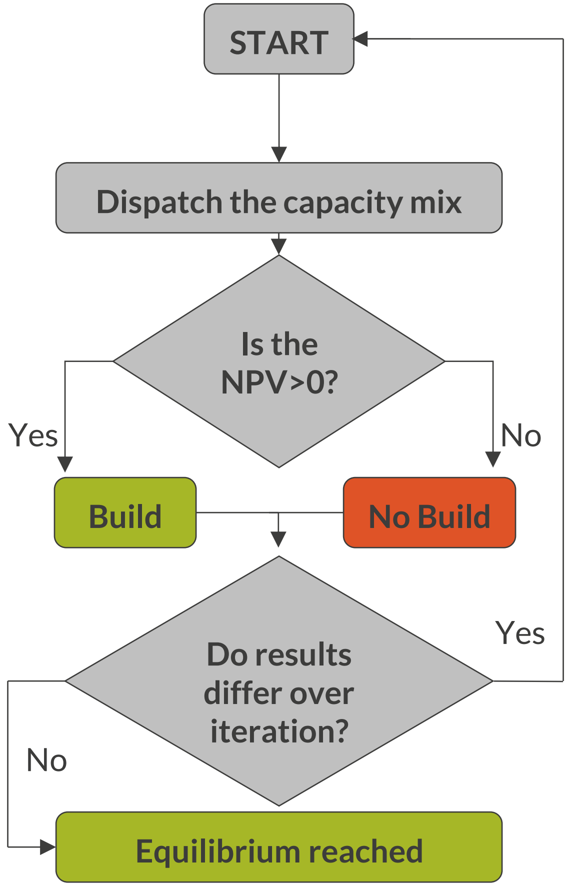
Inclusion of capacity from the ERCOT Interconnection Queue

- 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 independent forecasts and data-driven intelligence for the global energy transition

Power markets

Renewables & PPAs

Storage

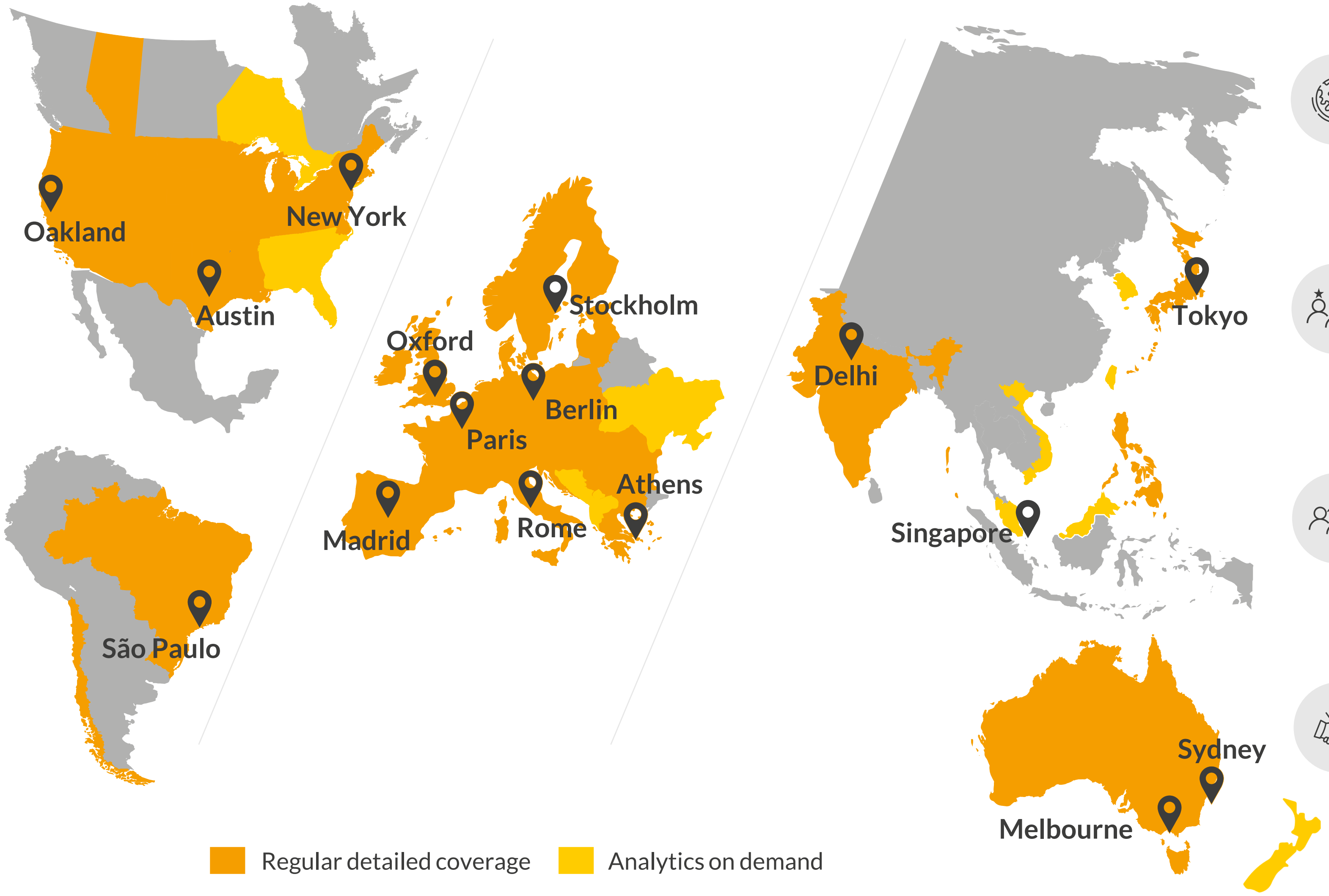
Grid & Congestion

Electric vehicles

Hydrogen H_2

Carbon CO_2

Natural gas



16 offices

900+ market experts

850+ subscribing companies

150+ transactions supported in 2024

Source: Aurora Energy Research

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Details and disclaimer

Date: April 16th, 2025

This report was commissioned by the Texas Association of Business (TAB). All analysis and findings are the independent work and opinion of Aurora Energy Research.

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