AQUILA CAPITAL

SYSTEM STABILITY AND EFFICIENCY THROUGH BATTERY STORAGE – A TURNING POINT OF THE SUSTAINABLE TRANSFORMATION?

Abstract

The stability of grids and thus the security of energy supply depends on a constant balance between generation and consumption. Due to the dependence of renewable energies on the weather and relatively inelastic demand patterns, fossil power plants are persistently needed to ensure energy security. The resulting dual structure of Europe's energy supply leads to persistent emissions on the one hand and high costs on the other.

However, with increasing technological progress and economies of scale, significantly supported by the development in e-mobility, the competitiveness of battery solutions is rising. Utility-scale battery storage, i.e. systems with capacities of usually more than 20MW with a direct connection to the transmission and distribution grid, have seen a price reduction of more than 80 % in the last ten years.

In line with this development and the technological characteristics, significant competitive advantages are already coming to bear in the market for ancillary services[1]. For example, batteries can offer flexibility in both directions, while gas-fired power plants have to be connected to the grid with their minimum capacity and can consequently only offer lower flexibility. Due to the essential importance of this balancing energy for the stability of grids, renewable energies are subject to a curtailment in favour of the minimum output of gas-fired power plants. Battery storage avoids similar loads on the grids and improves the integration of renewable energies. As a result, system efficiency and cost efficiency would benefit.

However, in order to enable a significant expansion of battery storage, an appropriate regulatory framework is necessary. While investment is still relatively low in most EU countries, the opening of markets and special balancing energy products for batteries in the UK gave the technology an enormous boost. Today, the installed capacity of utility-scale battery storage in the UK is 1.3 GW, more than double that of the entire EU.

However, while Aquila Capital outlined the barriers to battery storage expansion in a 2018 analysis **(Insights: Charging ahead)**, there are signs of a reversal in the trend. Compared to 2018, the price reduction of batteries has significantly exceeded expectations and a new dynamic in the stationary battery sector can be observed globally (see USA, Australia). Due to market developments, more European countries have followed the regulatory model of the UK in recent years to create incentives for the expansion of battery storage.

A corresponding market environment enables battery storage to continuously optimise in various wholesale and balancing energy markets. But the ongoing heterogeneity of regulation in Europe requires a selective approach for investors. In particular, countries such as the BeNeLux, which offer a corresponding market environment, open up opportunities for investors to benefit from the development at an early stage.

Battery storage offers attractive business models in the long term through participation in the market for ancillary service and optimisation in electricity wholesale markets, benefiting from the increasing competitiveness compared to fossil power plants. At the same time, battery solutions stabilise the framework conditions for renewable energies and thus support the energy transition. The battery storage segment offers investors sustainable investment opportunities that also increase diversification within renewable energy portfolios.

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[1] Ancillary services are reserves held by grid operators to ensure the stability of grids. This means balancing out too high or too low frequencies.

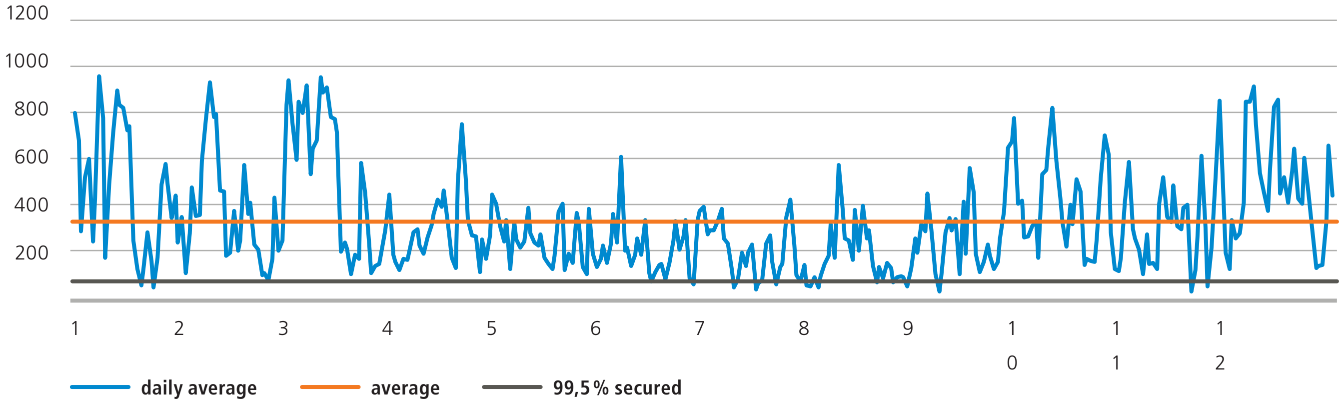
1. Why is battery-storage needed?

Renewable energies form the foundation of the transformation towards an emission-neutral industry and society. In particular, the mature technologies for wind and solar generation offer opportunities to sustainably reorganise energy systems. However, at the heart of the profound disruption is energy security as an essential component, as well as affordability, enabling access for everyone and ensuring fundamental acceptance. Since renewable technologies have already significantly surpassed grid parity[2] and offer monetary advantages even compared to the operation of existing thermal power plants, this conflict seems to fade into the background. But in real terms, the advantages do not yet reach the consumer.

The progressive inflation of energy prices since the beginning of 2021 is placing a heavy burden on private households, the competitiveness of industry and the central banks' ability to act. The rapid increase in electricity prices raises doubts about the European strategy. However, the developments are largely based on the increased global demand for fossil fuels (in the course of the economic recovery after the pandemic), which is accompanied by strong price increases and additionally burdened by Europe's continued dependence on imports. In contrast, renewable energy production dampened the impact of the high prices of fossil generation.

The reason for this distortion between theory and reality is a very inelastic demand for energy, which leads to fossil power plants continuing to set the price on the market. To ensure the stability of the grids, a constant, sensitive balance between generation and consumption is required. While conventional power plants generate a stable, because controllable, base load depending on demand, renewable technologies are dependent on the weather.

Chart 1: Wind power generation Germany 2019 (in GWh)[3]



In this context, Chart 1 illustrates the representative annual generation profile of wind energy. The actual secured output is below the annual average and thus poses challenges to energy security.

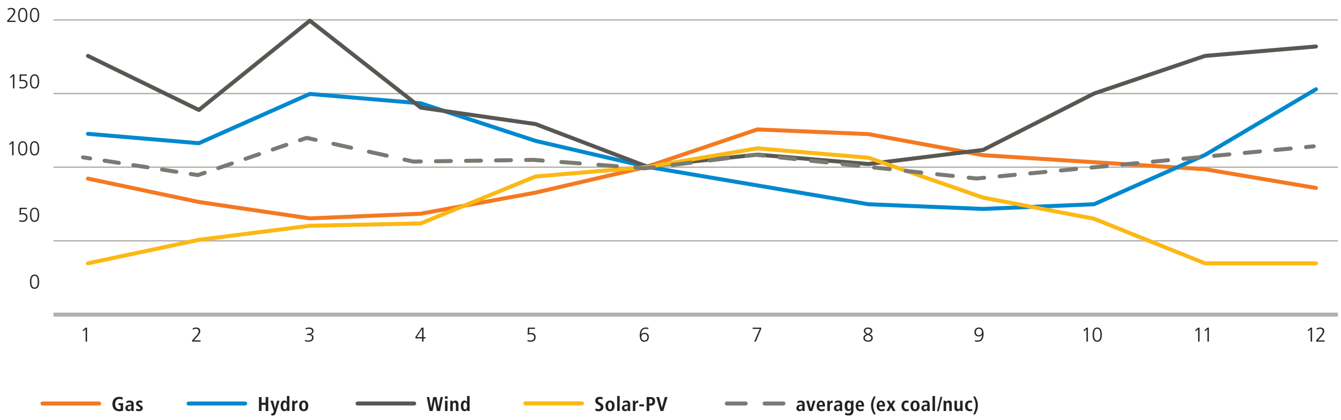
Due to these conditions, power generation via flexible gas-fired power plants is seen as the ideal counterpart to volatile renewables. But, on the one hand, the technology is not compatible with the pursuit of emissions neutrality, and on the other hand, current price developments and dependencies on exporting countries raise doubts about the long-term sustainability of the model.

