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ENERGY RESEARCH

A Shift in Iberian Demand: From Machinery to Data

26 November 2024

Public Report

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Source: Aurora Energy Research

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

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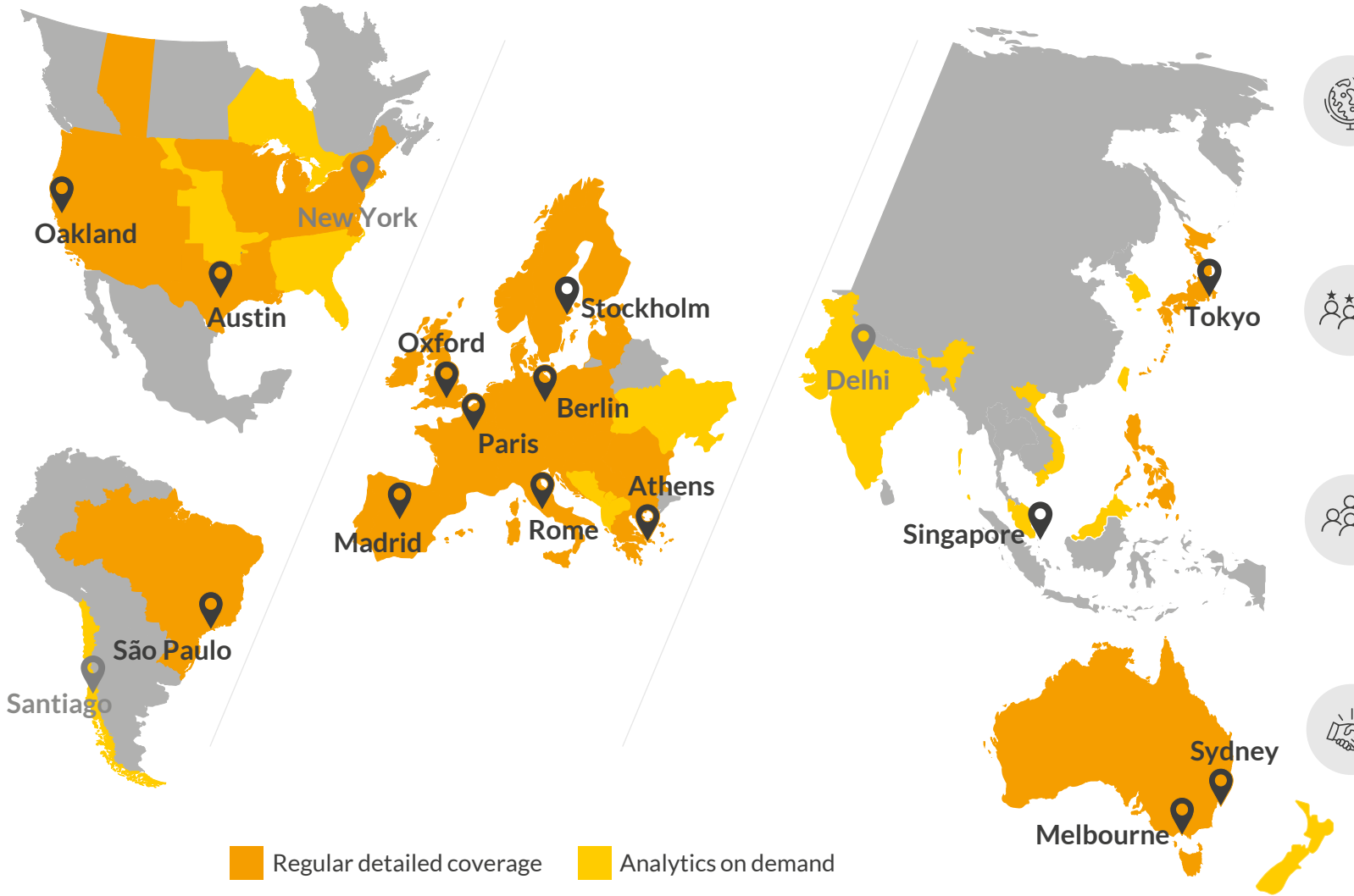
- Renewables & PPAs
- Storage
- Grid & Congestion
- Electric vehicles
- Hydrogen H_2
- Carbon CO_2
- Natural gas



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Source: Aurora Energy Research

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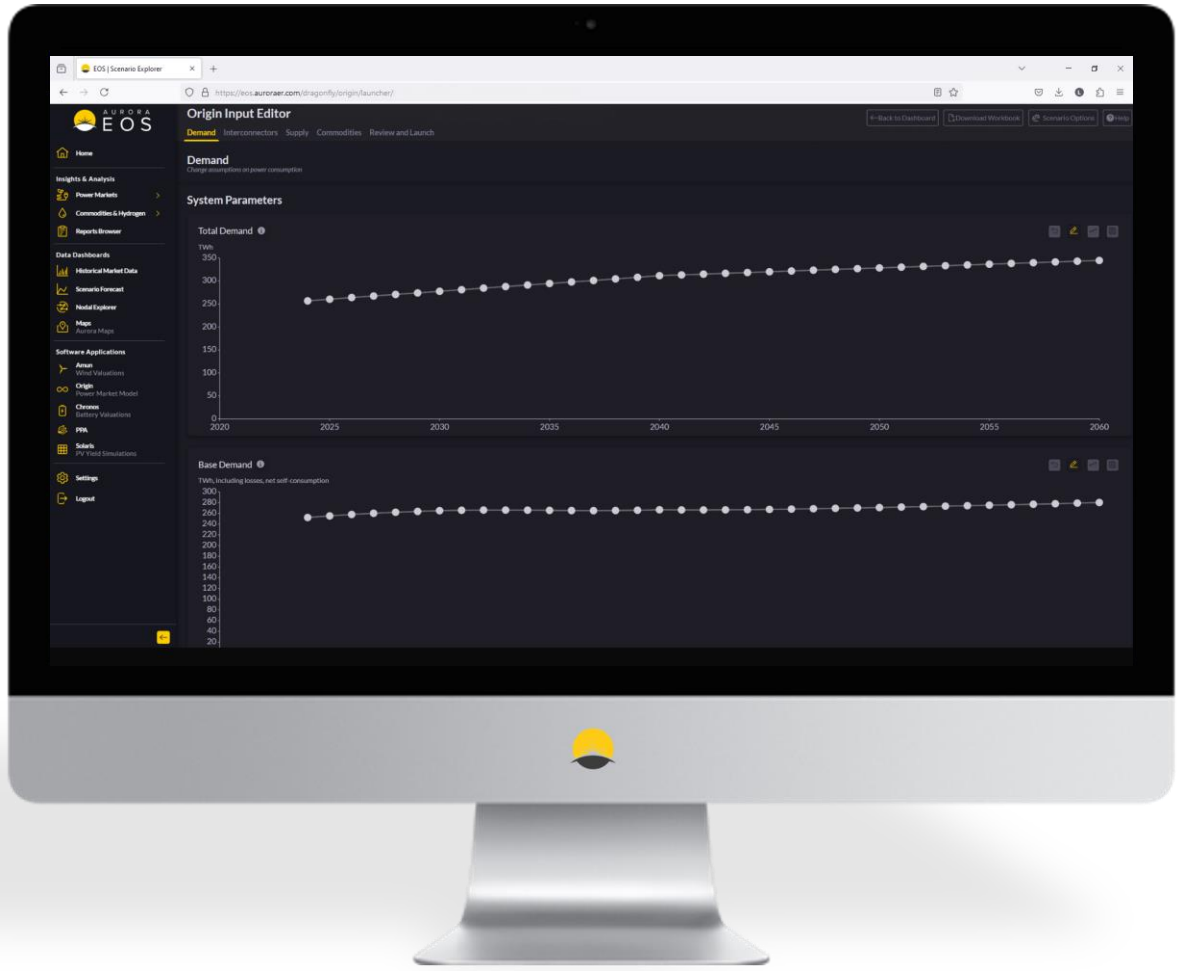
- Inform your strategy with our unique iterative investment module, capturing real investment behaviour
- Identify opportunities and risks by customising Aurora forecasts to reflect your unique market sensitivities



