We are *not on track* to meet the Paris Agreement's objectives. What should we do?

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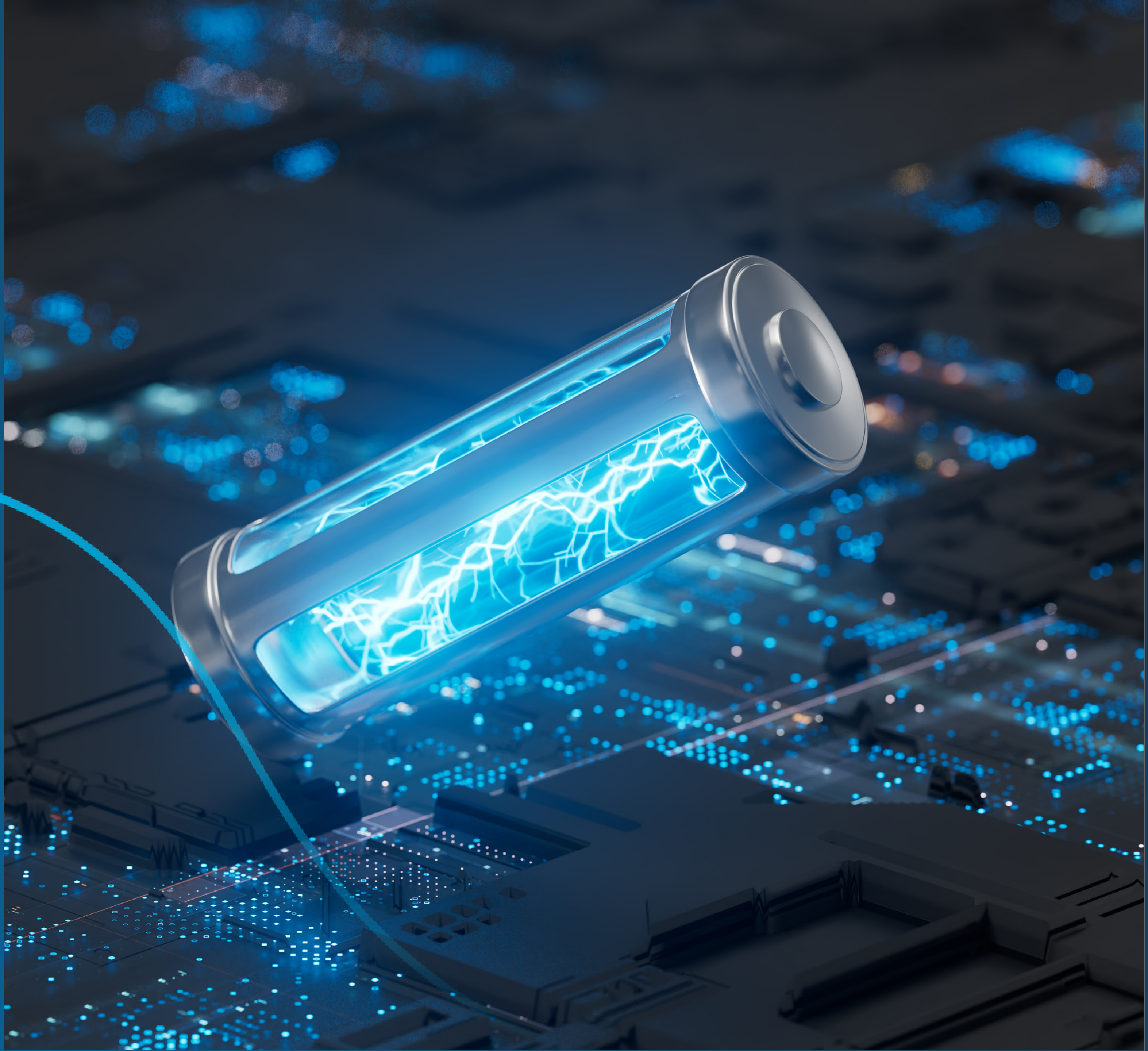
03