However, advantages can be generated through the seasonal smoothing of renewable energy production. A regionally interconnected and technologically diversified approach shows a way forward that focuses on weather-dependent and resource-coordinated production and distribution of renewable energy.

The negative correlation of solar-PV compared to wind and hydropower as well as the regional differences between wind speeds on the coasts and high solar radiation in the south complement each other. The model of the Iberian Peninsula is a good illustration of this correlation, as the natural resources offer very good and equivalent conditions for all three technologies.

[2] Levelized costs of electricity generated by renewables match those of conventional power plants.
[3] Aquila Capital Research based on data from ENTSO-E (2021)

Chart 2: Indexed generation profiles by month in Spain (Average 2018, 2019, 2020)[4]



As can be seen in chart 2, a balanced generation mix results in a smoothed, stable generation profile, which significantly reduces the remaining need for storage capacities. At the European level, an integration of energy markets, i.e. international grid expansion, would reduce the need for storage by a factor of 10 compared to self-sufficiency, as calculations by the Fraunhofer Institute for Wind Energy Systems show.

However, significant daily fluctuations remain, which must be balanced by flexible generation and demand, to ensure the stability of the power grid. Lithium-ion battery storage offers ideal conditions for balancing out these short-term fluctuations and stabilising the grids.

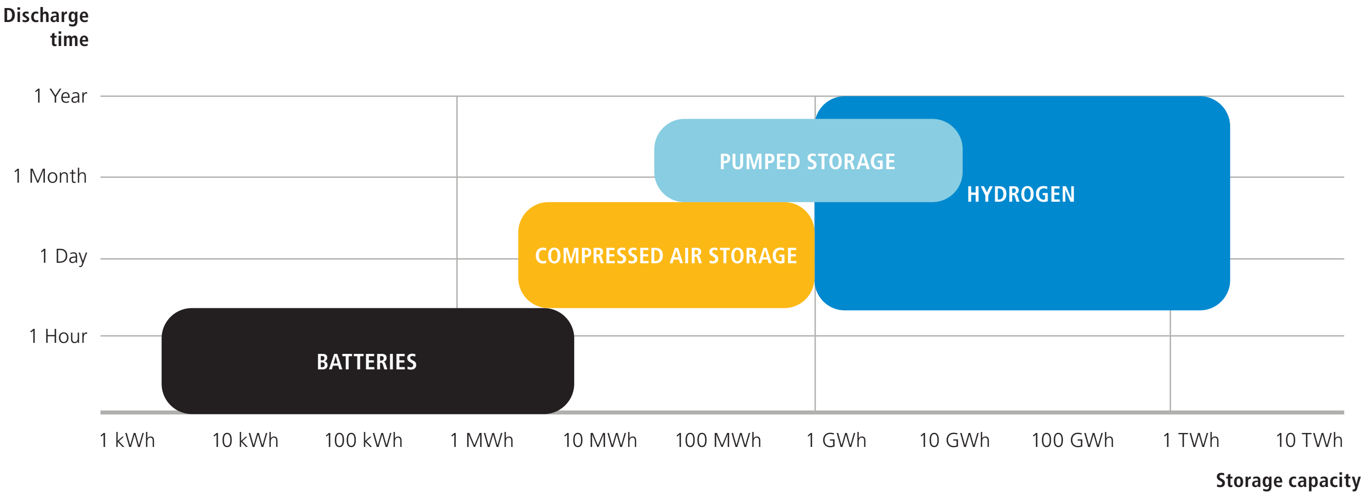
2. Technological framework for battery storage

Batteries can solve the challenges related to the reliability of fluctuating renewable energy by storing surplus electricity for the periods when wind and solar energy are not available. This flexibility of supply is the basic prerequisite for increasing the integration of renewable energy sources and thus enabling higher shares of renewable energy in the system.

As short-term storage devices, batteries offer a high degree of flexibility and thus fulfil the requirements of a sustainable energy system based on fluctuating renewable energy sources, especially for stabilising the grids (ancillary service) and for load shifting during the day.

[4] *Aquila Capital Research based on data from ENTSO-E (2021)*

Chart 3: Comparison of electricity storage technologies[5]



Compared to long-term storage, batteries have lower capacities and discharge times. While pumped-storage power plants and, in the foreseeable future, hydrogen applications offer opportunities to compensate for seasonal differences with just a few cycles per year or to build up longer-term reserves, batteries can go through several cycles per day. Lithium-ion batteries in particular are convincing because of their ability to make energy available again quickly, which makes them the ideal short-term supplement to the fluctuating daily generation of renewable electricity compared to the other technologies.

Lithium-ion batteries

Lithium-ion batteries are currently the leading technology for new storage projects. Due to the high energy density and the resulting low weight compared to other technologies, they are indispensable for portable electrical devices and for the increasing use in the transport sector. In the field of lithium-ion batteries, a distinction is mainly made between NMC chemistry (nickel-manganese-cobalt) and LFP chemistry (lithium-iron-phosphate). NMC chemistry has been the dominant technology in recent years, especially in the transport sector.

However, LFP chemistry is increasingly gaining market share. Despite a lower energy density, i.e. higher weight compared to NMC for the same performance, this technology offers clear advantages in other areas. In particular, due to the non-use of the critical raw materials cobalt and nickel, there are on the one hand cost reductions and on the other hand, due to the lower energy density, a higher thermal stability, which goes hand in hand with a reduced risk of fire.

