Finding opportunities in Europe's Battery Energy Storage Systems (BESS) Market

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Index

Section 1: The inexorable growth of renewable power in Europe

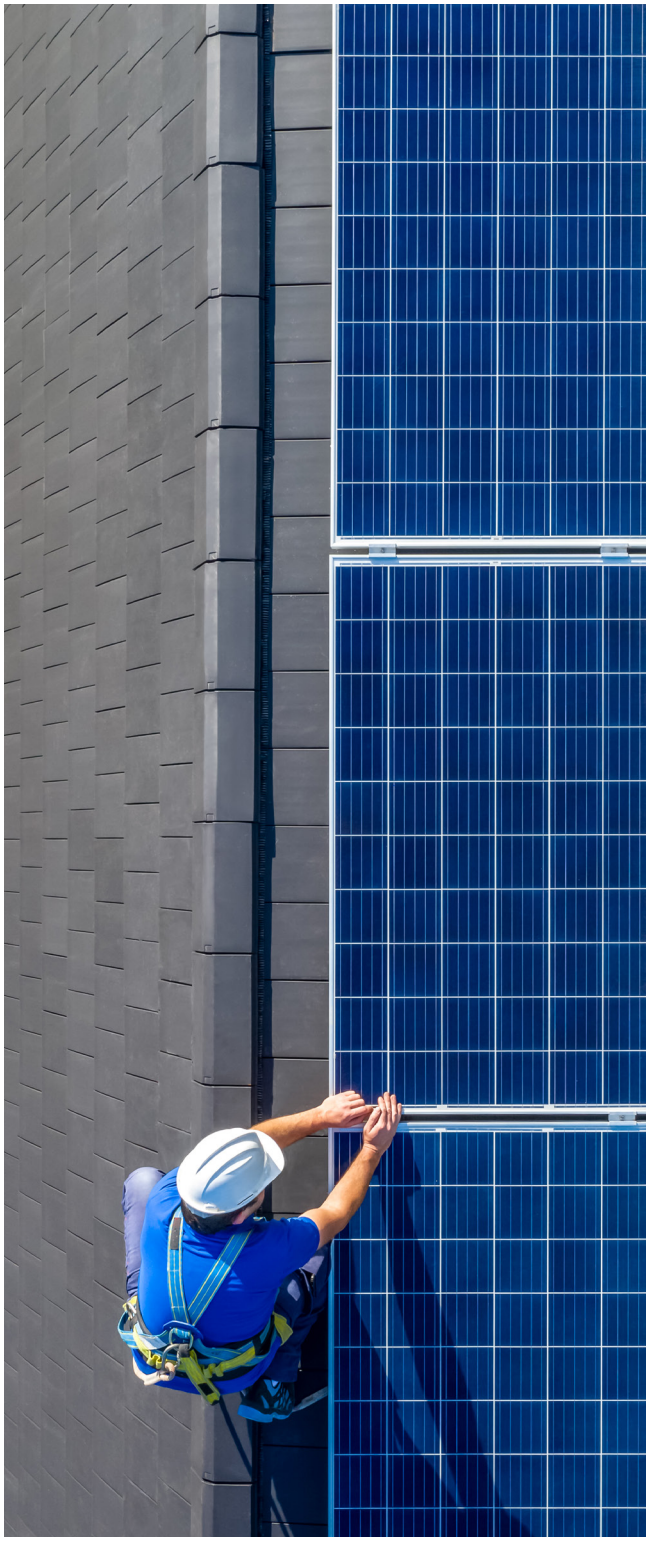
The large-scale integration of renewable power sources in European grids marks a significant transition in the energy landscape and plays a central role in advancing Europe's net zero ambitions.

But the inherent variability for these sources makes the management of the grid much more challenging if the targets set by the EU and US governments for demand coverage by renewables are to be met.

In the EU, the Renewable Energy Directive was recently revised to raise the EU's binding renewable target for 2030 to a minimum of 42.5%, up from the previous target of 32% and almost double the share that currently comes from renewable sources.

To meet these ambitious targets while ensuring supply reliability will require major investment in digital technologies and new assets to provide more flexibility in power generation and meet demand requirements.