The Business Case for *batteries* needs to be clearer



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How to make money from a battery

1. There is money to be made in batteries, but market conditions need to be right for this to happen.
2. In the regions such as North America, Europe and Australia, making money in EV batteries will depend on the extent to which governments consider this a strategic industry and protect companies from fierce Chinese competition.
3. Making money by attaching batteries to the electricity grid is also possible but relies on regulators establishing the right market conditions and taking a long-term commitment to maintaining them. Stationary grid battery technology will follow where automotive manufacturers lead.
4. It's clear that we can't hit net zero without batteries, so work is needed to make them an attractive investment.

Introduction

There should be many ways to make money from a battery: sell it to a motor manufacturer; attach it to the grid and export electricity for more than it costs; sell it to homeowners to go with their solar panels; put it next to a windfarm to avoid curtailment issues when the network cannot cope.

Yet, around the world, many are struggling to make money, and plans are being re-evaluated. Having batteries in the energy system helps us to decarbonize carbon-intensive use cases, like transport and home heating. They also make renewable energy more predictable and usable.

Despite a brief increase in 2022, battery costs have been falling consistently for a decade and are now at 20% of their cost from a decade ago. The business case should be accelerating. There are cases of money being made from batteries which provide clues of how good returns can be made. Tesla has six gigafactories and its automotive business is making money. Texas is planning to install over 6 GW of capacity this year and the Hornsdale 100 MW Big Battery in South Australia has been operating at good margins.

The role of China cannot be ignored as, China currently accounts for about half of global production, with plans to increase this share to three-quarters by 2030. With one player so dominant, questions need to be asked about what other countries and businesses should do to respond.

However, governments and regulators are not uniformly creating the environments required for batteries to thrive.

The vertically-integrated EV battery manufacturer

The battery value chain encompasses a wide range of roles, from design and manufacturing to ownership, operation, and end-of-life management.

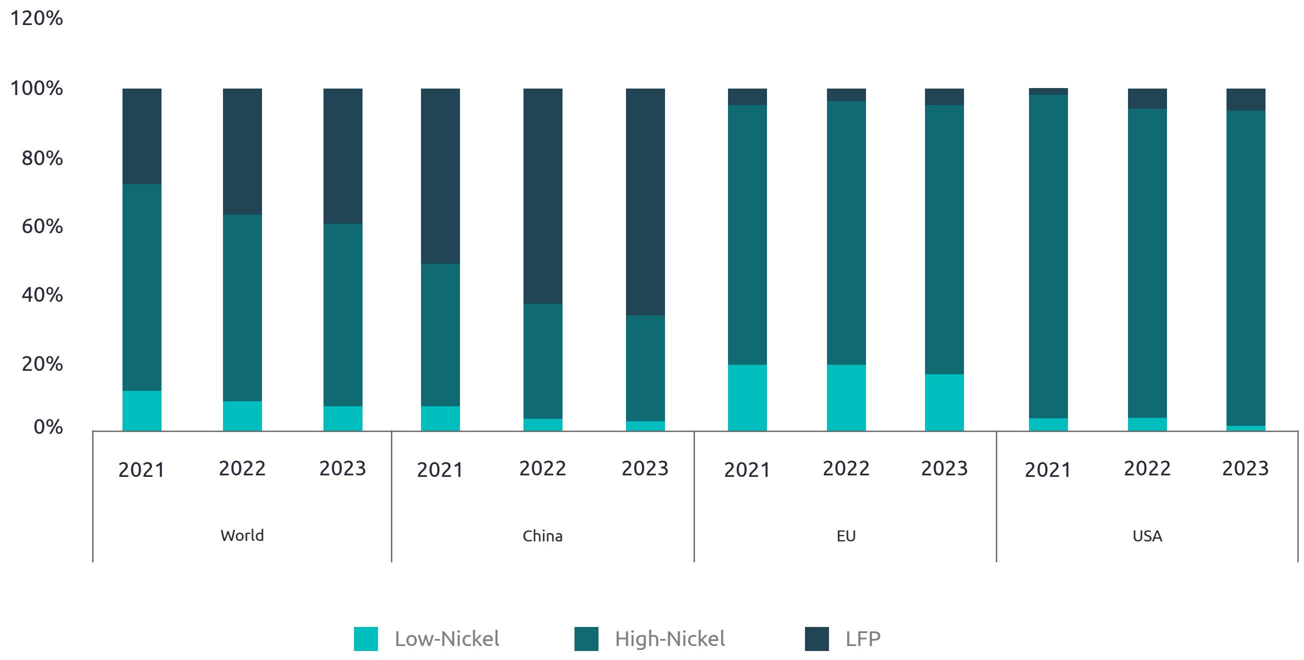
The model of the vertically-integrated automotive manufacturer, where the same company produces both the car and owns the manufacturing part of the value chain for the battery, is beginning to dominate.