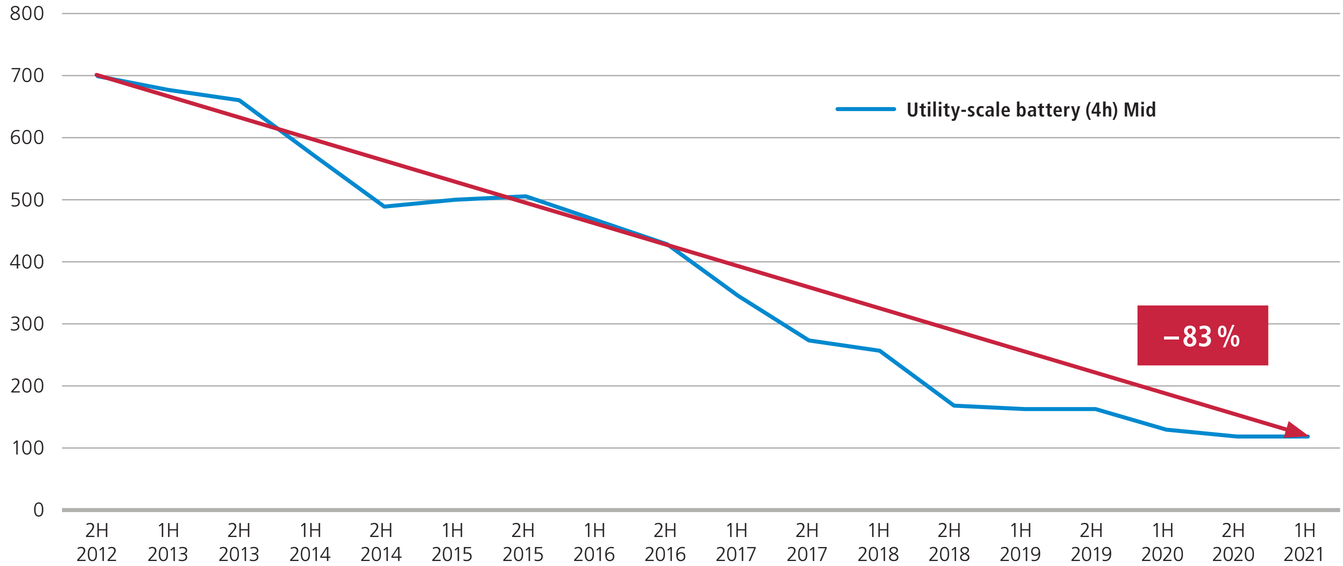
As a result, LFP chemistry is increasingly gaining market share for use in battery electric vehicles (e.g. Volkswagen and Tesla) and is increasingly dominating the segment for large stationary battery storage, which has a much lower sensitivity to weight compared to the transportation sector.

As Aquila Capital, we focus on the use of LFP as the leading chemistry in the utility-scale battery storage segment and combine the technical characteristics with our focus on sustainability and social aspects in this context.

Lithium-ion batteries are currently the dominant technology due to their high efficiency of around 90 % and high energy density. They also benefit from technological progress and massive economies of scale due to their use in E-mobility. In line with this development, batteries are showing enormous price drops.

[5] *Aquila Capital (illustrative)*

Chart 4: LCOE[6] global benchmark (in EUR/MWh)[7]



As chart 4 illustrates, the LCOE of utility-scale batteries has fallen by 83 % over the last 10 years. In line with this development, the competitiveness of utility-scale battery storage is increasing, which is measured particularly in comparison to gas-fired power plants.

Gas-fired power plants have become the bridging technology of the energy transition, in particular due to their flexibility, i.e. rapid start-up and shutdown according to the feed-in from renewable sources, and seemingly lower emissions compared to coal. However, as batteries become competitive, a trend reversal can be expected that will bring significant advantages in terms of the efficiency of the energy system. For example, while gas-fired power plants compensate for bottlenecks in the energy supply by producing when renewable generation is too low, they do not provide a solution for surpluses in other hours. In contrast, batteries can be charged during these periods and thus avoid grid-related curtailments for wind and solar-PV plants. In hours with low production from renewable sources, the corresponding emission-free electricity can be fed back into the grid. In addition, the EU's need for energy imports would be reduced, which has a positive impact on sovereignty and energy security and also limits the effects of volatile commodity prices.

In this context, it is also worth taking a look at the USA. In California, competitive large-volume battery storage is already being built. In combination with solar parks, they perpetuate the supply of renewable energy at prices that are competitive with fossil alternatives. A solar farm near Los Angeles currently being developed by the company 8minute, with a capacity of 400 MWp and a 4-hour battery of 300MW/ 1200MWh, for the first time offers prices significantly lower than fossil alternatives.[8] In addition, already decommissioned capacities of flexible gas-fired power plants are being replaced by new battery projects.[9] Beyond cost efficiency, this will lay the foundation for emissions neutrality by 2040. However, a prerequisite for accelerating this development in Europe as well is a corresponding regulatory framework that offers operators a positive and stable market environment in the long term.

[6] *Levelised costs of electricity*
[7] *BNEF (2021)*
[8] *https://www.8minute.com/2019/11/the-city-of-los-angeles-taps-8minute-solar-for-game-changing-clean-energy-project/*
[9] *https://www.energy-storage.news/expansion-complete-at-worlds-biggest-battery-storage-system-in-californial/*

3. Business models for battery storage

3.1 Regulatory requirements for investments in battery storage systems

Based on the benefits that energy storage brings, the regulatory framework is constantly evolving but differs widely across Europe.

The first generation of battery storage systems, which began to be built in 2014 in the United Kingdom and continental Europe (e.g. Germany), was limited to primary reserve. On the one hand, the battery storage systems had significantly smaller outputs and storage capacities. They had discharge periods of one hour or less, which also technologically limited their use in other markets. On the other hand, they were denied access to further market segments due to the regulatory framework conditions. With increasing market saturation in primary reserve, prices fell and thus limited the economic viability of business models.

However, technological progress and the fundamental change in the European electricity sector are leading to a change in the initial situation. Today, larger capacities enable the realisation of economies of scale and longer discharge periods also open up the possibility of serving further markets on a technology basis. In addition, adjustments to the regulatory framework, originally made in the United Kingdom, enabling access to further markets.

Basically, the markets can be divided into three categories:

- **Short term ancillary service:** daily auctions for primary, secondary and tertiary reserve
- **Wholesale electricity market:** day-ahead, intraday and imbalance markets
- **Long-term auctions:** e.g. capacity schemes, voltage control, last reserve

The design and maturity of these individual market categories still varies greatly across Europe. However, the creation of special reserve products for batteries in the UK, in particular, enables the diversification of battery operators' revenue opportunities and thus reduces merchant risks. In the course of this, financing conditions are benefiting significantly and projects are also attracting the interest of institutional investors.

Chart 5: Capacity development of utility-scale batteries comparison EU and UK (in MW)[10]

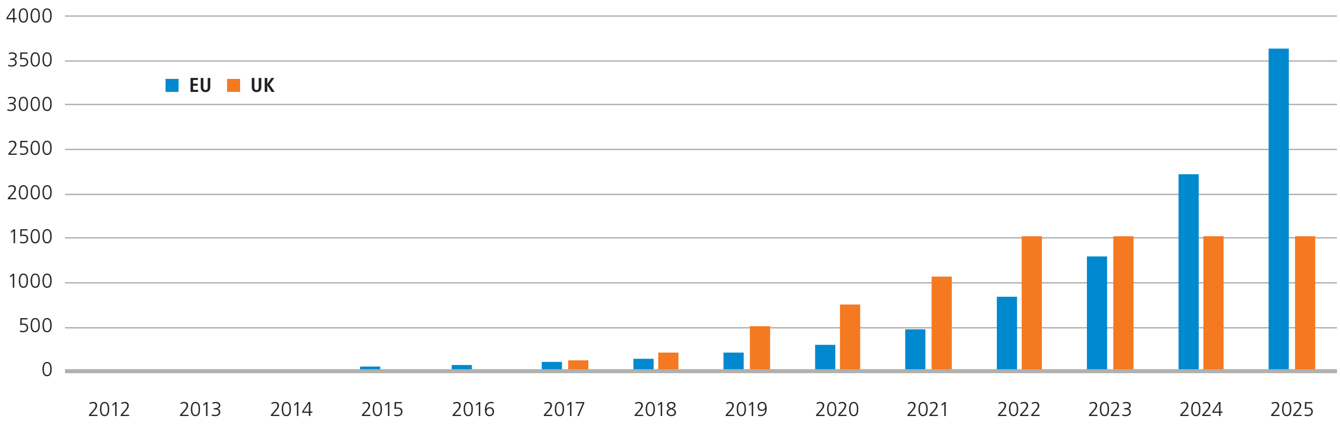


Chart 5 shows that the market design in the UK gives battery solutions a massive boost. Today, battery capacity in the UK is more than double that of the European Union as a whole. In addition, there is a pipeline of 15 GW of battery projects under development in the UK.

