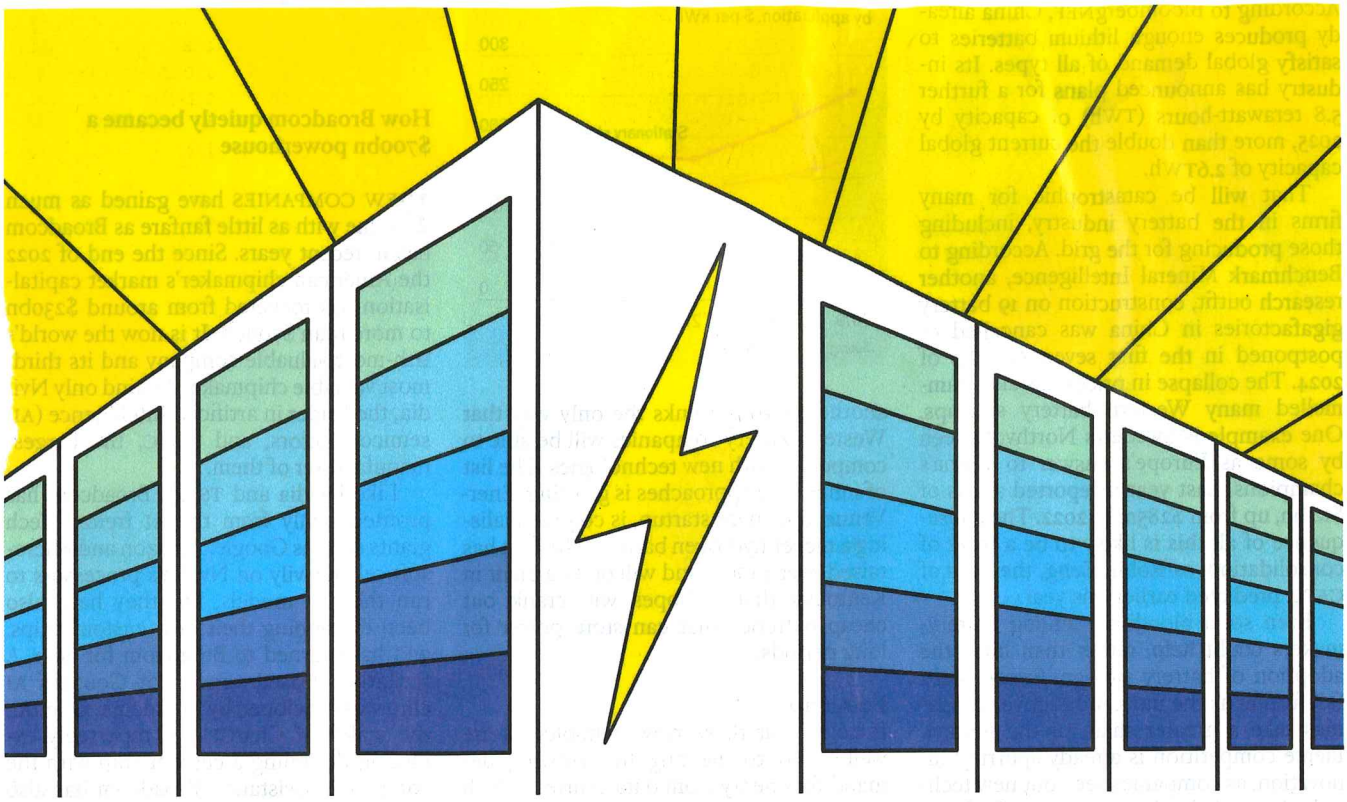
# Business



Grid-scale batteries

## Charging forward

**Clean energy's next trillion-dollar business**

DECARBONISING THE world's electricity supply will take more than solar panels and wind turbines, which rely on sunshine and a steady breeze to generate power. Grid-scale storage offers a solution to this intermittency problem, but there is too little of it about. The International Energy Agency (IEA), an official forecaster, reckons that the global installed capacity of battery storage will need to rise from less than 200 gigawatts (GW) last year to more than a terawatt (TW) by the end of the decade, and nearly 5TW by 2050, if the world is to reach net-zero emissions (see chart 1 on next page). Fortunately, though, the business of storing energy on the grid is at last being turbocharged.