Strategy Transactions Risk Analysis Financing

Upcoming developments for Aurora's Iberian services

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Third subscriber Group Meeting 2024
- Power demand: current status, near-term development and price impact in the Iberian market

Bi-annual update of the Iberian Flexible Energy Forecast
- Comprehensive review of regulatory and market framework for storage
- Updated Investment Cases for co-located and stand-alone assets

Quarterly update of the Power and Renewables Market Forecast
- Updated to reflect near-term commodity price changes

First subscriber Group Meeting 2025
- Battery sensitivities over weather years and different market scenarios

2024 | November | December | 2025 | January | March | April

Chronos webinar: 21 November
- Aurora battery software demonstration and its usage across multiple European markets

Grid Curtailment Add-On update
- Power-flow implementation with nodal analysis
- Update with the latest market assumptions

Bi-annual update of the Power and Renewables Market Forecast
- Updated to reflect near-term commodity price changes
- Update following relevant regulatory or policy announcements

CHRONOS

Chronos release for Iberia, allowing clients to use Aurora's battery dispatch model to run sensitivities is currently available

Source: Aurora Energy Research

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II. **What are the drivers of future demand?**

1. Industrial demand
2. Data centres
3. Electric vehicles
4. Heat pumps

III. **Demand evolution and its impact on prices**

IV. **Key takeaways**

Demand growth is key for investments and price stability; high RES generation and stagnant demand have led to lower than average residual demand

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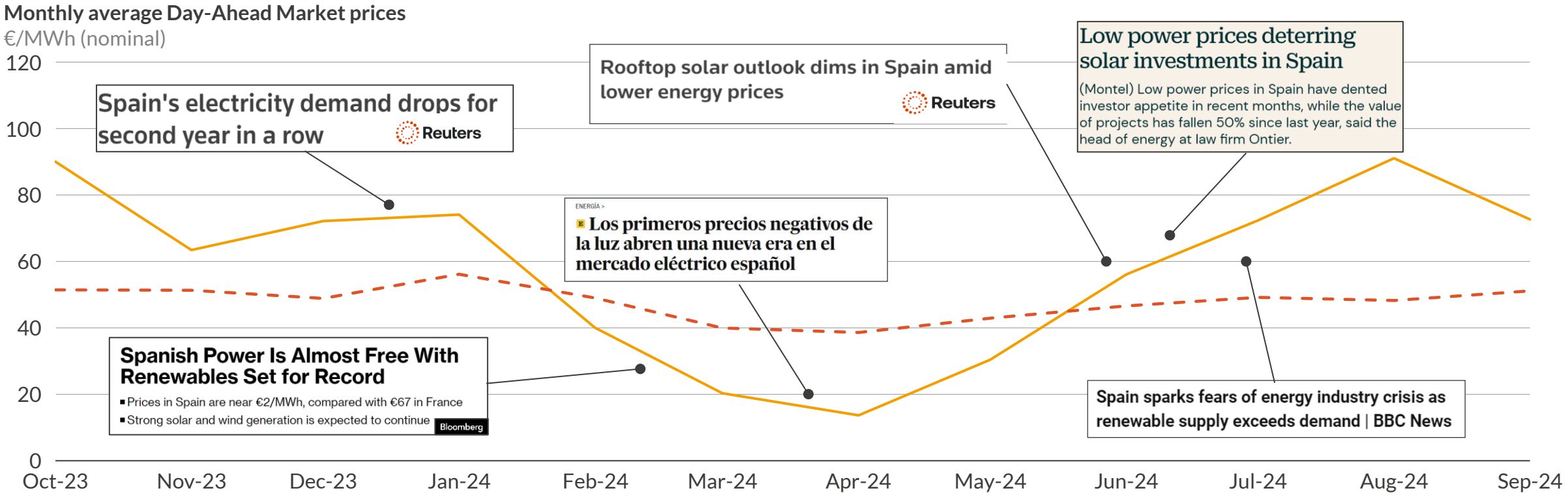

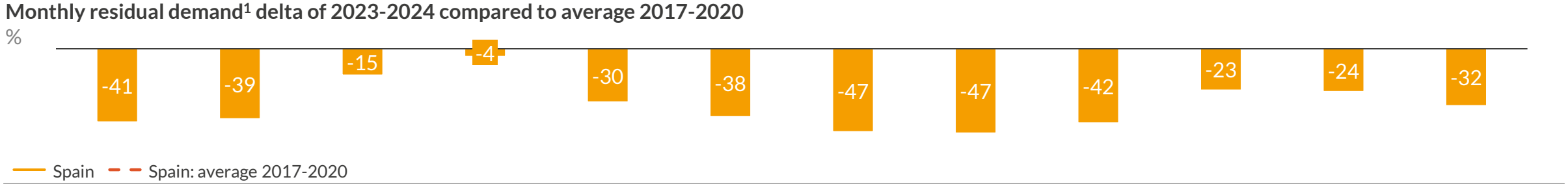

1) Residual demand refers to total demand minus solar PV generation and wind generation.

Sources: Aurora Energy Research, REE, Reuters, Bloomberg, Montel, BBC News, El Pais