However, based on the market design in the UK, EU countries are also increasingly changing the regulatory framework. But, the still lacking harmonisation and heterogeneous strategies continue to require a selective approach. For example, Italy, Portugal and Spain continue to have restrictions on the participation of batteries in ancillary markets. However, it is expected that national regulators will adapt the market design in the near future and this will improve the framework conditions for batteries. Furthermore, there are projects at EU level, such as Picasso[11], to harmonise the market design. In particular, the BeNeLux countries already have a market design that is oriented towards the UK market and thus provides a good basis for investing in batteries. For example, the market in Belgium and the Netherlands allows for a constant optimisation of battery yields across different market segments, especially in the very short-term and volatile sector.

[10] *BNEF (2021)*
[11] *https://www.entsoe.eu/network_codes/eb/picasso/*

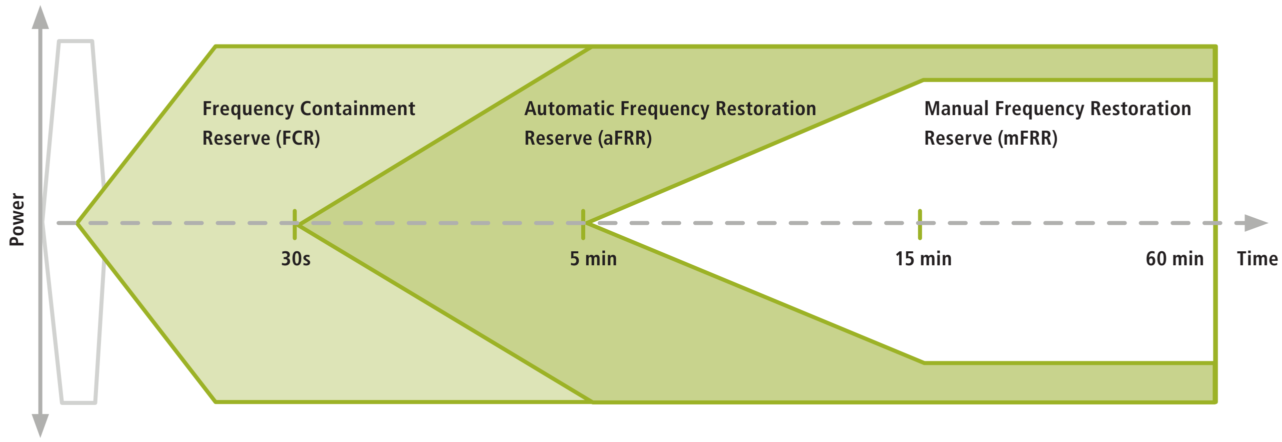
In addition to the market design, the regulatory classification of battery storage is particularly crucial. Due to their dual role as electricity consumer and producer, there is a risk of double surcharges, transmission fees and taxes, which are responsible for around two thirds of consumer prices in many European markets.

In the following, the main revenue sources of ancillary service and the wholesale electricity market are examined in more detail in order to define the advantages of batteries compared to fossil power plants.

3.2 Ancillary market

With the expansion of renewable energies, there are naturally higher fluctuations in electricity feed-in depending on the weather. However, in order to keep the power grid stable, a constant frequency (alternating current) of 50 hertz is required. In this context, the stability of the grid depends on ensuring a constant balance between electricity feed-in and electricity consumption. In addition to the obligation for electricity producers and suppliers to optimally plan the load flows, reserves are necessary. This energy is held in reserve in order to either increase electricity feed-in in the event of a deviation or to throttle it in the opposite case. The result is a business model that is based on the provision of capacity for flexibility and is remunerated accordingly by grid operators.

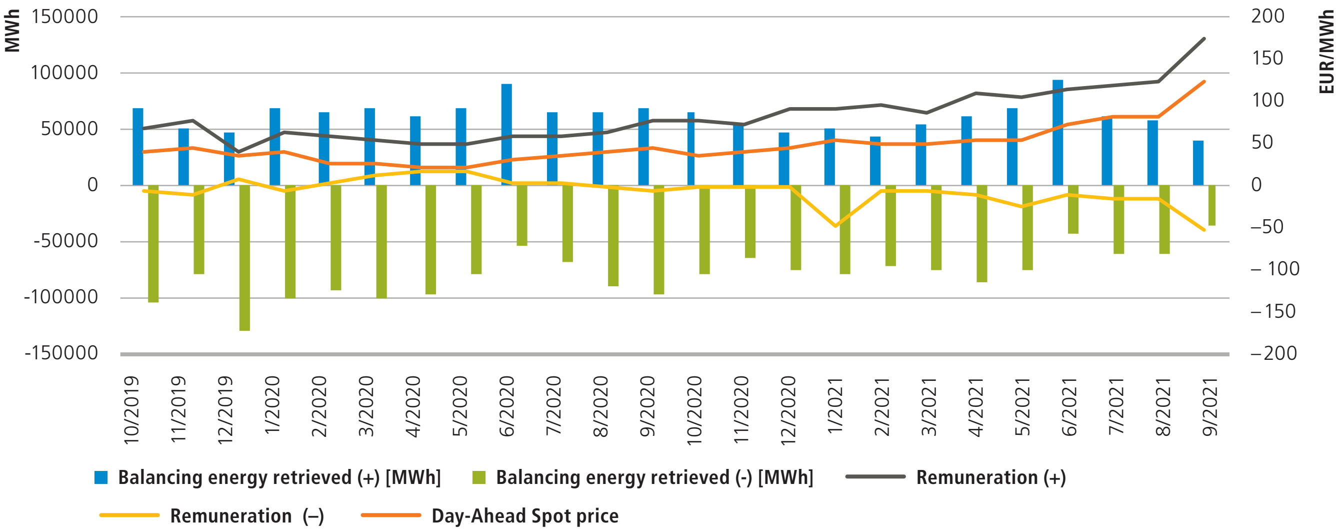
Chart 6: Overview ancillary service (example Germany)



The market design for balancing energy has not yet been harmonised at European level. In principle, the market in most countries is divided into three areas, as shown in Chart 6, which are ordered according to the provision time. The primary reserve is responsible for immediate balancing within seconds. This is followed by the secondary reserve with a provision time of 5 minutes and the minute reserve, which must be ready for use within 15 minutes.

Within the framework of the liberalisation of the European electricity markets, the ancillary service, which is calculated on a rotational basis, is put out to tender by the transmission system operators. Prequalified suppliers can submit bids for the provision of flexibility in the following. A distinction is made between the provision (capacity price) and supply (working price) of capacity.