Key reasons include the critical nature of battery manufacturing to the future of automotive players. They cannot rely on global supply chains for such a critical component and need to develop battery technologies that match the brand promise and expectations of buyers. Porsche buyers have different expectations than Toyota buyers, after all.

This results in limited standardization in batteries. Operating characteristics and form factors will also be manufacturer specific.

FIGURE 1

Share of battery capacity of electric vehicle sales by Chemistry and Region, 2021-2023



Building a better battery

Huge resources are currently devoted to designing better batteries. The rewards for finding batteries with longer lives, greater energy density, and cheaper production costs are huge.

LFP is the technology currently used by Tesla and BYD accounting for over 30% of EV usage. The LMFP battery seeks to improve LFP energy density and usable cycle performance by introducing manganese. Both LFP and LMFP rely on a liquid electrolyte between the cathode and diode, replacing this with a solid electrolyte promised further increases in performance and reductions in cost.

Proving new battery developments will take time and battery adoption is likely to rely on existing technologies for many years.

Battery development and industrialization programs have primarily focused on the next big leap in energy density and chemistry or solid-state technology. However, they have also overlooked the need to achieve better price points for existing materials and techniques.

Limited development capital has been deployed in achieving improved processes and pricing for finished active materials. This has led to a slowdown in European and American efforts to enhance process efficiency and supply chain development for existing proven materials, which are often sufficient for most applications, such as low-cost LFP in affordable EVs and stationary energy storage.

There has been hope that a re-established technology lead will counter China's dominance of the battery industry. However, new battery developments historically take near-decade timescales to reach volume industrialization. Many of the newer technologies may not deliver the cost benefits hoped for in the next decade. In the meantime, Chinese dominance continues unbridled.

Stationary grid scale batteries

Buy low, sell high is normally a certain way to make money—especially in an electricity system with very predictable price swings across a day. This looks very low risk, so why aren't battery owners printing money?

The battery is a very expensive asset and, by comparison, the electricity it stores is very cheap. A 1 kWh battery might cost $200, but the electricity that it stores could be worth as little as $.30.

The spread of cost between cheap and expensive electricity might be $.25, meaning that the battery needs to cycle 800 times before it breaks even. The price of electricity typically cycles across the day, so it would take 800 days to break even.

800 cycles is close to the design life of some forms of batteries, which means no returns. A battery that can handle 3,000 cycles is possible, resulting in positive returns after its eight-year life. If the life can be extended for a further four years, the last years are very profitable. But this is a long time to wait for returns.

An alternative model for grid operators is to build a big cheap battery and only discharge it when the conditions are right and prices very high. These batteries may only cycle a few times, but when they do, they earn large sums. Relying on automotive manufacturers for battery supply creates issues for stationary grid batteries. A lack of standardization means grid operators cannot assume that all installations will behave the same. A previous assumption that end-of-life batteries from the automotive industry could be used for grids and homes is also looking unsafe, as the calendar life of batteries is an increasing concern. A potential outcome is that stationary grid batteries will be built on production lines that are obsolete for automotive manufacturers. The higher volumes required by the automotive industry drive faster development of production assets and reduce price points quickly, so adjacent industries can capitalize on the benefits of an automotive-first approach. This is also been seen as cost efficient for both R&D and equipment CAPEX.