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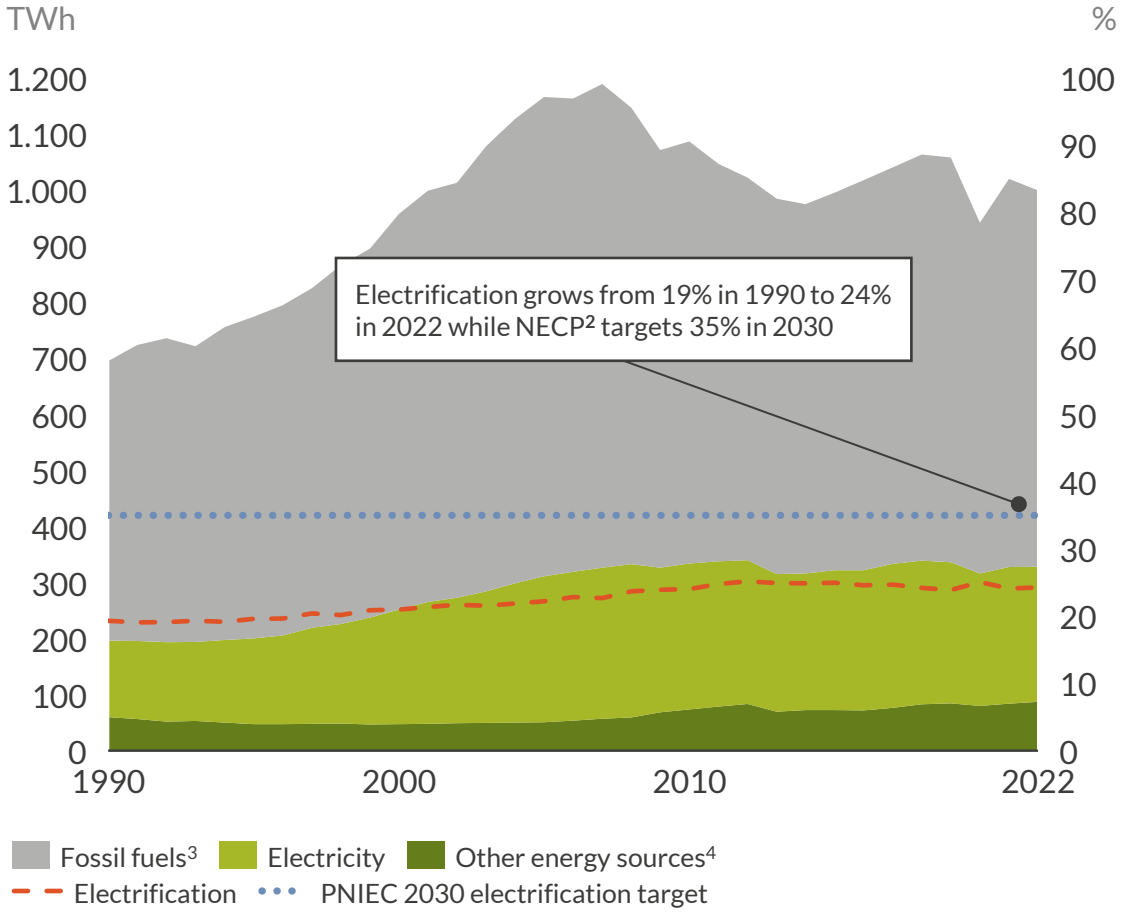
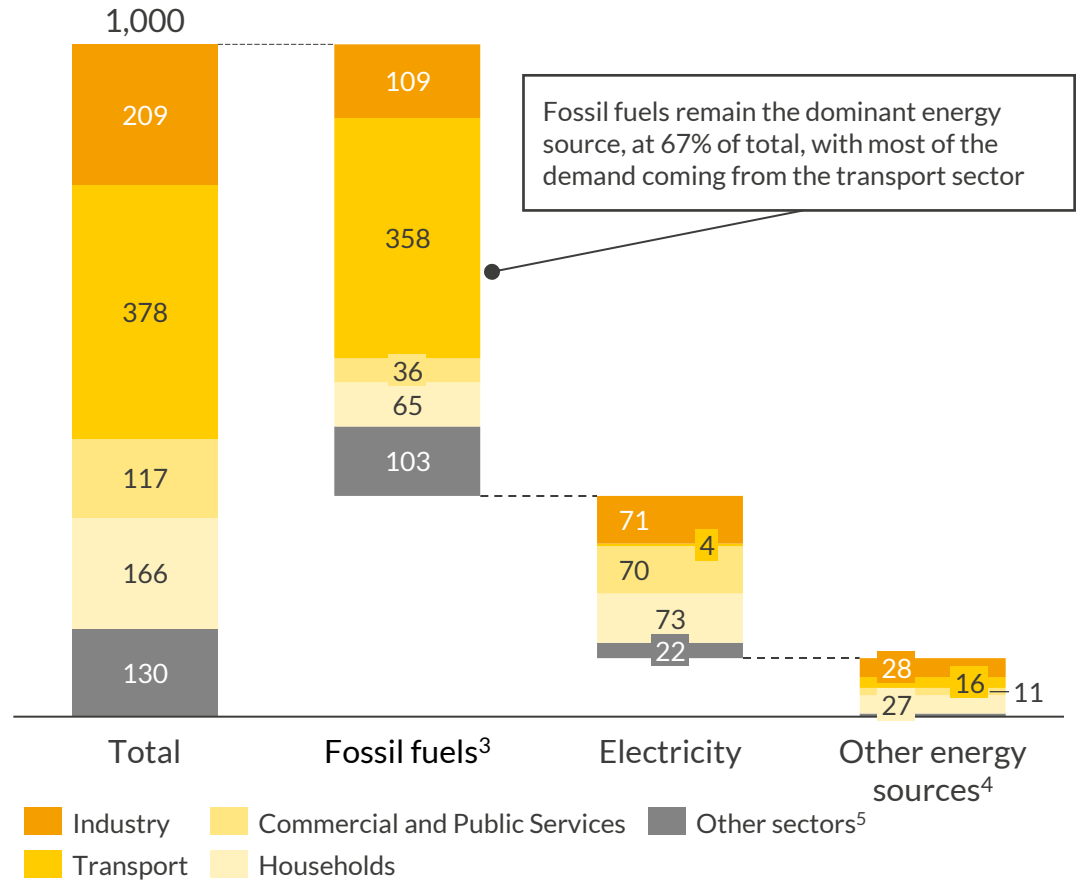
Spanish energy demand is still reliant on fossil fuels, partially due to a decade of stagnant electrification rates

The transport sector has the highest energy demand in Spain, with fossil fuels meeting 95% of consumption. Decarbonising transport via increased electric vehicles will be crucial for achieving the country's net-zero goals. Meanwhile, electrification in the industrial sector has only increased from 30% in 2010 to 34% in 2022.

Final energy consumption by fuel source for Spain



2022 final energy consumption per sector for Spain



1) Share of electricity in total final energy consumption. 2) Spain's integrated National Energy and Climate Plan for 2021-2030. In Spanish, PNIEC, i.e., Plan Nacional Integrado de Energía y Clima. 3) Incudes solid fossil fuels, natural gas, and oil and petroleum products. 4) Includes renewables and biofuels, heat, and other fuels. 5) Includes agriculture, forestry, fishing, energy and other sectors not specified.

Sources: Aurora Energy Research, Eurostat, MITECO

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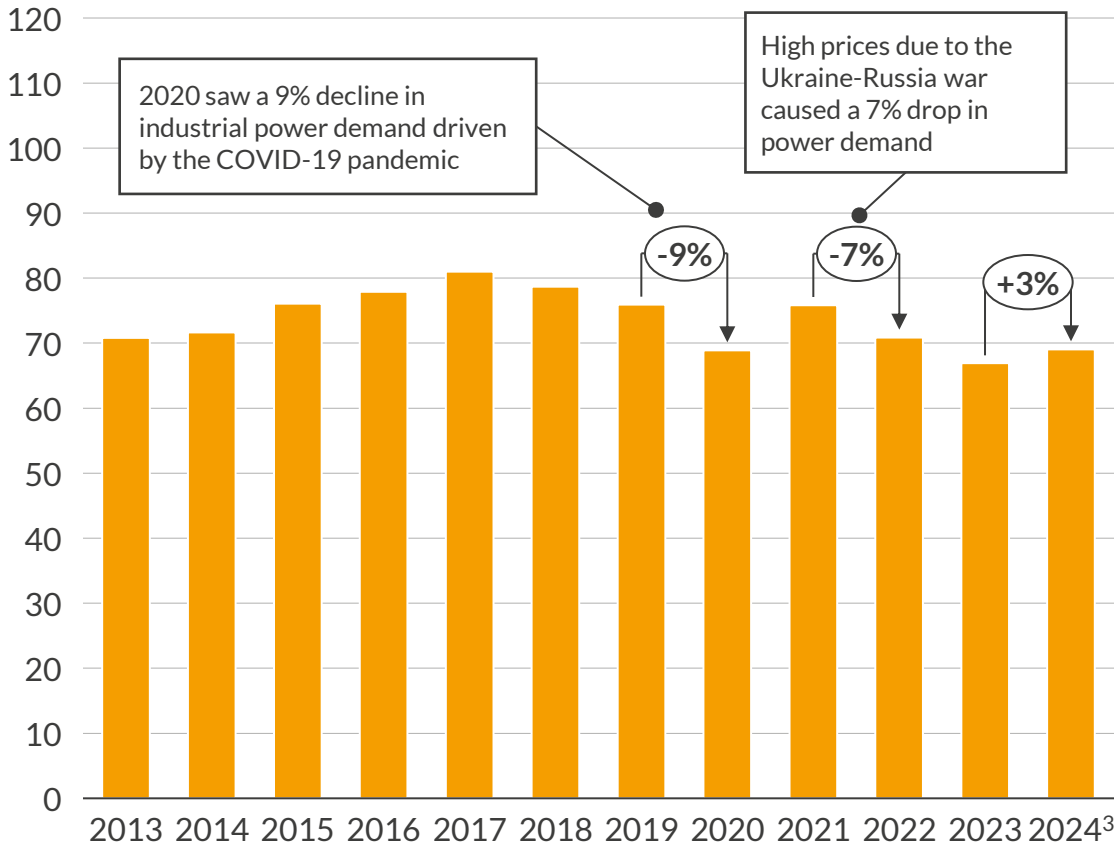
Industrial demand has grown 3% in 2024 due to low power prices and economic recovery, reverting years of demand reduction

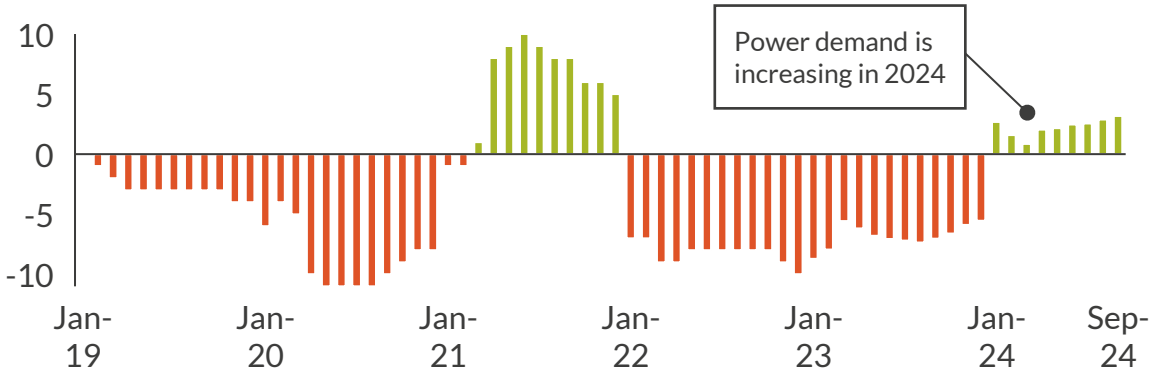
Industrial power demand, which represented 21% of total final energy consumption in 2022, declined 5.6% between 2013 to 2023. Demand dropped sharply in 2020 due to COVID and the 2022 energy crisis further slowed recovery. Industrial demand has grown at 3% during 2024.