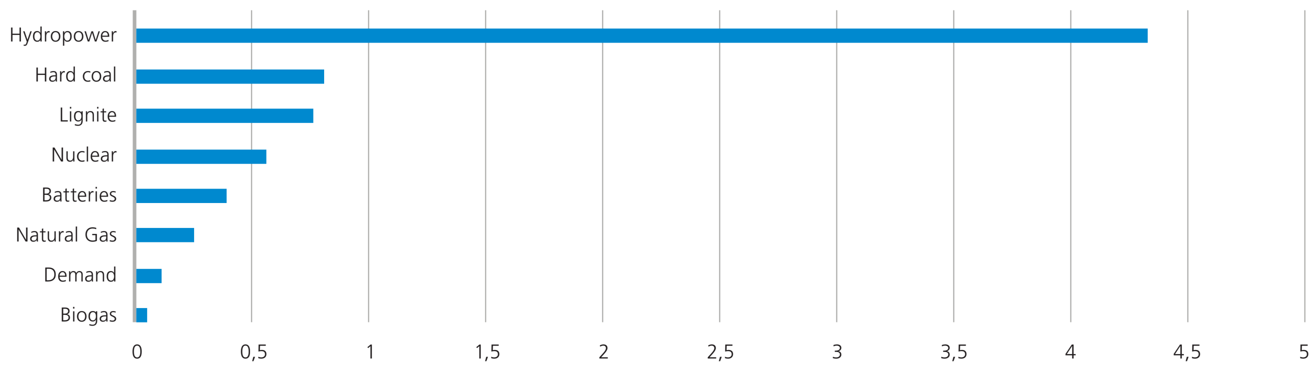
Chart 7: Capacity and price development in ancillary market of Germany compared to wholesale electricity prices[12]



Using the example of the German market, chart 7 illustrates the development of the ancillary market. It shows that the remuneration is higher than the wholesale electricity price due to the short-term nature of the flexibility.

Battery storage offers ideal characteristics for participation in the ancillary reserve markets. Income is generated both when charging (negative balancing power) and when discharging (positive balancing power). Due to the possibility of providing immediate positive or negative ancillary service, battery storage systems are predestined for participation in the market for primary reserve.

Chart 8: Primary reserve / Prequalified capacity of different technologies Germany (in GW)[13]



Even if the share of battery storage seems low at only 5 % of the qualified capacity, there are significant advantages that contribute to the increasing dominance of battery storage in the primary reserve market.

In particular, the „must-run problem" as well as the significantly lower flexibility performance of fossil power plants in ancillary markets limits the integration of renewable energies. This context also points to the limitations of gas-fired power plants, which are recognised as a bridging technology.

[12] *Bundesnetzagentur, ENTSO-E (2021)*
[13] *https://www.regelleistung-online.de/batteriespeicher-dominieren-den-prl-markt/ (2020)*

Chart 9: Comparison flexible capacity of a 100MW Battery and a 100MW gas plant (illustrative)[14]

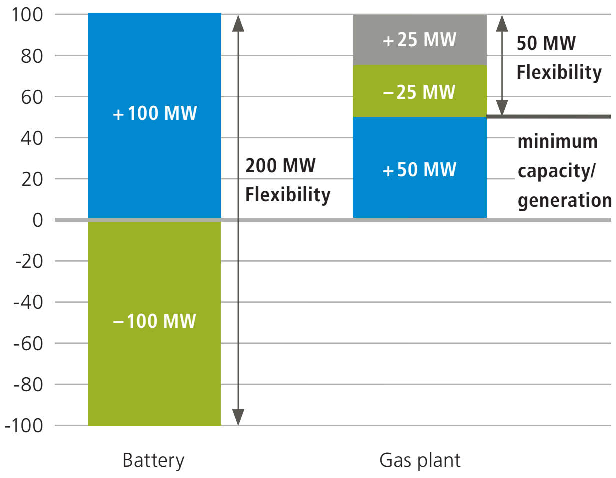


Chart 9 illustrates the advantages of battery storage, which offers around four times the flexibility compared to gas-fired power plants. Fossil plants, on the other hand, have to provide their minimum output in order to be able to offer flexibility at all. In the course of this, they partially displace the feed-in of renewable energies in times of high renewable production and thus increase the system costs of the energy supply.

In line with these conditions, battery power plants are increasingly dominating the markets for primary reserve, as they have already achieved competitiveness in this area and can offer ancillary service at lower prices.

Although battery storage, with approx. 300 MW, is only responsible for around 5 % of the prequalified capacity, it has already achieved a market share of more than 50 % in the German primary reserve market. It is expected that the grid operators' demand for ancillary service will increase with the expansion of renewable energies, furthermore greater growth opportunities for storage will arise primarily from additional revenue sources on the wholesale market.

3.3 Wholesale optimisation

In the course of the expansion of renewable energies, the volatility of the energy supply increases. Since the demand for energy is mostly inelastic and has limited adaptability, a more frequent imbalance between demand and supply increases the fluctuations in electricity prices.

Chart 10: Wind and solar-PV generation and corresponding wholesale electricity price Germany[15]

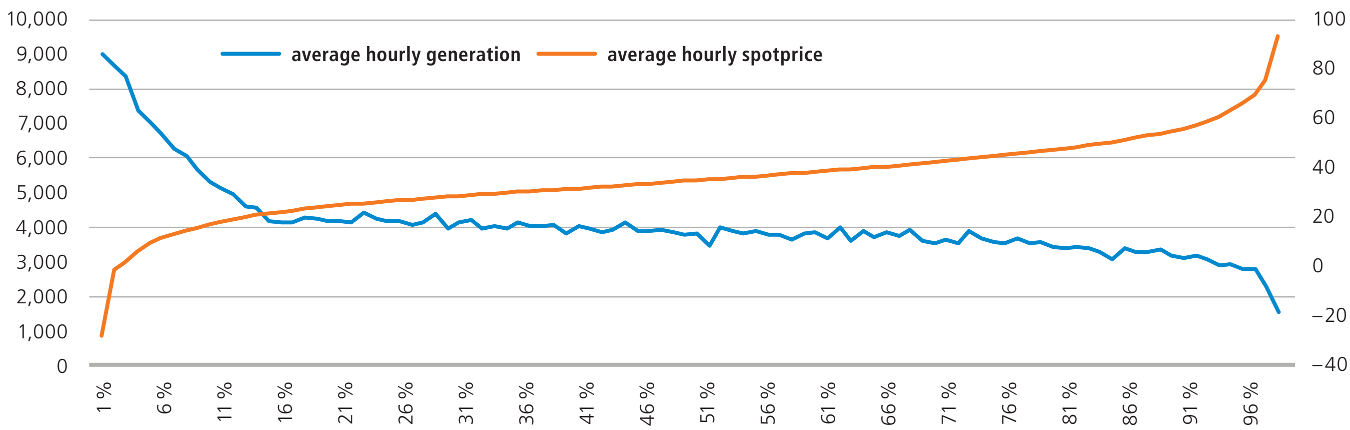


Chart 10 illustrates the relationship using the example of the German electricity market. High feed-in of renewable energies goes hand in hand with low prices on the electricity market, which in Germany sometimes even slide into negative territory. Conversely, low generation from renewable sources leads to price peaks.

