HORIZONS

Conversation starters: Five energy charts to get you talking

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Malcolm Forbes-Cable
Vice President, Upstream and Carbon Management Consulting

Wood Mackenzie

With the energy sector becoming increasingly diversified, interconnected and complex, energy markets have never been more fascinating. Key themes abound: decarbonisation, demand growth, electrification, technology, tariffs and escalating geopolitical tensions.

As the year draws to a close, we have compiled five charts to make you think. We start and end with charts on the power markets of the world's two largest economies, the US and China. We have a chart to share with anyone who still thinks electric vehicles (EVs) are the car of tomorrow. And we have two charts to which your immediate reaction may simply be, 'why?'

The charts can be scored on a number of metrics:

- **Wow factor:** how much does this make you pause and think?
- **Signpost:** significance of this trend for the energy markets
- **Dissonance:** incongruity of plot or potential discomfort caused by analysis
- **Conversation index:** potential for use in a conversation over the holidays

	Wow factor	Signpost	Dissonance	Conversation index
US power	● ● ● ●	● ● ● ●	●	● ● ●
North Sea	● ● ● ●	● ●	● ● ● ●	● ● ● ●
China EV	● ● ● ●	● ● ● ●	● ● ●	● ● ● ●
CCS ambitions	● ● ● ●	● ●	● ● ● ●	● ●
China power	● ● ● ●	● ● ● ●	●	● ● ●

Note: These scores are highly subjective and may vary considerably depending on your world view.

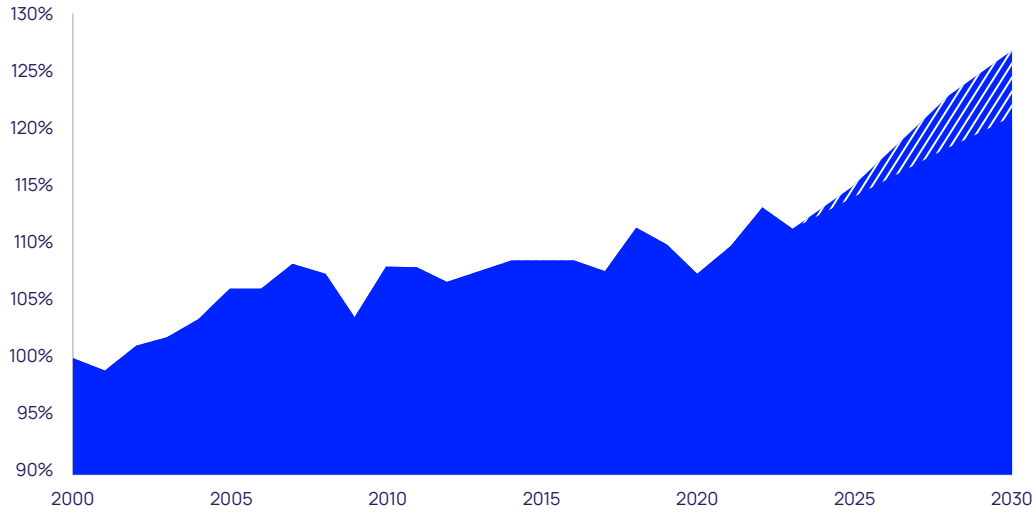
1. US power:
Data's growing power habit

Between 1950 and 2005, US power demand and gross domestic product (GDP) grew in lockstep. After 2005, however, demand flattened, while GDP continued its ascent at a compound annual growth rate (CAGR) of 1.9%. Since 2020, power demand has seen a turnaround and is set for a period of growth at least through the rest of this decade, with a CAGR of between 1.2% and 1.9% from 2024 to 2030. This chart was inspired by the October edition of Horizons, which analyses the opportunities and challenges facing the US power industry. In the chart, we focus on the sectoral outlook to 2030, looking at a range of outcomes spanning 25 GW to 50 GW of data-centre growth to 2030.

What is exciting about this new growth is that it is a manifestation of the Fourth Industrial Revolution. Central to this is the explosive growth of data centres, the beating heart of the infrastructure supporting artificial intelligence (AI), cloud computing, digitalisation and big data. Second is a new wave of cleantech, manufacturing semiconductors, batteries and renewable energy equipment. Third is the increasing electrification of the economy.

Increasing power output is fundamental to the success of the new economy. The government and utilities will have to find a way to expedite the development of the network. The challenge of meeting the power demands of high-tech growth is not unique to the US, but crucial if the country wants to maintain its leadership in the field of digital technology amid growing competition from China, which has demonstrated unparallelled capacity for rapid market expansion and economic growth.