Power demand[1] from industry, TWh



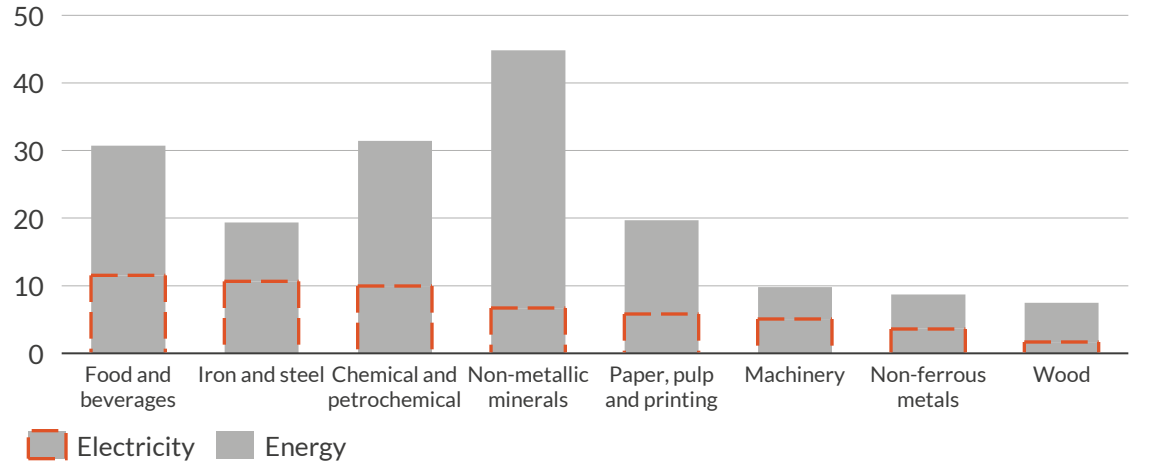
Power demand delta[2], %

Deep dive: monthly growth



Large industry energy consumption (2022), TWh

Deep dive: sectorial demand



1) Net demand (i.e., 'en barra de central'). 2) Yearly accumulated delta. 3) Estimated value considering yearly accumulated growth rate until September 2024.

Sources: Aurora Energy Research, REE, Eurostat

Spanish industrial demand is projected to grow extensively by 2050, with the petrochemicals sector exhibiting the highest increase

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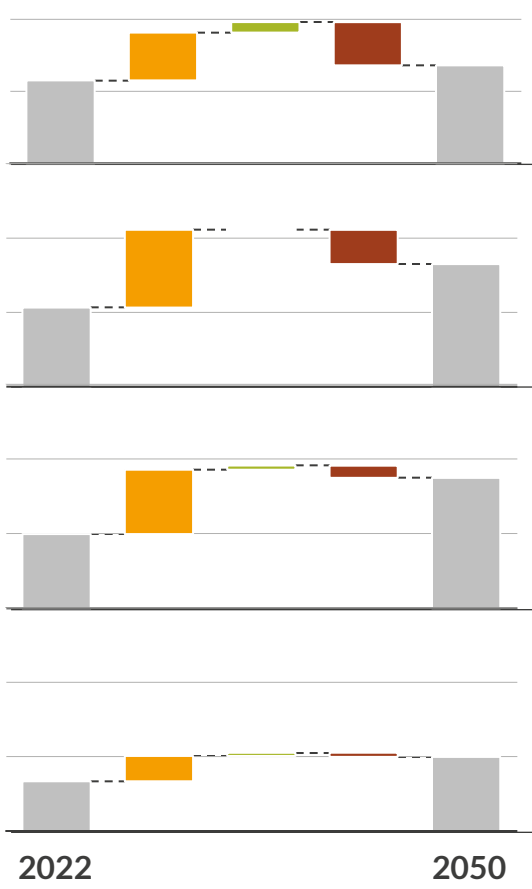
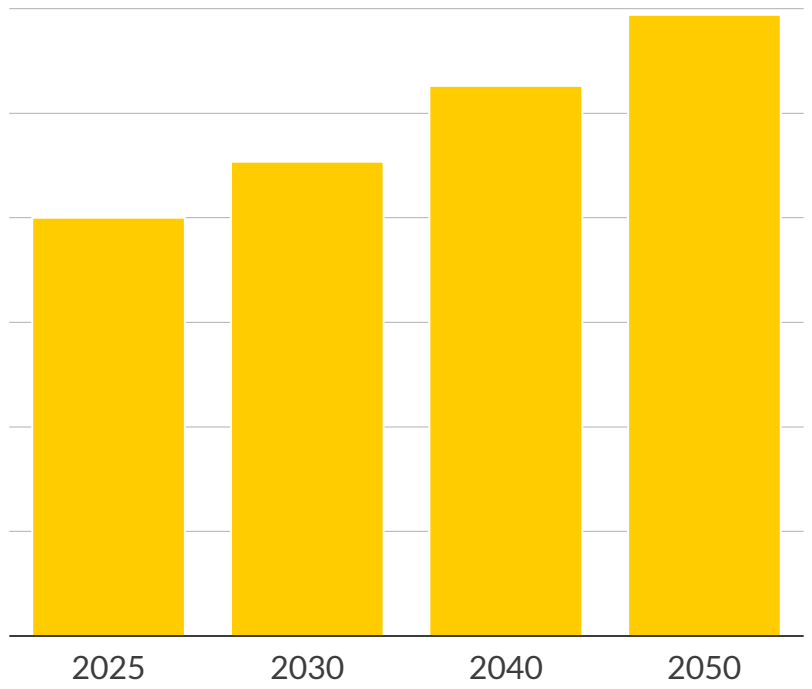
Industry	Power demand in TWh (2022 – 2050)
Food and beverage	▪ Rising demand for processed and ready-to-eat foods will drive growth. Electrification will increase demand, but increased process efficiency will limit the net increase on power demand.
Iron and steel	▪ Electrification of iron and steel is already high in Spain, as electric arc furnaces (EAF) are widely used. Despite projected efficiency gains, demand is expected to increase driven by economic growth.
Petro-chemicals	▪ Petrochemical products are essential across industries, driving sector demand growth. Direct electrification of process heating will further boost power demand.
Non-metallic minerals	▪ Economic growth is expected to slightly increase power demand in the non-metallic sector, which is hard to electrify due to high processing volumes and furnace temperatures.



Economic growth[1] Electrification[2] Efficiency gains[3]

Industrial power demand in Spain
TWh



- Industrial power demand is expected to grow thorugh 2050. The drivers of this increase are economic growth and additional electrification. However, efficiency gains place downwards pressure on demand.