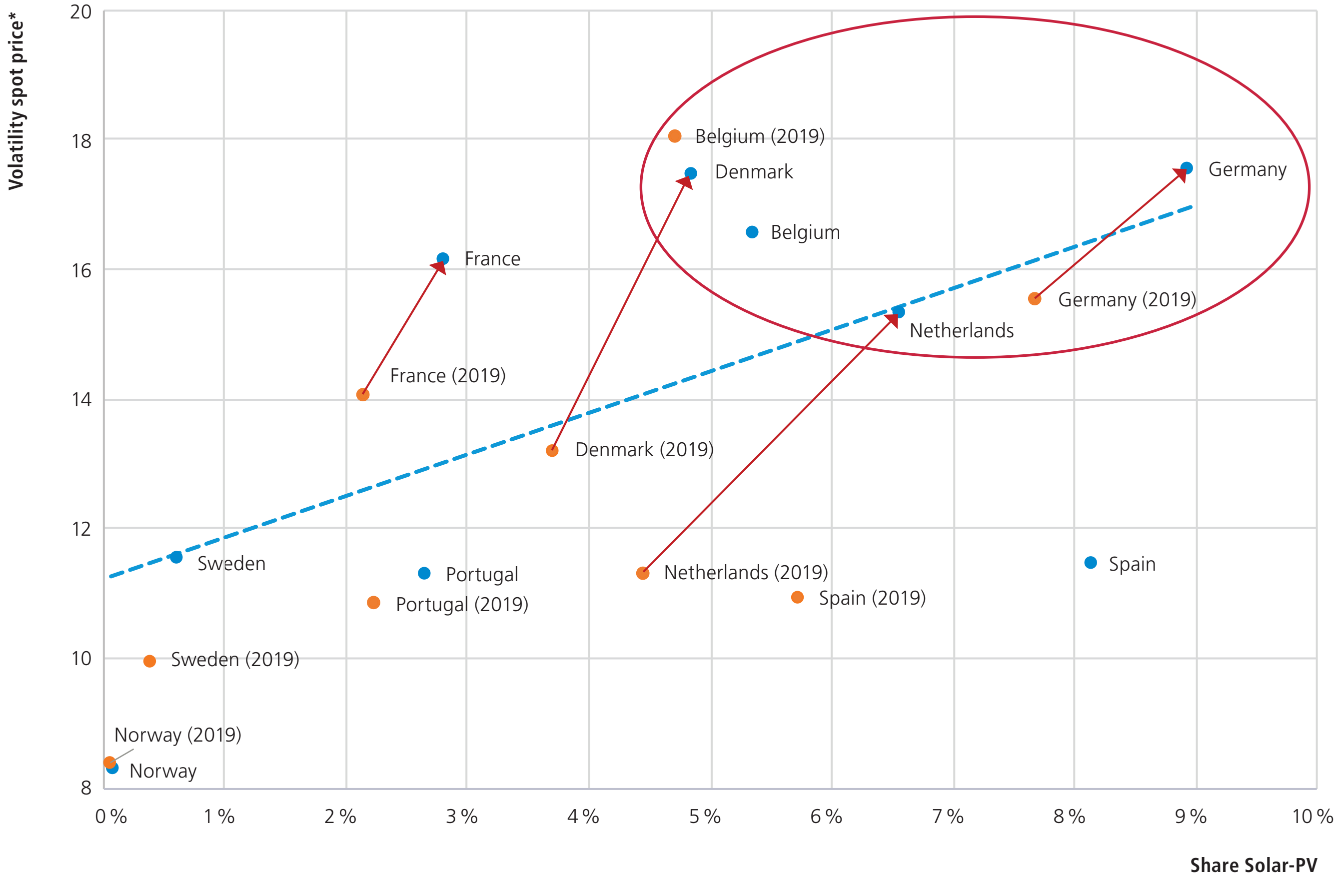
This correlation is largely based on 3 factors. Firstly, renewable energy production is weather-dependent and thus independent of the consumer load profile. Secondly, peak loads that are not covered by renewables require fossil power plants - especially gas - which have significantly higher marginal costs compared to renewables. Thirdly,

[14] *IRENA (2015)*
[15] *Aquila Capital Research based on data from ENTSO-E (2021)*

many European countries, including Germany, have persistently high shares of inflexible coal and nuclear power plants. Since these types of power plants have high start-up and shut-down costs, it makes economic sense for operators to accept negative prices to a certain extent.

In particular, the respective shares of solar-PV production in the electricity mix show a connection to volatility in the markets.

Chart 11: Volatility of the electricity price depending on the share of solar-PV in the national generation mix (comparison 2019/2020) [16]



In this context, the year 2020 is suitable as an outlookof further developments for the coming decade. The decline in energy consumption caused by the pandemic resulted in higher shares of renewable energy in the electricity mix. Chart 11 illustrates that as the share of solar-PV increases, the majority of markets also show significantly higher volatilities. The decisive factor is the diurnal dependence of solar-PV production. Starting with sunrise, generation peaks around midday and then gradually decreases again. The European peak load in the evening hours can therefore not be covered by solar-PV and requires additional capacity, mostly from flexible gas-fired power plants, which is associated with significantly higher costs.

[16] *Aquila Capital Research based on data of ENTSO-E and BNEF (2021)*
* *Volatility as standard deviation of the hourly electricity prices of the respective year*

Chart 12: Index of solar-PV generation and wholesale electricity prices (12 o'clock=100) Germany 2020 [17]

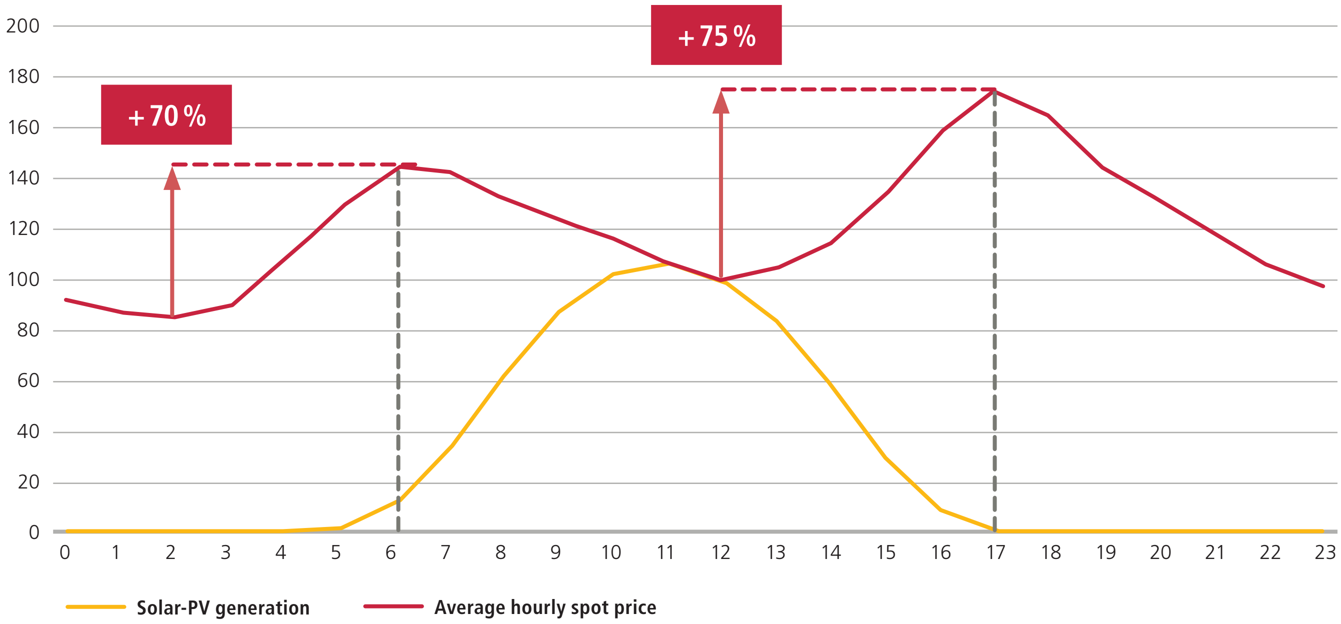


Chart 12 illustrates the relationship using Germany as an example. The average hourly values during the course of the day are shown. Electricity demand peaks in the morning hours between 6 and 10 o'clock and in the evening hours between 4 and 6 o'clock. Production from solar-PV plants, on the other hand, naturally reaches its highest production in the midday hours, when demand is rather low. Production from gas-fired power plants follows this pattern and compensates for the lack of solar-PV production in the morning and evening hours. This development is directly reflected in the price, which develops in exactly the opposite way depending on the solar-PV production. Between the peak production from solar-PV systems and the peak load around 6 p.m., the electricity price increases by 75 % on an annual average. Battery storage systems can achieve this load shift by charging during hours with high solar production and discharging in the evening hours.