Figure 1:
US electricity demand growth



Source: Wood Mackenzie, Energy Information Administration

2. North Sea energy: The tortoise and the hare

The success of both the North Sea oil and gas and offshore wind sectors has roots in the drive for energy security. The development of oil and gas across the North Sea — spanning Belgium, Denmark, Germany, the Netherlands, Norway and the UK — saw accelerated development on the back of the oil shocks of the 1970s, while more recently, offshore wind has been propelled by goals set amid the energy insecurity created by Russia's war on Ukraine.

Under the banner of the energy transition, there is a seductive narrative of one replacing the other, clean renewables usurping dirty hydrocarbons. This simplification belies the complexities of energy supply and the utility of oil and gas far beyond power generation, although it does raise interesting questions.

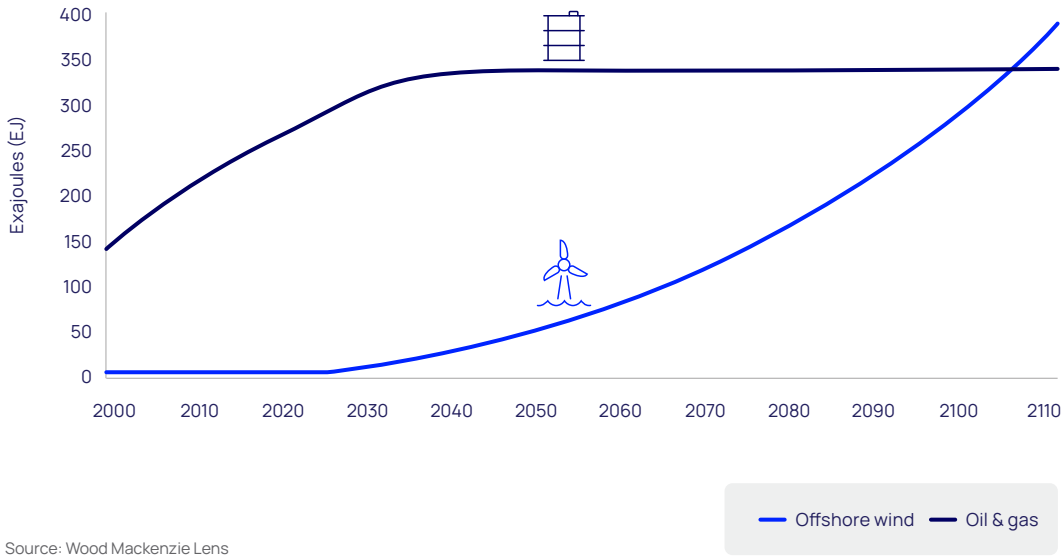
What energy has the North Sea oil and gas sector bequeathed us and how does this compare with the rapidly growing output of offshore wind?

From the shore, it is hard to appreciate the awesome power of North Sea wind. It really is a world-class resource, much like the oil and gas reserves first discovered there in the 1960s. As we see the rise of one form of energy and the waning of the other, one cannot but wonder how these two sources of energy compare.

The chart plots the cumulative final energy output of oil and gas against offshore wind. It takes into account the thermal efficiencies of oil and gas; for example, when oil is refined into a transport fuel, the final output at the wheel is 25% of the original energy content. By contrast, offshore wind's power output has an efficiency of 92%. That said, what may impress is how long it will take for the cumulative output of wind to exceed that of oil and gas, despite this disparity in energy efficiency. Across the North Sea the installed offshore wind capacity is currently 36 GW and is forecast to exceed 240 GW by 2050.

The chart communicates a number of things, but perhaps most striking is the extraordinary contribution that oil and gas has made to energy supply and what a gargantuan task it will be to build a new low-carbon system in its place.

Figure 2: North Sea cumulative final energy output of oil and gas versus offshore wind



Source: Wood Mackenzie Lens

Note: Beyond 2050, for the purposes of finding the intersection, it has been assumed that offshore wind power output grows by 2% annually.