By 2030, the EU predicts €170bn will need to be spent on digital technologies to upgrade European grids. Within this scenario, Battery Energy Storage Systems (BESS) have emerged as a leading business opportunity.



Section 2: Operational challenges driving demand for BESS

In May 2022, for the first time ever, more electricity was generated in the EU from wind and solar power than from fossil fuels. But the obvious drawback of this growing dependency on renewable sources is the problem of intermittency.

As their output and capacity factor depends on weather conditions, daily, and seasonal variations, it is difficult to imagine a future where 100% of the demand is satisfied by renewable power sources as this will require huge oversizing.

Renewable sources cannot be used to meet constant electricity supply needs, nor can they be relied upon to respond to peak demands. For that reason, legacy CCGT power plants continue providing flexibility services (e.g. peaking), despite the EU's desire to reduce its dependency on imported gas and evolve to Net Zero.

In addition, renewable energy projects are often located in remote areas and transmitting power from these distant locations to demand sites leads to congestion problems in some nodes. As a result, investments in transmission grids will be needed, but they are costly and project implementation times are lengthy, so alternative solutions will also be needed.

Both generator and grid operators can deploy various energy storage solutions to address challenges associated with providing power on demand, flexibility services, grid stability, and overall system reliability. These include traditional pumped storage hydroelectric, compressed air energy storage, power-to-gas systems or flow batteries.

In this paper we will focus on Battery Energy Storage Systems (BESS), which are usually based on lithium-ion batteries and whose adoption is growing rapidly. Consultancy Wood Mackenzie forecasts that 89GWh of grid-scale BESS capacity will be installed in Europe by 2031 – a 20-fold increase over 2022. The UK, Italy, Germany and Spain are the four largest markets for BESS in Europe.

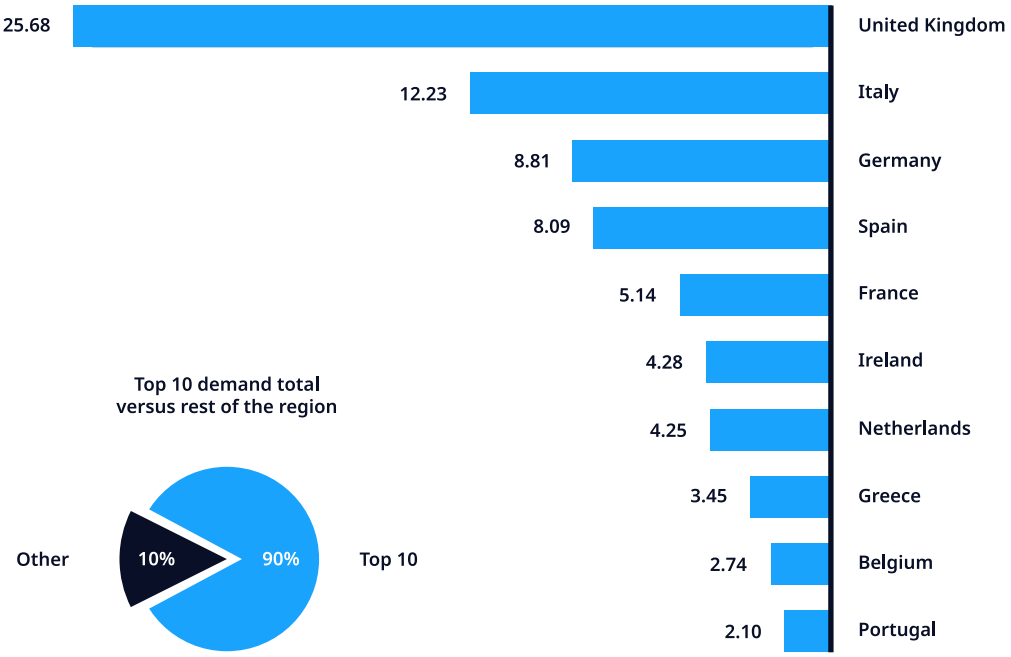


Figure 1. New capacity forecasts for top 10 European grid-scale energy storage markets 2022-2031 (GWh). Source: Wood Mackenzie.