This would reduce the grid-related curtailment of solar generation and thus lower system costs. In addition, it would avoid emissions from gas-fired power plants. While storage capacity operators would benefit from a current price difference of 75 %. With the increasing shutdown of coal-fired power plants as well as nuclear power plants in parts of Europe, this development will intensify significantly and open up great potential for battery storage. In particular, countries with very volatile prices or a forecasted high expansion of solar-PV offer attractive opportunities in this context. Battery storage is in direct competition with gas-fired power plants, which can react flexibly to the load (gas-peaker), but are not able to store surplus electricity.

Moreover, battery storage is a valuable addition to renewable energy portfolios, as it has a negative correlation to renewable generation due to load shifting and thus effectively increases diversification.

[17] *Aquila Capital Research based on data from ENTSO-E (2021)*

4. Outlook

With the EU's goal of increasing the share of renewable energies in electricity supply to 65% by 2030, fluctuations in the electricity market will increase significantly. Solutions to increase the flexibility of supply in order to stabilise the balance between supply and demand are indispensable in this environment.

Chart 13: Forecasted capacity build-out of solar-PV, wind, coal and nuclear power within EU (in MW) [18]

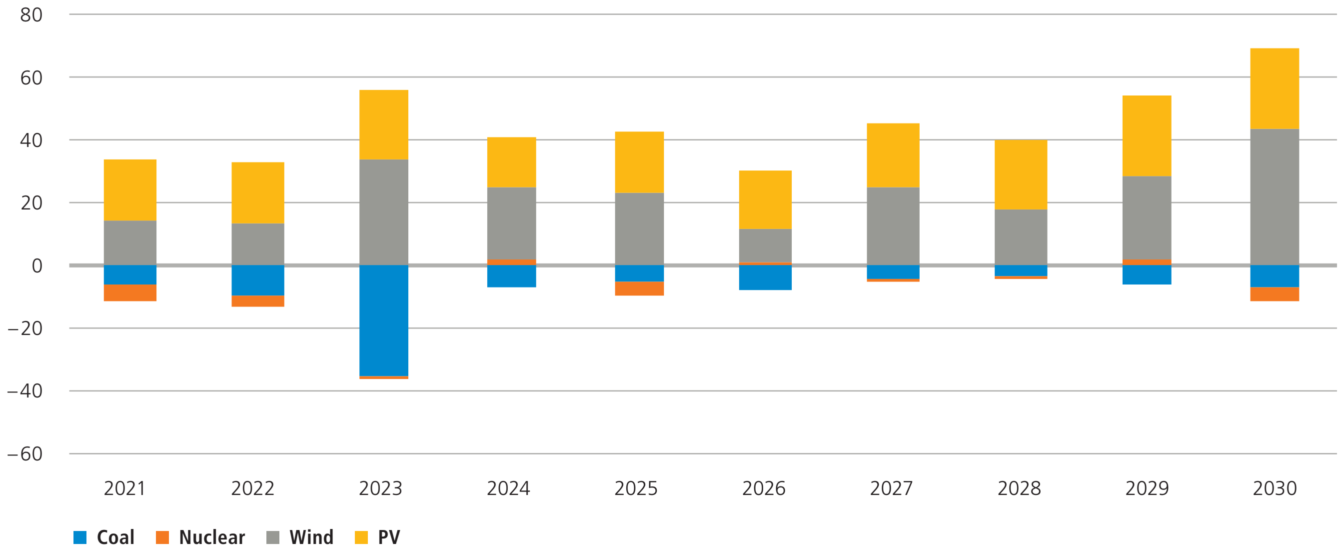


Chart 13 shows the projected development of capacities in the EU. Wind and solar-PV capacities are expected to more than double by 2030. In particular, solar-PV plants will become increasingly important for the European electricity supply with a growth of 122 %. At the same time, the capacity of coal and nuclear power plants, which continue to provide the base load, will decrease by more than 70 % and 10 %, respectively. Following these developments, grid-related curtailments will also increase, as renewable energy generation does not match consumption patterns. In addition, it is expected that peak loads in the morning and evening hours will increasingly intensify as a result of advancing electrification. For example, the expansion of heat pumps for heating buildings will potentially increase demand during these periods. In this course, batteries can store the surplus electricity and shift the load. Thus, the economic conditions for battery storage would benefit, while system efficiency and costs are positively influenced. In particular, countries that are planning a comprehensive phase-out of base-load capable fossil and nuclear power plants will offer high potential for battery storage, because the corresponding capacities can only be absorbed by the stabilisation of renewable production. Countries like Belgium, which on the one hand have the appropriate market design and on the other no longer operate any coal-fired power plants and want to phase out nuclear power - which was responsible for around 50 % of electricity production in 2019 – by 2025, offer considerable opportunities to participate in this development via batteries.

Forecasts by Bloomberg New Energy Finance expect the expansion of flexible gas-fired power plants as a bridging technology to triple within the EU by 2050. But the competitiveness of battery storage is steadily increasing.

[18] *BNEF (2021)*

Chart 14: Forecast of LcOEs in Germany (in EUR/MWh)[19]