1) Based on long-term expected GDP growth, historical industrial gross value-added delta per sector and Aurora assumptions. 2) Increased level of electrification between 2022 and 2050. 3) Consumption reduction between 2022 to 2050 due to efficiency improvements.
Sources: Aurora Energy Research, Instituto Nacional de Estadística, Eurostat, McKinsey, Agora Industry, Eurofer, Material Economics

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Data centres have a stable intraday demand which increases during warmer months, although the increase moderates as PUE[1] values decreases

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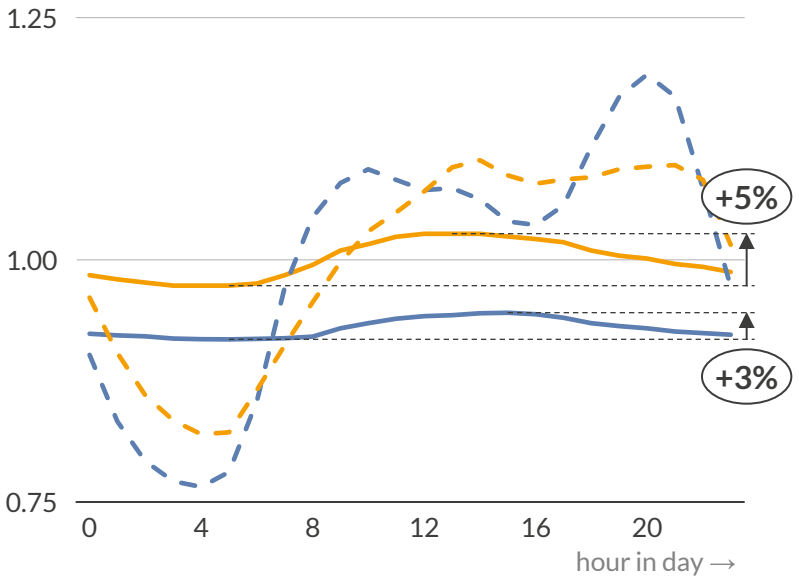
DC[2] demand profiles do not vary significantly during the day due to high demand for cooling

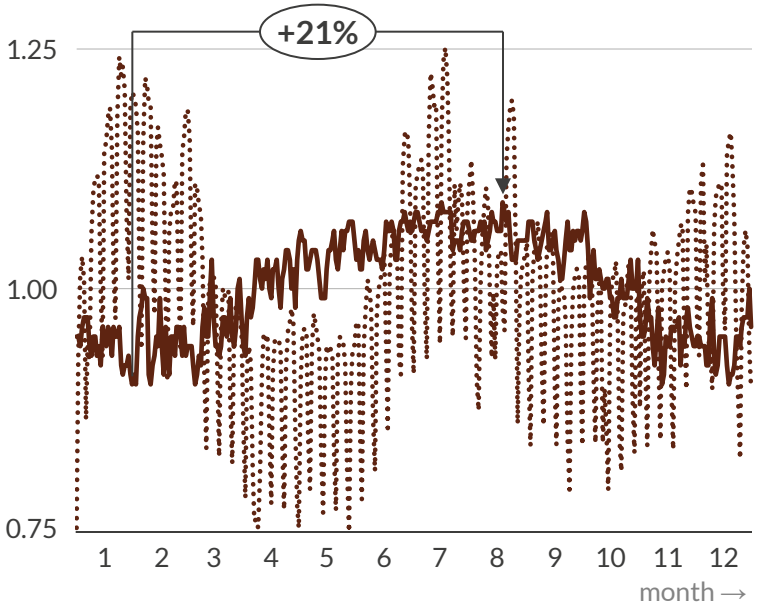
Normalised DC[2] and Spanish demand daily profile
Hour-of-day average (January and July), normalised



- DCs demand correlates with high temperatures as up to 40% of DCs power usage is for cooling.
- Summer DCs intraday demand profiles are relatively constant varying up to 5%, whereas winter profiles vary slightly less, up to 3%.

Throughout the year, DC[2] load profiles vary more due to changing temperature patterns

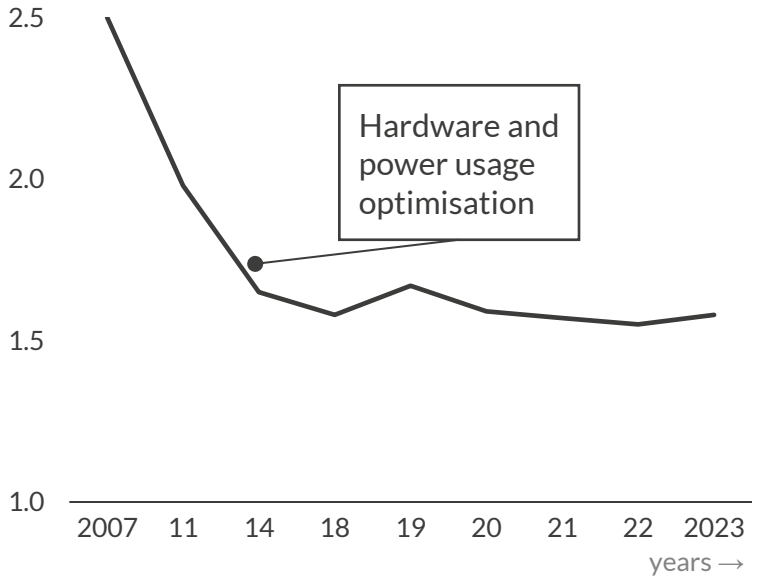
Normalised DC[2] and Spanish baseload yearly profile
Daily average, normalised



- DC load profiles can vary by up to 21% throughout the year due to fluctuations in cooling demands, which, in turn, are driven by temperature patterns.
- The profiles with the highest demand are thus seen in summer.

Progress in lowering energy demand slows as cooling technologies reaches their efficiency limits

Average PUE[1] of large data centres[3]
PUE [TWh/TWh$_{IT}$]



- Until 2014, advancements in cooling and sustainability goals drove the energy consumed by DCs down, hence decreasing PUE values.
- New state-of-the-art DCs can achieve operational PUE of 1.1[1], so future energy efficiency improvements may still be achieved from 1.5 PUE.

DC January load profile[2] — DC July load profile[2] — DC Yearly Load Profile ··· Spain 2023 Demand Profile

1) Power unit effectiveness i.e., ratio between the total energy consumption of the data centre and the energy consumed by the services (IT load). The theoretical minimum PUE is 1. 2) Based on *Dominion* data centre in PJM with data normalised over a year . 3) Uptime Institute "Global PUE's — are they going anywhere?".

Source: Aurora Energy Research, Dominion Virginia

The Iberian market has become attractive for DCs due to its abundant low-cost RES, reliable grid infrastructure, and extensive fibre connectivity

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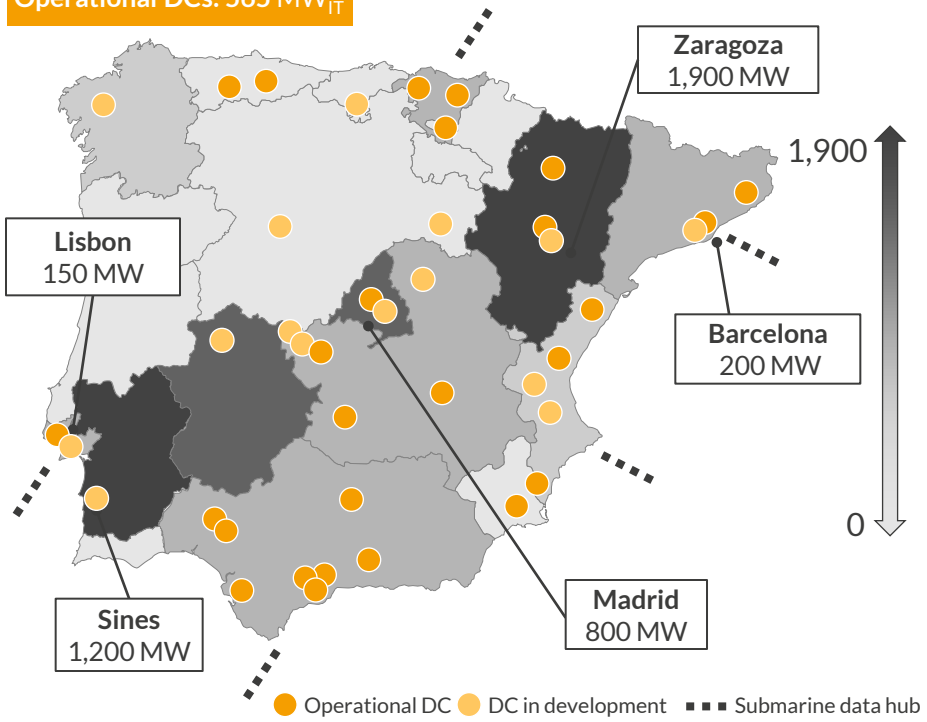
Data centres in Iberia

MW_{IT}

Operational DCs: 565 MW_{IT}



- Power demand from data centres in Iberia is currently ~2.8TWh, accounting for 1% of the total global market[1].
- Main growth centres are in Madrid, Zaragoza, Barcelona, and Lisbon with new hubs emerging across the countries.