Section 3: Utility scale applications of BESS

At the grid level, BESS play a crucial role as a buffer in the energy grid, positioned strategically to manage the temporal misalignment between power generation and consumption, and also help with other grid management challenges such as reactive power compensation. It can also participate in the wholesale market, levelling out peaks in demand via peak shaving and avoiding congestion in the nodes, and therefore, curtailments.

The three most important revenue sources for BESS in Europe are wholesale energy market arbitrage, ancillary services and long term capacity provision.

Installed on the site of a renewable energy plant, BESS can store surplus energy during periods of high generation and release it when demand peaks or during periods of low renewable energy production or even when available capacity in the grid exists.

This buffering capability not only ensures a consistent and reliable power supply to meet consumer needs but also facilitates the seamless integration of renewable sources into the existing grid infrastructure and market model. This capability can be applied in various ways, as described briefly below:

Fast reserve

Batteries deployed at any grid level play a critical role in providing fast-response power to address sudden changes in demand. Fast reserve applications require batteries to quickly inject or withdraw power to stabilize the grid, ensuring a rapid and efficient response to unforeseen fluctuations in electricity consumption.

Deferral applications

By acting as a temporary energy store, batteries help manage the temporal misalignment between electricity generation and consumption, reducing the need for immediate generation or transmission adjustments. This deferral capability contributes to more efficient grid management and optimized resource utilization.

Re-dispatch

Re-dispatch involve the strategic use of batteries to balance supply and demand, ensuring that electricity is dispatched efficiently across the grid. This contributes to grid stability and supports the integration of renewable energy sources by adapting to variable generation patterns.

Frequency regulation

Batteries can be an additional player in providing frequency regulation to maintain grid stability. Frequency regulation is vital for ensuring the reliability of the electricity supply and preventing damage to motors and other sensitive equipment.

Voltage control

Batteries contribute to grid stability by providing voltage control based on inertia and load control. This capability becomes increasingly important as the grid integrates more renewable energy sources with variable output.

Black start

Batteries can provide the capability to restart the electricity supply to isolated areas during blackouts. This capability enhances grid resilience by facilitating the rapid restoration of power in critical situations.

Section 4: Behind the meter BESS

BESS deployed behind the meter (BtM) provide electricity generators and consumers with greater control and autonomy over their electricity usage, and enable the integration into the grid of Virtual Power Plants (VPP) and distributed energy resources (DER).

According to analysts at BloombergNEF, the growth of DER will see the share of electricity fed directly into distribution networks grow to reach 50% by 2030, benefiting from national incentives such as attractive feed-in tariffs for prosumers and EU policies that promote DER.

One of the big changes created by DER, from the grid operator perspective, is that power generation is distributed across various smaller sources, reducing the need for electricity to travel extensive distances.

In this scenario, the national grid will acts as a "father" providing extra energy for local "child" DER systems which incorporate BtM BESS to store surplus energy and make them less dependent on the grid.

So the integration of DER implies a move towards a more flexible and sustainable power grid, as it minimizes transmission losses, enhances reliability, and promotes the generation and consumption of renewable energy at the local level.

Section 5: Grid-level integration of BESS

As described above, it is generally accepted that there are two main areas where BESS can play a relevant role at the grid level:

1. As a hybrid solution for renewable power plants and transmission networks. In this case, BESS act as a buffer, either:
    - Between generation and consumption, enabling asset managers to trade between peak and off-peak prices, flattening the price curve. There is a threshold point beyond which capturing the spread between peak and off-peak prices becomes challenging. This is similar to capturing the spread on an interconnect as the grid gets more congested.
    - Or between transmission and consumption, enabling TSOs and DSOs to apply the time variable to grid management (this is the end of instant supply), reducing curtailments and expensive grid developments and providing flexibility to the grid.
2. Providing power and ancillary services to the grid, where the appropriate business case will depend on the total capacity and the response time (see Figure 2):
    - **Small capacity (3 hours or less) and fast response:** these can be used for peak shaving and frequency regulation and RT dispatching to absorb generation-demand imbalances. They should be connected to a dispatch center. They will enable system operators to reduce their dependence on CCGT. Investment required is low and the ROI is high for early movers.
    - **Mid capacity (3-8 hours) and fast response:** these can provide short-term services and on top, should participate in voltage control and mid-term balancing. They are key to helping renewables contribute to overnight demand. The investment required is medium, as is the ROI and the opportunity here depends on regulatory developments.
    - **High capacity (8 hours to several days):** these systems will be essential in the overall decarburization of the grid as renewable energy to be stored and consumed during periods when production is low, such as cloudy winter with no rain and no wind. They can be managed as a Virtual Power Plant (VPP) to inject power to the grid when required. The investment required in VPPs is high, the ROI is mid to low, but the opportunity is potentially large if renewable targets are to be met.