Grid-scale storage traditionally relied on hydroelectric systems that moved water between reservoirs at the top and bottom of a slope. These days giant batteries stacked in rows of sheds are increasingly the method of choice. According to the IEA, 90GW of battery storage was installed globally last year, double the amount in 2022, of which roughly two-thirds was for the grid and the remainder for other applications such as residential solar. Prices are falling and new chemistries are being developed. Bain, a consultancy, estimates that the market for grid-scale storage could expand from around $15bn in 2023 to between $200bn and $700bn by 2030, and $1trn-3trn by 2040.

A plunge in the price of lithium batteries is fuelling their adoption on the grid. According to BloombergNEF, a research group, the average price of stationary lithium batteries per kilowatt-hour of storage fell by around 40% between 2019 and 2023. A global deceleration in the adoption of electric vehicles (EVs), which run on similar technology, has led battery manufacturers to take a keener interest in grid storage. In 2019 stationary lithium batteries were almost 50% more expensive than those used in EVs; that difference has fallen to less than 20% as producers have piled in (see chart 2). The IEA reckons that solar power combined with batteries is now competitive with coal-fired electricity in India, and is on track to be cheaper than gas-fired power in America in a few years.

The centre of global battery production is China. It is home to four of the world's five biggest manufacturers, including CATL and BYD. The share of China's battery production destined for stationary storage has risen from almost nothing in 2020 to around a fifth last year, overtaking the share used in consumer electronics. Growth has been helped by policies at home mandating that big solar and wind projects also install storage.

China's battery firms are intensely innovative. CATL, for example, has increased its investment in research and development eight-fold since 2018, to $2.5bn last year. BYD, which has invested heavily in robotics and artificial intelligence, has built a ▸▸

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54 Broadcom's quiet rise
55 IKEA learns from eBay
56 Can VW be fixed?
57 The Gulf looks east
58 Bartleby: Cover-letter confusion
59 Schumpeter: Berkshire blues

battery facility in the Chinese city of Hefei that is almost entirely automated. But the industry is also swimming in overcapacity. According to BloombergNEF, China already produces enough lithium batteries to satisfy global demand of all types. Its industry has announced plans for a further 5.8 terawatt-hours (TWh) of capacity by 2025, more than double the current global capacity of 2.6TWh.

That will be catastrophic for many firms in the battery industry, including those producing for the grid. According to Benchmark Mineral Intelligence, another research outfit, construction on 19 battery gigafactories in China was cancelled or postponed in the first seven months of 2024. The collapse in prices has also pummelled many Western battery startups. One example is Sweden's Northvolt, seen by some as Europe's answer to China's champions. Last year it reported a loss of $1.2bn, up from $285m in 2022. The consequence of all this is likely to be a wave of consolidation, as Robin Zeng, the boss of CATL, predicted earlier this year.

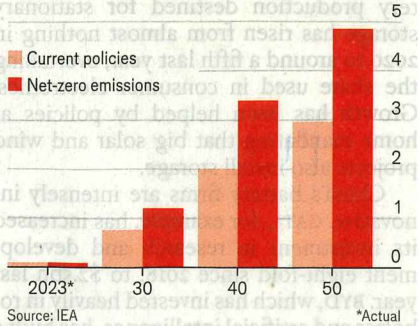
Even so, a bloodbath among battery-makers could help, rather than hurt, the adoption of battery storage. Prices could fall further as the most productive companies take a greater share of the market. Fierce competition is already spurring innovation, as companies seek out new technologies to help them compete. Sodium-ion batteries are one promising alternative. They do not require pricey lithium, and although they offer lower energy density, that is less of a problem for stationary batteries than for those powering EVs.

Incumbents are rushing to develop the technology for the grid. Several startups are betting big on it, too. Natron, an American firm backed by Chevron, an oil giant, is investing $1.4bn to build a sodium-ion battery factory in North Carolina, which is scheduled to open in 2027. Landon Mossburg, the chief executive of Peak Energy, a sodium-ion startup, says he wants his firm to be "the CATL of America".