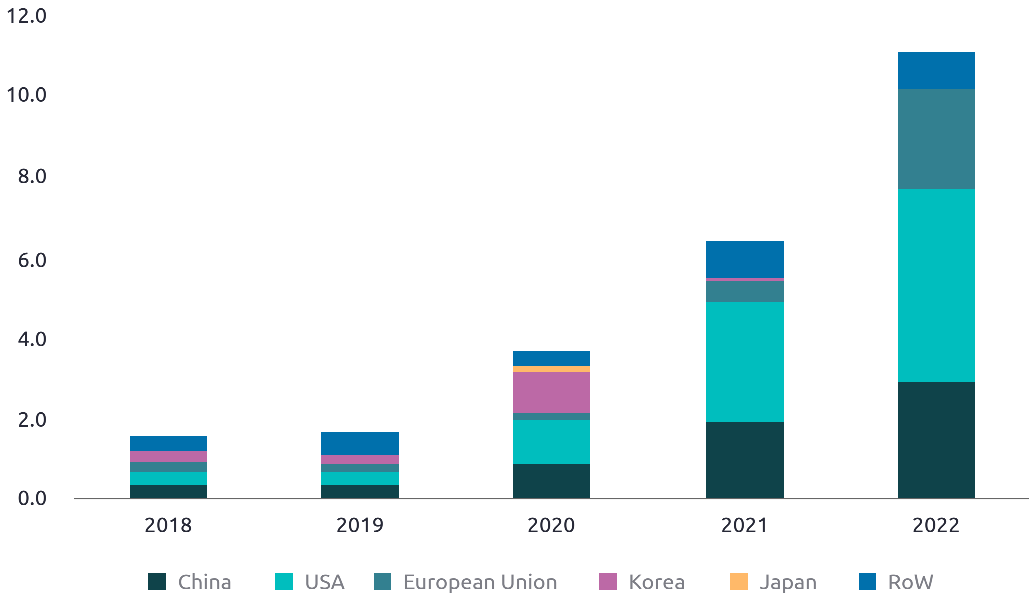
Oil & Gas companies are seasoned investors in long-term assets, but they are used to faster and greater returns than grid scale batteries can offer.

Utility companies view assets in the long term and may have investors willing to wait longer if the risk is also low. A condition is that they must trust governments and regulators to provide stable market conditions over this longer term. This will depend on consistent and clear long-term government policy driven from well researched governmental initiatives.

FIGURE 2

Annual grid-scale battery storage additions, 2019-2022

All Figures in GW



Source: IEA

Box – economics of grid batteries

Cost = $200 per kWh, elect in = $0.05, elec out = $0.30, spread = $0.25. 200 / 0.25 = 800 cycles to break even.

365 days per year = 2 ¼ years to break even.

If life of battery is 3,000 cycles then life is 8 ¼ years. 3,000 cycles x $0.25 = $750 returns, = $550 profit over 8 years.

If life extended to 12 years then returns = $1,095.

Renewables need batteries

Experience in California and Australia is highlighting the need to couple renewables with batteries to create an effective energy system. Many existing electricity systems fill the gaps between total demand and renewable production with dispatchable fossil fuels generation (often Combined Cycle Gas Turbine CCGT). Capturing the carbon from this generation is a possible way to run a renewables-dominated system, although this has not been proven at any scale. Batteries are good candidates to fill this gap.

Regulators have not made great progress in linking the roll out of renewables with batteries. Many schemes, such as the UK's CfD auctions, have encouraged renewable deployment, but they have not been matched with similar schemes for batteries.

There are further issues with the way metering works, with the UK serving as a clear example. The point that is metered is very important to the interaction between renewables and batteries. If they are separately metered, then some of the opportunity to collocate and increase returns is lost as it relies on both network capacity and interoperability of market schemes for renewables and batteries.