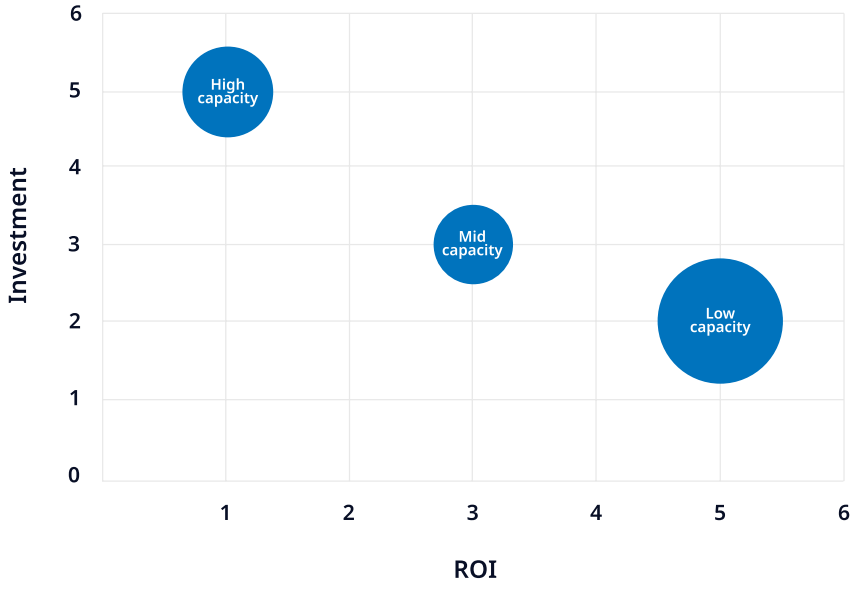


Figure 2. ROI and required investment varies according to BESS capacity.

Section 6: Opportunities in a developing market

As the BESS market develops and battery technologies evolve, new opportunities will emerge across the energy value chain, both in the utility-scale market and in DER.

Ambitious renewable energy targets are pushing grids in multiple countries to a critical turning point and the rising levels of renewable generation and lack of grid enhancements create a compelling need to increase storage capacity on national grids. Nevertheless, utility-scale BESS projects face several challenges, not least the high upfront costs.

Several countries provide subsidies and incentives to encourage the development of BESS projects but while battery technologies have been improving, reducing the costs and improving lifetime of the batteries will be critical in making grid-scale BESS a more attractive investment, particularly for independent power producers (IPPs).

To address this, a centrally coordinated market offers opportunities for IPPs who wish to offer ancillary services to the grid operator. In some countries, such as the UK, this approach has been tried but as more BESS projects specifically target this opportunity, saturation of the ancillary services market has driven clearing prices to record low levels.

In Texas, which has a grid independent of the rest of the US, it is estimated that the installed battery storage capacity will soon exceed the market for ancillary services.

To reduce the uncertainty and volatility in pricing created by market-based mechanisms, some BESS facilities may consider entering long-term contracts with system operators, effectively renting their storage capacity to the operator to use as it directs.

Despite the challenges, it is clear that timely engagement in the BESS market will yield attractive business opportunities. Today, the prerequisites for BESS are not overly stringent, and operational efficiencies can be swiftly realized.

In formulating business cases, it is crucial to discern all potential revenue streams over the long term. This comprehensive approach is vital for project design, considering that different products may result in varied revenue outcomes.