Development pipeline	GW_{IT}	4.5	1.4	1.2	4.5	1.0
Driver	Commentary	**Iberia**	**Great Britain**	**Germany**	**Virginia**	**Sydney**
Grid availability	Constrained networks have made grid access the top criterion for data centres	🟡	🔴	🟡	🟡	🟡
Fibre connectivity	Access to high bandwidth, well-connected fibre networks increases site use	🟢	🟢	🟢	🟢	🟡
Power prices	Low power prices are a driver for the building of DCs to reduce costs	🟢	🟡	🟡	🟢	🔴
PPA market	Securing long-term power contracts and costs is factored by consumers	🟢	🟡	🟢	🟢	🔴
Land price & availability	Land costs account for around 10% of data centre CAPEX	🟢	🟡	🟡	🟢	🟢
Weather	Low temperature decrease cooling costs as less power is needed to refrigerate chips	🟡	🟢	🟢	🟡	🔴

1) The IEA estimates global energy use for data centres between 240-340 TWh in 2022.

Sources: Aurora Energy Research, Colliers

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EV penetration in Spain is increasing, representing 12% of all newly registered vehicles in 2023; however, adoption is lagging behind other EU countries

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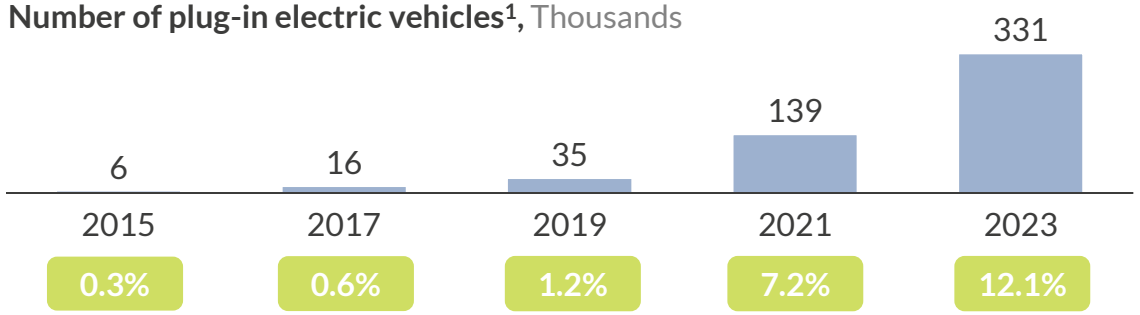
1 Plug-in EV numbers have been steadily rising led by increases in passenger cars, although the total remains below 2% of the fleet

Number of plug-in electric vehicles[1], Thousands



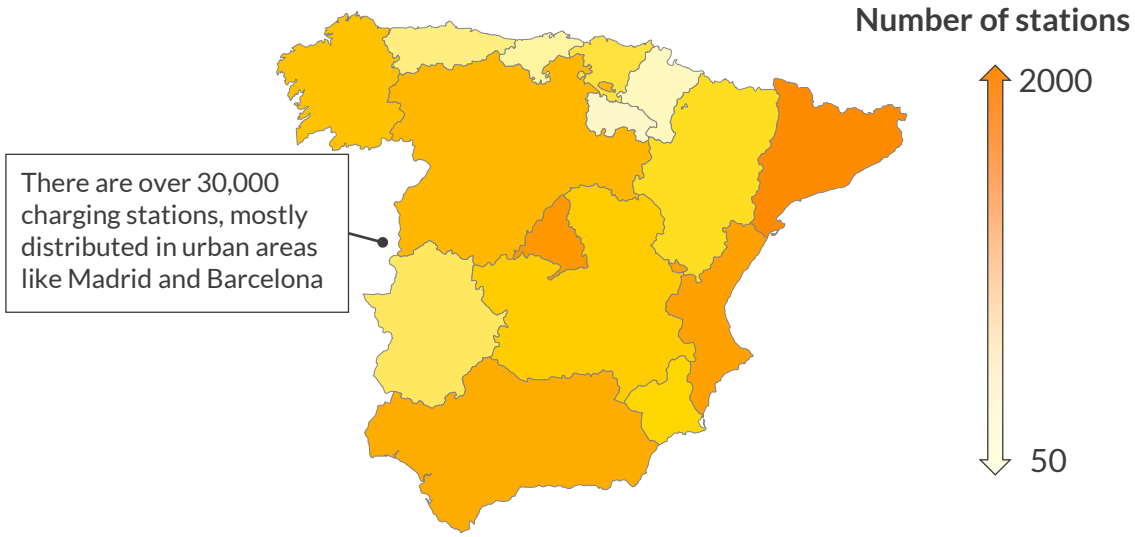
X% Electric vehicle registrations as a percentage of total annual vehicle registrations

2 Adoption is impacted by financial and non-financial factors, including the price premium of EVs and factors like range anxiety

Upfront cost	Up to 100% purchase price premium for EVs compared to ICE, with limited availability of affordable models, alongside the additional cost of charger installation.
Infrastructure	Availability and accessibility of public charging infrastructure, particularly in rural communities, and required grid reinforcement.
Consumer Confidence	Autonomy range alongside concerns over battery life, replacement costs, and servicing and maintenance prevent consumers choosing EVs.

3 Whilst charging stations in Spain have grown to over 30,000, this lags far behind EU leaders like France and Netherlands with over 140,000 installed

Distribution of public charging points, 2023



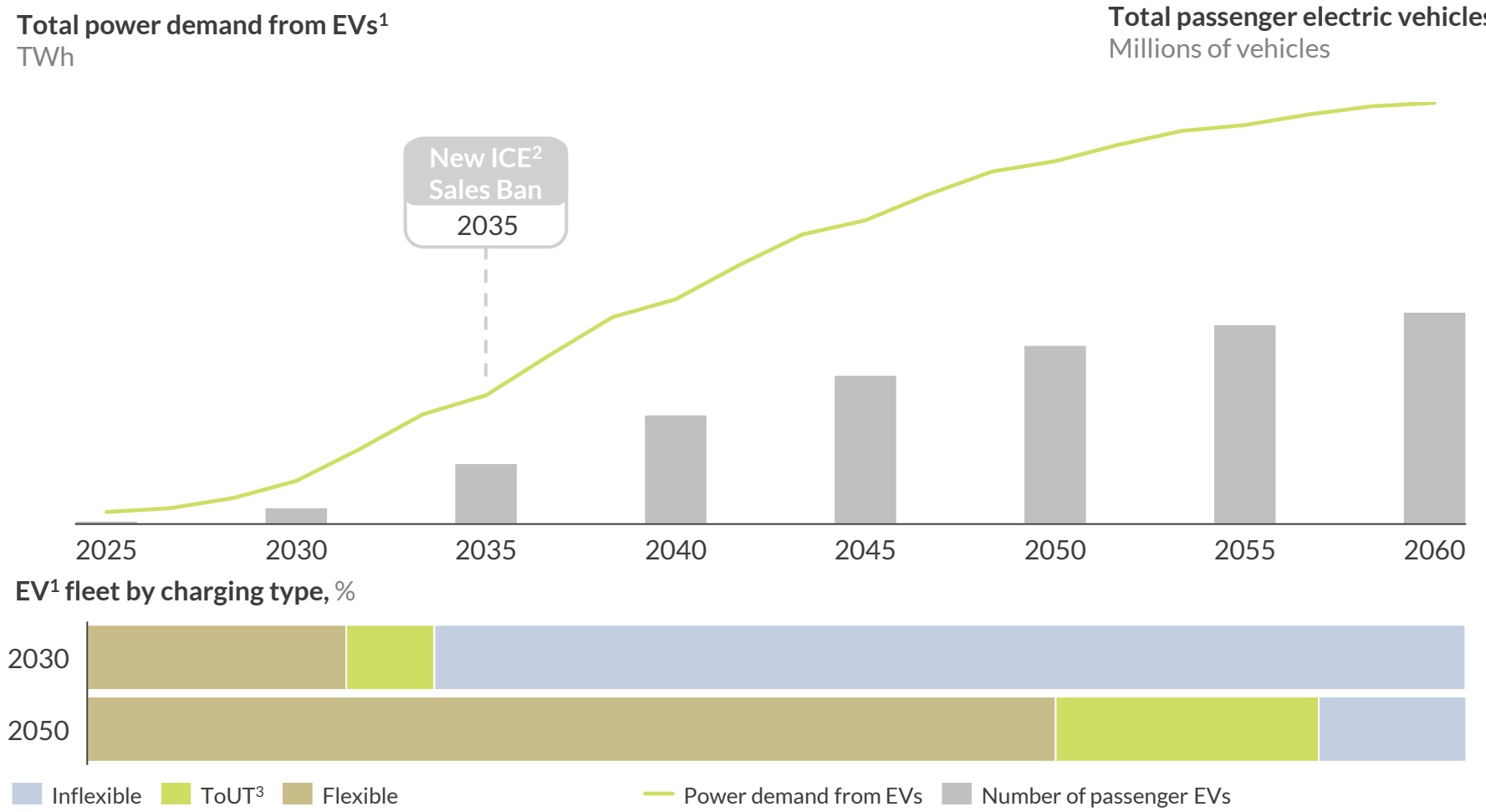
- **Charging station grants**: 70% of cost for individuals; 30%-55% for firms.
- **Tax incentives** : 15% income tax deduction for charging infrastructure.
- **Dominance of AC chargers**: More than 80% of Spain's public charging points consists of AC chargers, primarily medium-speed (between 7.4 and 22 kW), followed by slow AC charging points (up to 7.4 kW). The remaining points are fast and ultra-fast DC chargers (more than 50 kW).
- **Inactive chargers**: Nearly 8,900 charging points in Spain were inactive at the end of 2023.