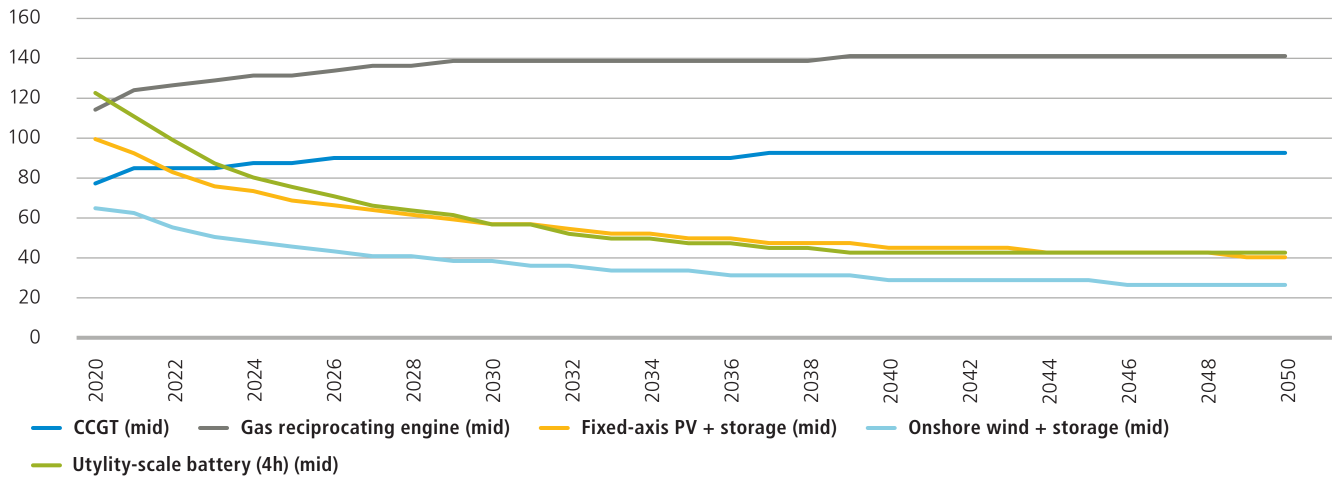


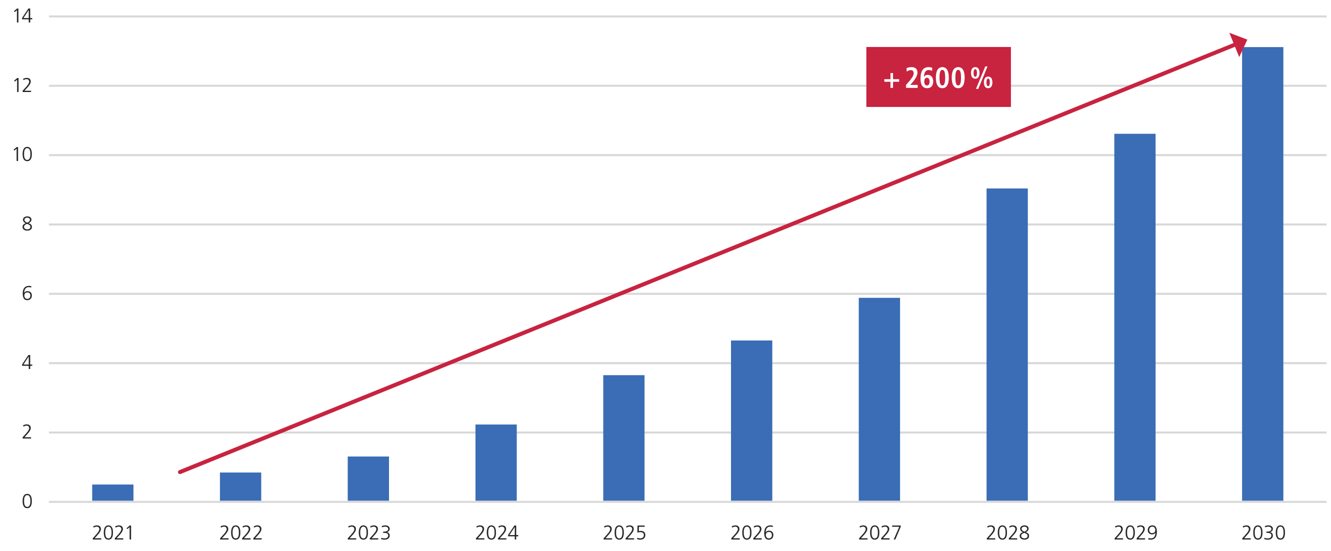
Chart 14 illustrates that battery storage has already achieved competitiveness compared to gas peakers and will also develop this competitiveness over the next few years compared to highly efficient gas-fired power plants. The steady increase in this dynamic is also evident when compared to our market analysis from 2018.[20] For example, at 75 EUR/MWh, the forecasts for 2025 are already 13 % below the level expected in 2018.

The continuing cost reduction is particularly due to technological progress as well as economies of scale, as the return on equity on which the calculations are based on only falls marginally.[21]

Following these framework conditions, an immense growth market for battery storage is developing. The positive effects on system efficiency and costs of the energy supply as well as the avoidance of emissions give the development additional impetus. By 2030, battery storage capacities are expected to grow from the current level of around 0.5 GW to more than 13 GW.

[19] *BNEF (2021)*
[20] *Insights: Charging ahead*
[21] *LCOE calculation assumption cost of equity (BNEF 2021): 2021: 9,0 % / 2030: 8,7 %*

Chart 15: Forecasted capacity development of utility-scale batteries in Europa (in GW)) [22]



Aquila Capital Portfolio Highlights

In Belgium, Aquila Capital and a partner are building the largest battery storage facility connected to the national grid to date. Completion of the storage facility, which will have a capacity of 25MW, is scheduled for the end of 2022. With a storage capacity of 100 MWh, the project will be one of the first four-hour battery storage facilities in Europe. Furthermore, by observing relevant ESG standards and focusing on sustainable construction and operation, the project will also set a high benchmark in European comparison.

Building on our expertise in the energy markets, this project increases our commitment to supporting the energy transition while offering attractive and sustainable investment opportunities for our investors. The realisation of the project on the site of a former coal-fired power plant metaphorically underlines the ongoing transformation within the European energy supply system.

[22] *BNEF (2021)*

5. ESG risks

Battery storage is a significant technology, driven in particular by the transport sector. However, in order to exploit the potential of the technology and to contribute significantly to sustainability goals in addition to the prospects for returns, a comprehensive analysis of the value chains that span the entire globe is essential. In particular, the dominant technology of lithium-ions leads to a significant demand for raw materials. In this context, it must be ensured that mining meets high standards on a social and environmental level. From the extraction of raw materials to production and recycling, a life cycle analysis must be carried out. For example, recycling the raw materials or using renewable energy in production can significantly reduce the CO2 footprint of battery production.

In addition, battery research will make decisive progress in reducing the need for limited raw material deposits and increasing efficiency.

Alternative battery compositions already exist in the dominant lithium-ion technology. While NMC chemistry (nickel-manganese-cobalt) has a higher energy density, LFP (lithium-iron-phosphate) offers lower costs because it is based on less scarce raw materials. In this area, this results in more diversified supply chains, while at the same time social aspects (e.g. working conditions) have a higher transparency.

In order to support the sustainability of energy supply in Europe, neither environmental nor social problems should arise in other parts of the world. Working with partners that address these aspects, as well as being proactive and having appropriate control mechanisms, are crucial in this environment.

6. Conclusion

The increasing expansion of renewable energies will continue to increase the demand for flexibility in the electricity grid. Due to technological progress, battery storage in combination with low-cost renewable energies offers a cost-efficient and sustainable alternative to fossil power plants.

The higher yield risk compared to renewable energies - due to the lack of hedging options (PPA) - must be viewed in a differentiated manner. While hedging against high price fluctuations for wind and solar parks ensures the security of earnings, batteries offer the opportunity to profit from these fluctuations.

Companies with expertise in renewable energies and the energy markets can benefit from entering the segment at an early stage. Service providers who increasingly specialise in trading flexibility offer the possibility of continuously optimising yields according to the price signals of the market. As a result of the low costs of batteries, which are increasingly lower than those of fossil alternatives, even when combined with renewable energies, optimisation in electricity trading results in potential returns in the high single-digit range for battery investments. In addition to higher potential returns, battery storage also offers positive diversification strategies for renewable energy portfolios.

While the energy transition benefits from the developments by increasing system stability and efficiency, sustainable and attractive investment opportunities arise in the current disruptive environment.

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