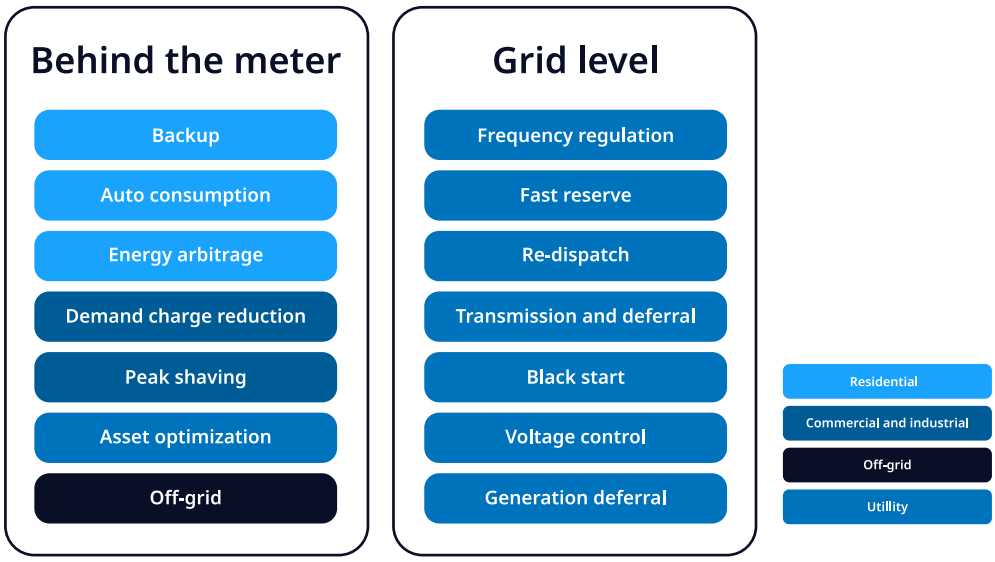


Figure 3. BESS use cases in the grid and behind the meter.

Section 7: The evolutionary path to a fully developed BESS market

As with any other market that is developing, we can define three different stages of market evolution for BESS:

- **Early stage:** This is the current situation in which a developed regulatory framework is lacking, installed capacity is insufficient, and assets are expensive and of low efficiency. This stage will conclude when the peak and off-peak price spread is small and ancillary services prices start to be competitive versus CCGT.
- **Development stage:** The regulatory framework becomes clearer, technical capacity for executing projects is readily available, assets become more efficient and their price reduces. The transition into the next stage occurs when some fuel-fired power plants are kept dormant or used only intermittently.
- **Mature market:** In this final stage, the regulatory framework is well established, technical teams focus on asset operation and maintenance, products are mature and at some point, older BESS installations are repowered with more efficient technology, as already happens with wind turbines.

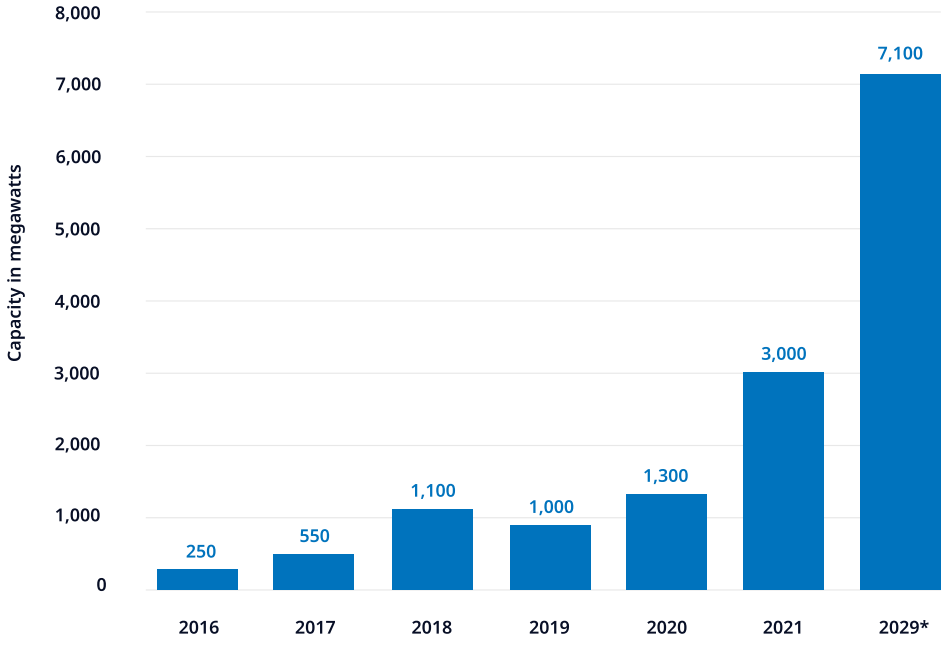


Figure 4. Annual battery storage installations in Europe from 2016 to 2021, with a forecast for 2029. Source: Statista