3. Chinese transport: Truly electrifying

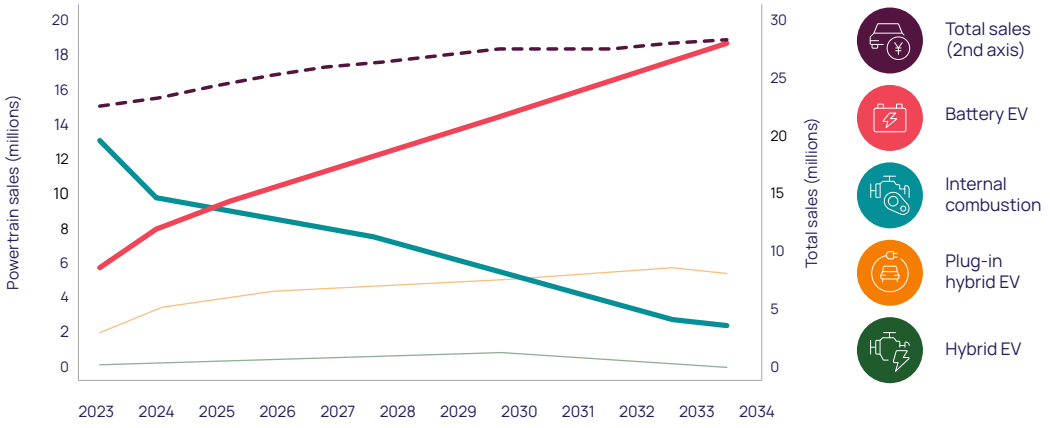
This chart is a stunner, showing the decline in the internal combustion engine (ICE) and the inexorable rise of EV sales in China. A few years ago, it would have seemed unimaginable. Indeed, Europe was winning the EV sales race. However, in a classic case of a 15-year overnight success, China is racing ahead in the EV car market and transforming its domestic transport sector in the process.

Considering just battery EVs (BEVs), by next year, sales in China will be neck and neck with those of ICEs. After that, the only way is up for BEVs, with 8% annual growth through to 2030 while ICE sales race to the bottom with an annual decline of 11%. By 2034, BEVs are expected to account for 66% of China's passenger vehicle sales. If you include hybrids, EVs will account for 89%.

China's success in EV car manufacturing has been characterised by a cost-to-quality ratio that the competition struggles to match. Important market features shaping the sector include fuel economy standards, sales incentives and manufacturing incentives. Rising fuel economy standards are increasingly challenging ICEs while also advancing extended-range EVs. In the nearer term, scrappage scheme incentives will maintain the momentum of EV penetration.

This extraordinary growth of the Chinese EV auto industry is transforming the domestic market and flowing through to the global market. Wherever you are, Chinese EVs are coming your way.

Figure 3: China passenger vehicle sales



Source: Wood Mackenzie

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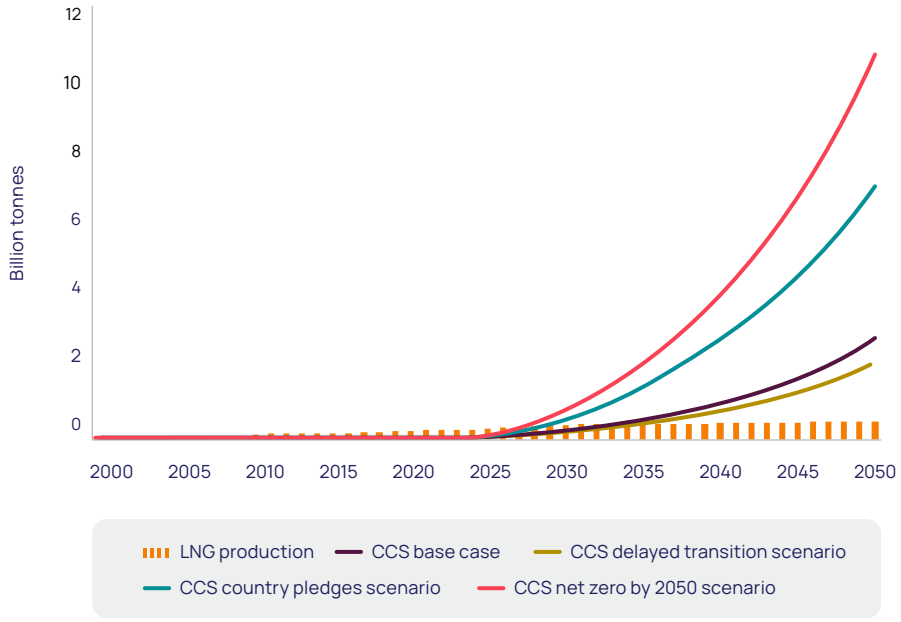
4. Carbon capture and storage: The ambitions of youth

If plotting oil and gas and offshore wind final energy output raised eyebrows among our Wood Mackenzie colleagues, charting liquified natural gas (LNG) and carbon capture and storage (CCS) capacity really had eyeballs rolling. Please bear with us: the chart is not here to draw equivalence between LNG and CCS — one is in the business of energy provision and the other of waste disposal. It does, however, shed light on the scale of global CCS industry ambition. Sometimes, strange juxtapositions are the best way to convey a point.