1) Plug-in EVs data includes hybrid, light and heavy vehicles and refers to Spain.

Sources: Aurora Energy Research' Alternative Fuels Observatory

EV[1] penetration on new sales accelerates towards 2035, driven by the EU's ban on ICE[2] vehicles

Improvements in battery efficiency, declining costs and infrastructure buildout sees EV demand growing drastically between 2025 & 2030 with the rate of uptake rising most rapidly before the ban on new ICE vehicle sales



1) Includes heavy and light electric vehicles. 2) Internal combustion engine cars. The EU bans new sales of ICE vehicles from 2035 onwards. 3) Time of Use Tariff.

Source: Aurora Energy Research

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- Aurora models three types of EVs (inflexible, ToUT[3], and smart) across different levels of flexibility, optimising charging with lower power prices.
- In 2050, an important part of EV's fleet will be composed by smart, charging with lower power prices and trading energy to make profits.

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Gas currently dominates Spain's heating systems, with the switch to electric heating heavily dependent on policy effectiveness

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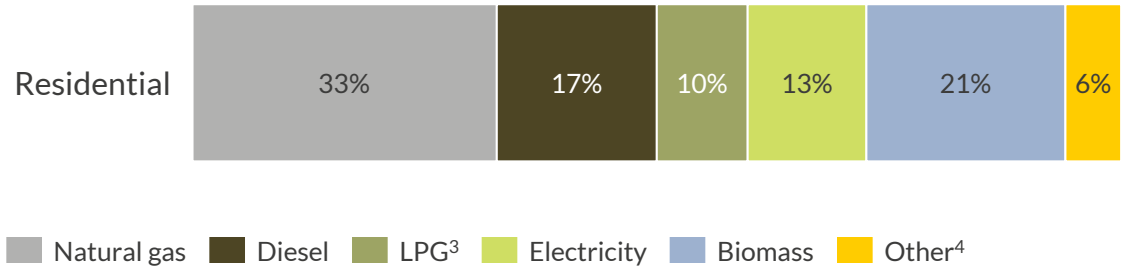
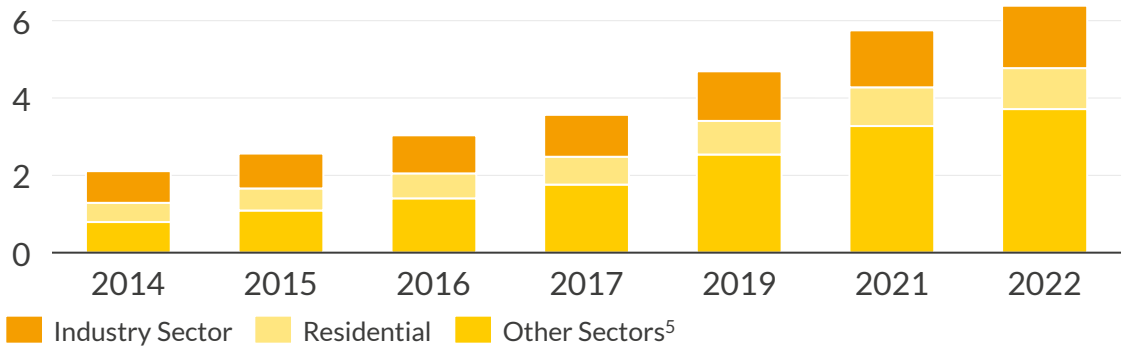
1 Fossil fuels remain the most common energy source for residential heating and cooling at 60% of the total, the main source of building GHG[1] emissions

Heating and cooling[2] energy source mix in Spanish buildings
Share of total, 2022



2 Driven by stronger adoption in residential and commercial buildings, heat pumps have increased since 2014, tripling their power demand to 6.38 TWh

Power demand from heat pumps
TWh



3 A wide variety of policies are in place to encourage the rollout of heat pumps and address financial, technical and consumer related barriers

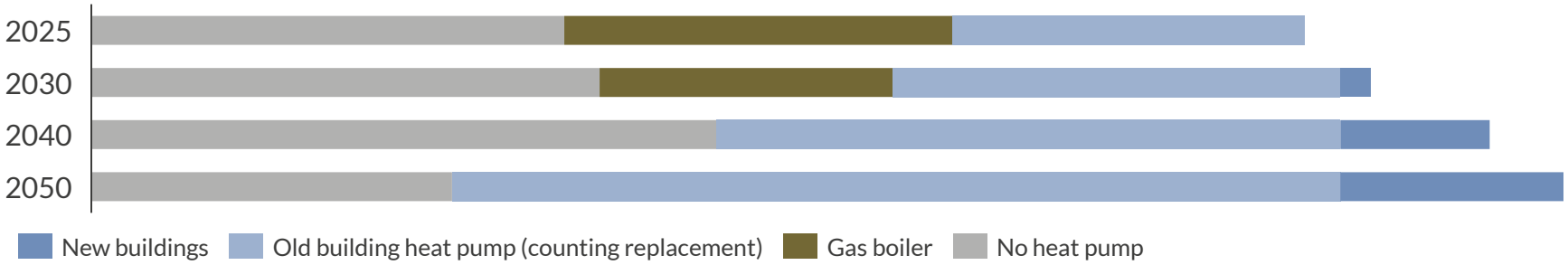
Policy	Description
Energy Performance in Buildings Directive	▪ 2030 – zero-emissions standard for new buildings ▪ 2040 – complete phase-out of fossil fuel boilers
Energy Performance Certificates	Provides energy efficiency information and encourages renovations that improve performance
Grants and Funding Mechanisms	Funding for energy efficiency improvements and heating system upgrades available

1) Greenhouse gases. 2) Includes space and water heating. 3) Liquefied petroleum gas. 4) Includes solar thermal, charcoal, ambient heat. 5) Other sectors include offices, health, commerce, hotels and restaurants, education, associative, recreational, cultural, and miscellaneous activities.
Source: Aurora Energy Research, IDAE

We forecast heat pumps growth to be compliant with the phase-out of fossil fuel boilers in new and existing buildings