Tom Jensen, the boss of Freyr Battery, another startup, thinks the only way that Western battery companies will be able to compete is with new technologies. The list of innovative approaches is growing. EnerVenue, one more startup, is commercialising a nickel-hydrogen battery. The firm has raised over $400m and will build a plant in Kentucky that it hopes will crank out cheap batteries that can store power for long periods.

**Turbocharged** 1

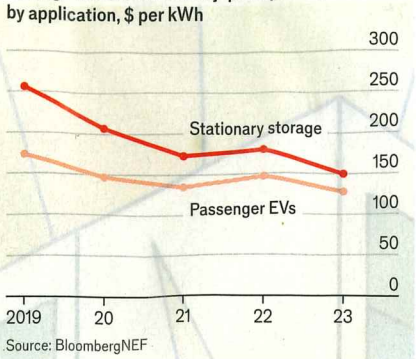
Global installed battery-storage capacity by scenario, TW




Source: IEA *Actual

**Hitching a ride** 2

Average lithium-ion battery-pack prices, by application, $ per kWh




Source: BloombergNEF

### Power up

It helps that these new technologies are well-suited to meeting the growing demand for energy from data centres, which tech giants are eager to run on renewable power. The fact that sodium-ion batteries are less prone to catching fire than lithium-based ones makes them particularly attractive for tech companies, not least because it lowers the cost of insurance, notes Jeff Chamberlain, the boss of Volta Energy Technologies, an investment firm focused on the energy-storage business. Colin Wessels, the co-chief of Natron, notes that his startup plans to supply batteries largely to data centres.

The rapid rollout of data centres is also leading to gaps in the grid infrastructure needed to produce and transmit power, which longer-duration batteries like EnerVenue's could help plug. Aaron Zubaty, the boss of Eolian, a renewable-energy developer, predicts a boom in storage solutions of four to eight hours to cope with the growing demand on power grids over the coming decade.

Grid-scale storage, then, is advancing quickly. "Batteries have done in five years what took solar 15 years," notes a veteran analyst of the solar boom, who now covers the industry. As Fatih Birol, the head of the IEA, sums up, "Batteries are changing the game before our eyes." ■



Chipmaking

# Broadly successful

## How Broadcom quietly became a $700bn powerhouse

FEW COMPANIES have gained as much value with as little fanfare as Broadcom has in recent years. Since the end of 2022 the American chipmaker's market capitalisation has rocketed from around $230bn to more than $700bn. It is now the world's 11th-most valuable company and its third most valuable chipmaker, behind only Nvidia, the leader in artificial-intelligence (AI) semiconductors, and TSMC, the biggest manufacturer of them.

Like Nvidia and TSMC, Broadcom has profited richly from the AI frenzy. Tech giants such as Google, Amazon and Microsoft rely heavily on Nvidia's processors to run their AI models, but they have also been developing their own custom chips, and have turned to Broadcom for help. A recently released version of Google's AI chip was developed by Broadcom. OpenAI, the maker of ChatGPT, is reportedly exploring designing a custom chip with the company's assistance. Broadcom has also benefited from its position as one of the leading suppliers of networking chips for data centres and its ownership of VMware, which makes software for in-house "private clouds". Demand for both has rocketed amid the AI mania.

The upshot has been a surge in sales and profits. Analysts reckon that in the quarter ending in August Broadcom's revenue grew by 47% and its operating profit by 39%, year on year; the company will report its results on September 5th, after *The Economist* goes to press.

As jittery investors begin to wonder how long the AI boom can last, they would do well to remember that Broadcom's rise began well before the coming of ChatGPT. In the decade preceding the chatbot's release Broadcom's value increased 20-fold (see chart on next page). More than whizzy technologies, it is dealmaking that has fuelled the company's growth; since its founding in 2005 the firm has spent more than $140bn on acquisitions. More than a tech firm, Broadcom is a buy-out shop.

Broadcom began life in 2005 as Avago, a spin-off from Agilent Technologies, a manufacturer of electrical components, that itself was carved out of Hewlett-Packard in 1999. In 2015, after acquiring a string of smaller semiconductor firms, Avago struck a deal to devour Broadcom, a chip designer with revenues that were nearly double its own, for $37bn—and then took the bigger company's name.