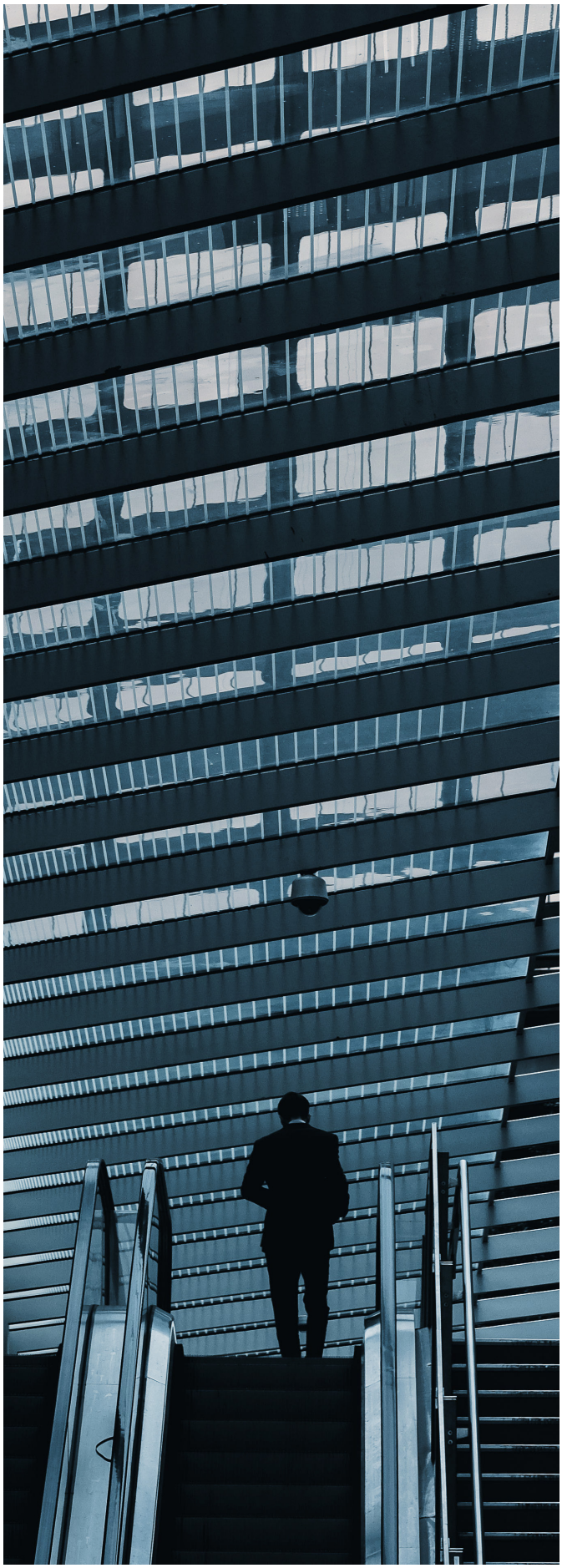
Section 8: Ways NTT DATA can help

NTT DATA is an international business and technology consulting company that works with utilities, grid operators and other businesses in the energy value chain.

We help energy companies finding new ways to deliver resilient networks and improve operations, adding new sources of power such as BESS and embracing digital technologies to make grids smarter and provide a better service to their customers.

Our offering includes:

- **Strategic consulting:** advisory services, battery roadmaps, business model creation, simulation tools for scenario analysis.
- **Business development:** deal generation, search for the best provider and technologies, due diligence support for investment rounds.
- **New business models definition:** identification of opportunities, TOM design and support to go-to-market, digital twin modelling.
- **Dispatch center:** provision of IT solutions for monitoring and teleoperation of assets and for market and ancillary services participation.
- **Trading:** market strategies, contract management, risk analysis and support for back-office processes.

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