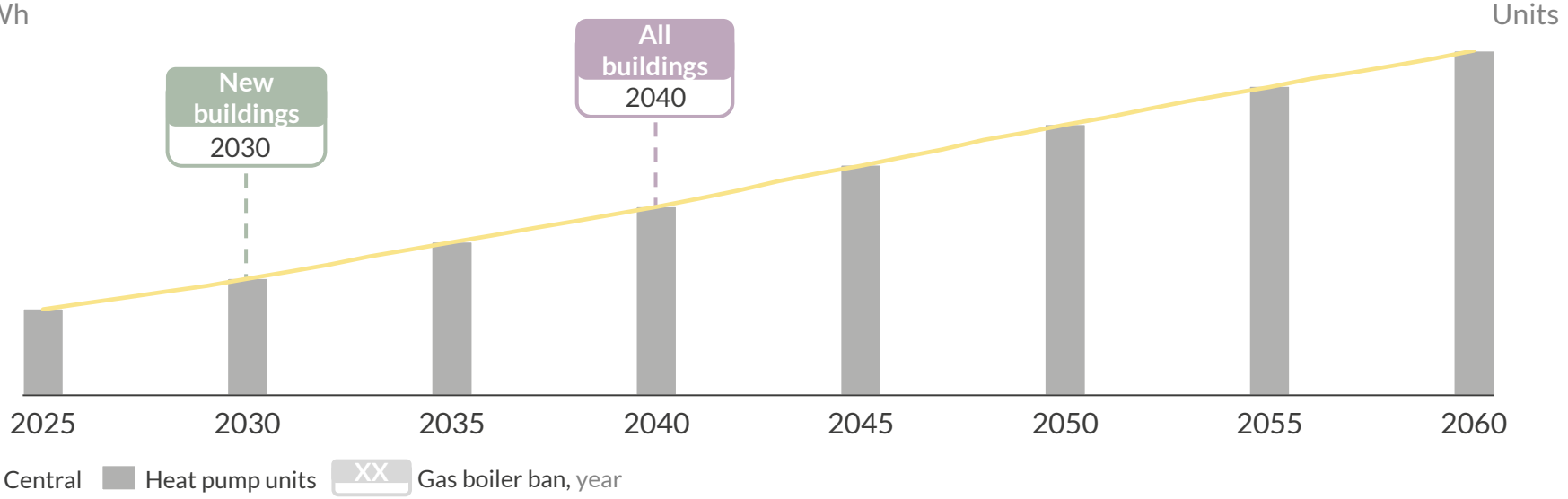
Following EPBD[1] targets, heat pumps installations increase from 2030, completely replacing gas boilers in 2040. Post 2040, uptake rates are driven by new buildings and replacement of electric heaters.

Spanish building stock growth, mn units



Total power demand from heat pumps[2]
TWh

Heat pump units
Units



1) Energy Performance of Buildings Directive. 2) Including heating and cooling.

Source: Aurora Energy Research, IDAE

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Comments

- EU's EPBD[1] targets all new buildings must be zero-emission by 2030 and bans fossil-fuel boilers in all buildings by 2040, meaning that a significant number of buildings will shift to electric solutions.
- The demand profiles of heat pump differ from winter to summer as cold seasons usually require more heating demand towards the end of the day while hot seasons lead to cooling demand during the middle of the day.

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The impact of higher electricity demand would increase baseload prices in 2030, yet higher renewables and interconnections mitigate the surge

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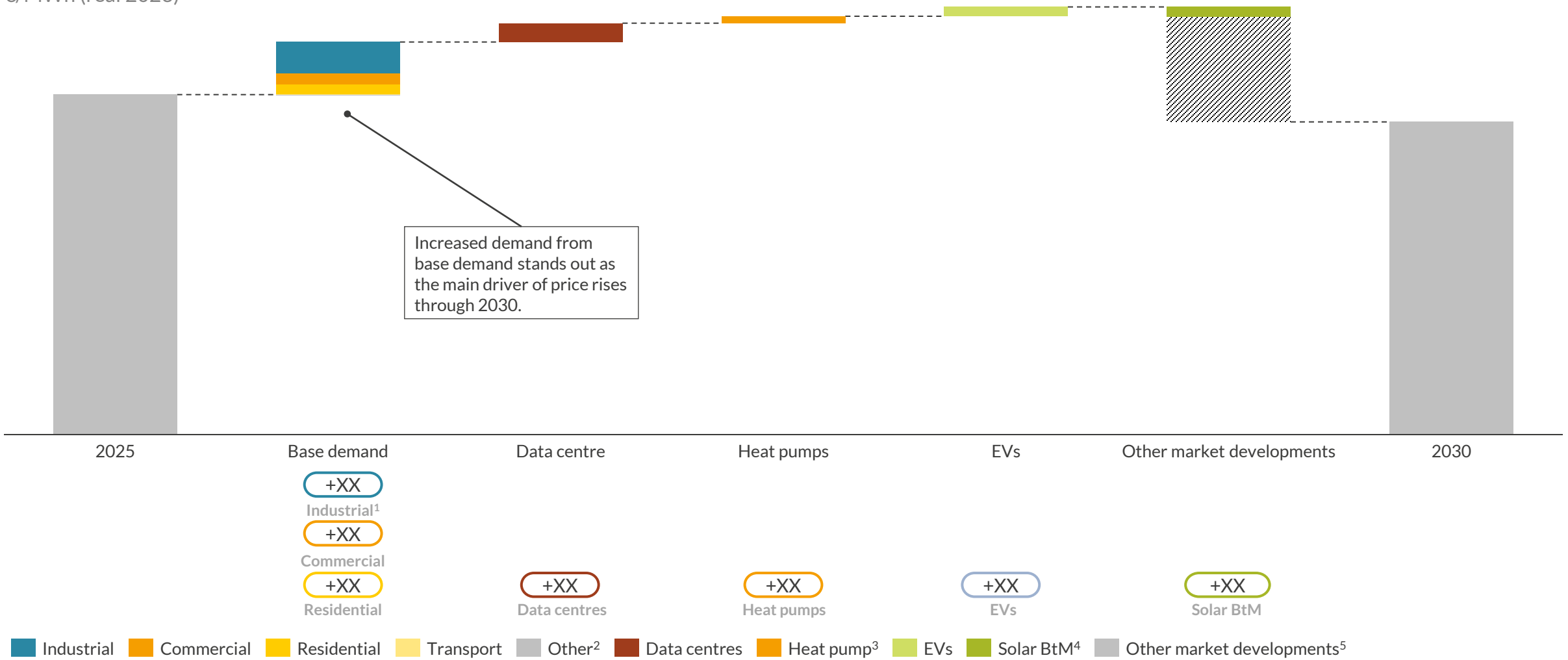
Baseload price by component

€/MWh (real 2023)



1) Demand increases by component in TWh. 2) Includes fishing and energy sectors. 3) Heat pump consumption in residential and commercial sectors. Industrial heat pumps are included in industrial demand. 4) Behind-the-meter. 5) Includes supply, interconnections and commodities developments.

Sources: Aurora Energy Research

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Key takeaways

1. The renewable capacity deployment rate has been increasing since 2019, while demand has decreased following the COVID pandemic and the energy crisis caused by the Russian-Ukraine war, leading to an oversupply of renewables and downwards pressure on prices.

2. Industrial demand has grown only slightly from January to October 2024, partially reverting the decline observed since 2008. As renewables lower Iberian prices, industrial demand is forecasted to increase through 2060 due to an output increase from current industries, new industries developing in Iberia and electrification of industrial processes.

3. Driven by low prices, high fibre connectivity and available land, data centres are emerging in Iberia. The additional power demand will increase baseload prices as data centres almost-constant consumption would require higher expensive CCGT production.

4. Policies on an EU level aiming to achieve Net Zero targets in the transport, residential and commercial sectors such as 2035 EU ban on new fossil fuel cars and the EPBD[1] directive, lead to accelerated adoption rates of EVs and heat pumps and an important increase in power in 2040.

5. The expected demand growth in Spain would help mitigate price cannibalisation and integrate renewable deployment in the short-term with an additional significant portion of power demand by 2030. Although flexible demand projects are being developed slower than previously expected, flexible demand will contribute the most to increasing renewable prices and securing long-term investments.

1) European Performance of Building Directive.

Sources: Aurora Energy Research

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