In operational terms, both industries deliver a gas in a cooled liquid state from production to end market. Both require a massive global infrastructure network for collection, processing and transportation. One starts at the reservoir and delivers to the customer, the other the reverse. One can be very profitable, the other is dependent on material subsidies, which are unsustainable long term, until such time as the carbon price supports a commercial market.

The chart plots global LNG supply and CCS capacity under Wood Mackenzie's four energy transition outlook scenarios. Even under the delayed energy transition scenario, CCS capacity will be three times LNG supply volumes by 2050. In our base case, it is four times. Another consideration is the rate of growth required to reach these targets. In the 2020s, LNG capacity will see more than 200 mmtpa brought to market at an annual growth rate of 5%. In the CCS base case between 2030 and 2050, once CCS has established itself more firmly, the annual growth rate will be 13% – a pace of growth that LNG has rarely matched.

Figure 4: Annual LNG production and CCS capacity



Source: Wood Mackenzie Lens

5. China's transition: Clean power to the people

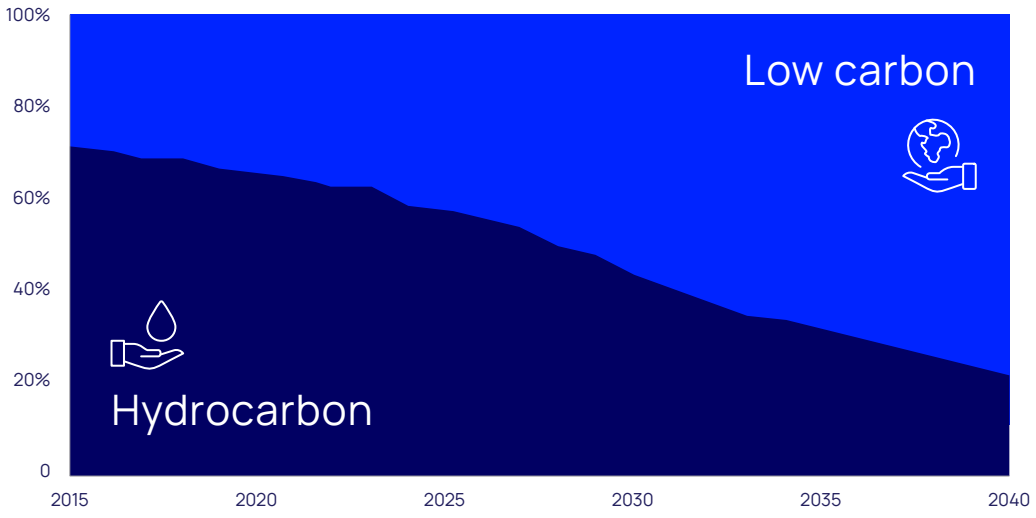
For keen observers of the energy markets, China's charts are a constant wonder. Never has the world witnessed the pace of growth or transformation of an energy system that China is currently achieving. This chart shows the power generation mix simplified into hydrocarbon and low-carbon sources. The hydrocarbons are coal and gas. The low-carbon sources are hydro, solar, wind, nuclear power and storage.

As the chart shows, the composition of the market is evolving rapidly. To give some sense of scale, China's installed solar and wind capacity will exceed that of Europe and that of North America by 2025. By 2029, low-carbon sources will deliver 50% of power generation and, by 2037, solar power and wind will both eclipse coal-fired power.

This rapid change is being driven by continued economic growth and a long-term strategy of energy security and decarbonisation, which is supporting the rapid expansion of the power market. In the last five years, annual power demand growth has been 6% and, to 2030, the outlook is for 5%. This growth is being driven by strong government policy, support for industry, electrification, high-tech manufacturing, data centres, and strong residential and commercial demand.

In this last edition of Horizons for 2024, we have compiled two power charts that depict energy developments in the world's two leading economies and reflect low-carbon power's central role in the energy transition. China's growth and change momentum are palpable, whereas the US (Figure 1) needs to return to growth from a comparative standing start. Delivery is critical to both. Things are about to get even more interesting!

Figure 5: China total power generation mix, 2015-40



Source: Wood Mackenzie, China National Energy Administration

Note: Also included is 'Other' category for fuel oil, waste and biomass: ~2% of total

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Europe: +44 131 243 4400
Americas: +1 713 470 1600
Asia Pacific: +65 6518 0800
Email: contactus@woodmac.com
Website: www.woodmac.com