FIGURE 3

USA (California) and Australia Case Studies

	Challenge	Approach	Benefits
USA (California)	California faces issues with excess solar power during the day and no solar capacity at night, known as the California duck curve The state also deals with climate change impacts like wildfires and droughts	The state is leveraging large-scale battery storage to store excess solar energy during the day and discharge it at night On 25 April 2024, California marked a major milestone, as it became the first state to deploy 10 gigawatts (GW) of battery storage capacity California is also investing in hydropower and offshore wind to complement its renewable energy sources	These efforts have led to reduced reliance on gas and fossil fuels, providing a cleaner energy system The growth in battery storage also offers economic opportunities and helps in achieving the target of 100% clean electricity by 2045
Australia	Australia faces issues with excess solar power during the day and high demand in the evening, like California There's also a lack of clear targets for battery storage	Australia currently has 1,705 megawatts of battery storage. While it's a low figure compared to California, another 3,200 have been committed, and the Australian Energy Market Operator (AEMO) is expecting around 22,000 megawatts of batteries to be connected in 2030 Government policies and investment in large-scale batteries are essential	Increased battery storage can lead to more stable and reliable energy supply, reduced reliance on fossil fuels, and economic opportunities through renewable energy investments

Market regulation for batteries

Many opportunities exist to make markets more battery friendly.

Capacity markets exist to support security of supply through payments for having capacity connected to the grid that can be called upon when needed.

In the UK's most recent capacity market auction, 67% of the contracts by capacity were awarded to gas producers. The 112 successful battery sites accounted for just over 2% of capacity, though many of these sites have not yet been built.

Various forms of locational pricing have been adopted in some networks. This gives different prices for electricity at different points on the network, rather than a uniform whole network price. In Texas, which has prices at each network node, revenues to battery owners have roughly doubled in the past two years. These revenues are now twice those expected from batteries in other states.

Further opportunities exist for batteries to provide services to support the operations of the grid. Imagine what happens if a major generator like a nuclear power station suddenly goes offline. Batteries can respond in less than a second, whereas spinning up a gas-fired station might take minutes. Grid operators are increasingly willing to pay for these services.

Steps towards market reform are needed in all countries to accelerate the pace of battery deployment. To enable this, a commitment to providing regulatory stability is required to ensure that investments are unlocked.

Money can be made, but it depends on market structures

Regulatory and market conditions need to be optimised for money to be made in batteries.

Grid connected batteries can make money, but in many markets limited locational price signals, immature ancillary services markets, and structural metering issues are hindering this. A long-term stability of market structures is required to attract investment, which seeks certainty of returns over many years. .

Governments need to consider batteries as a strategic industry and take steps to protect companies form fierce Chinese competition,

Stationary grid battery technology will take the price advantage of following where automotive manufacturers have led and already invested.

It's clear that we can't hit net zero without batteries, so work is needed to make them an attractive investment.

The turnaround time for changes in regulation are far slower than the ability to create and adopt newer technologies.

The UK exemplifies a situation where battery energy storage technology has been available for some time, but deployment has been significantly delayed due to challenges in adapting market structures to make the installation and operation of stationary storage systems financially viable.

Grid connections are facing years-long approval delays, with massive backlogs of projects and limited prospects for improved business model economics. This situation hampers the ability to deliver the grid stability needed during the transition to intermittent renewables as part of decarbonization efforts, as well as the connection of infrastructure like public charging facilities to support electric vehicle adoption.

The 8-hour battery

This is simply a battery that can supply its location for eight hours. Today most batteries have durations up to four hours. Extending this to 8 hours brings significant advantages in grid stability and compensates for the peaks and troughs of renewables production.

Key operating characteristics of batteries are its total storage capacity in MWh and its peak power production in MW. The duration of the battery is the capacity divided by the production.

$$\frac{\text{3,000 MWh Capacity}}{\text{750 MW Production}} = \text{4 hour duration}$$

$$\frac{\text{6,000 MWh Capacity}}{\text{750 MW Production}} = \text{8 hour duration}$$

About Capgemini

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