European energy strategy must reconcile the need for flexibility

Policy & regulation | Energy storage is among a number of key technologies which can bring much-needed flexibility to electricity networks and therefore to energy markets. With Europe at an unprecedented crossroads in its energy system planning, now is the time to factor in that critical flexibility, argue Julian Jansen and Lars Stephan of Fluence.

Credit: Wikimedia user Daniel Naczk.

Anti-war protestors photographed in Glasgow, Scotland, as Russia's invasion began, February 2022.

Over the last 12 months, we have witnessed an unprecedented crisis in the European energy markets. This was caused, among others, by the war in Ukraine, the growing effects of climate change, and the unavailability of the French nuclear fleet. Europe's response to those challenges is an even faster acceleration of renewable buildout in Europe.

As we rediscover the meaning of security of supply, it is time to better understand the value of flexibility as a critical enabler of the energy transition. European policy makers need to strengthen the role of flexibility technologies, including energy storage, in future Energy Market Design.

A perfect storm

In many ways, European power markets have faced a perfect storm in 2022. Towards the end of 2021, gas prices and corresponding electricity prices came under stress because of tightening gas supplies in Europe. After the start of the war in Ukraine, gas prices came under constant upwards stress driven by the uncertainty around international sanctions and Russian willingness to continue supplying Europe with gas, followed by reductions of gas volumes and, finally, the sabotage of the Nord Stream pipelines.

The European energy crisis of 2022 is not only about gas shortages, but also about a persistent heat wave during the summer. High temperatures and droughts resulted in reduced production of conventional power plants, which were lacking cooling water, and decreasing water levels at hydro plants and reservoirs around Europe.

Several Covid-related delays of maintenance schedules at French nuclear plants and unexpected maintenance challenges at some reactors contributed to a historic low in electricity generated from the French nuclear fleet. This turned France from one of the biggest exporters of electricity to one of Europe's largest importers of electricity, further increasing the stress on European power markets.

All of the above factors led to higher gas and electricity bills for households and businesses, bringing the social dimension of energy markets into the focus of European policy makers, and raising questions about the competitiveness of European industries and businesses.

Europe's reaction to the energy crisis

The REPowerEU Plan, published in May by the European Commission, aims to increase the target of energy generated from renewable sources to 45% by 2030, up from 40% compared to last year's targets. This would bring Europe's renewable energy generation to 1,236GW by 2030, including the installation of 320GW of new solar PV by 2025. By the middle of the decade, this would result in cumulative solar capacity surpassing electricity demand in several European countries.

The REPowerEU plan is widely received as an important step by energy industry stakeholders, but it has also left some important questions unanswered. Discussed between energy experts, but largely invisible to the general public, is the need to upgrade power networks and interconnectivity between markets in Europe. While pivotal, it is not only a huge investment challenge, but also hindered by slow planning cycles and resistance against new infrastructure.

The other major question is how to safely integrate the increasing shares of fluctuating renewable energy into the European power system and market, and aligning it with the load profiles of industry and consumers. Energy storage, demand response and other flexible technologies are ready to address the needs, but the need and their value remain underestimated.

In July 2022, the CEOs of several businesses and organisations with decades-long experience in building and supporting energy markets brought the above issues to the European Commission. The open letter that was co-signed by 28 companies, including major energy companies, technology suppliers (including Fluence), IPPs and associations calling on the European Commission to bolster the REPowerEU Plan with adequate targets and policy frameworks for the deployment of energy storage and other flexibility technologies.

To this end, battery-based energy storage is a quickly deployed, cost-effective, and low-emissions solution with the potential to become a backbone of modern, resilient, and decarbonised energy systems. Other technologies, such as demand side response (DSR), the improved utilisation of existing storage potential of pumped hydroelectric and other energy storage technologies, as well as the interconnectivity between national electricity markets, are all critical to enabling the European energy transition.

Despite having access to this ready-to-deploy and cost-effective technology, we continue to rely on high-emission natural gas-based generation for flexibility needs in European power markets, while the Europe-wide targets that would strategically scale up energy storage projects are yet to be developed and embedded in law.

The value of flexibility in the European Power System

Flexibility in the energy system is necessary to balance generation and demand in various time periods, from seconds to minutes, from hours to days and even weeks. Today, fast-ramping peaking plants, typically gas-powered Open Combustion Cycle Generators (OCCG) are often, and wrongly seen as the sole flexible asset class.

Peaking plants are defined as power generation assets that produce electricity during peak demand periods, typically evening hours, and are differentiated from base-load capacity that operates continuously. Peaking plants only operate for a limited number of hours per day or even month, doing so at a low asset capital cost and a high marginal cost due to their low efficiency. Electricity generated from these assets is typically the most expensive in the market. Their price-setting nature coupled with high gas prices caused directly drove high electricity prices currently observed in Europe.

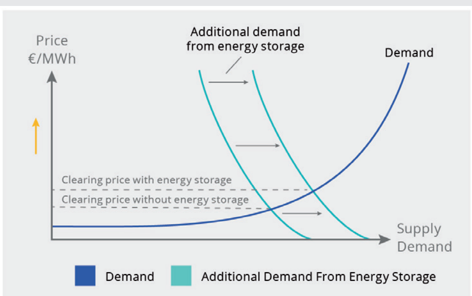
Today's reliance and focus on gas-based peaking plants risks a carbon lock-in of generation-emitting assets and import dependency on natural gas. Gas plants cannot shift or reuse renewable electricity in a cost-effective manner. Using hydrogen as a storage medium – first using renewable electricity to produce hydrogen and to re-electrify hydrogen in H2-capable gas plants – is inefficient, not technologically mature, and not optimal for short-term flexibility needed in the current phase of the energy transition.

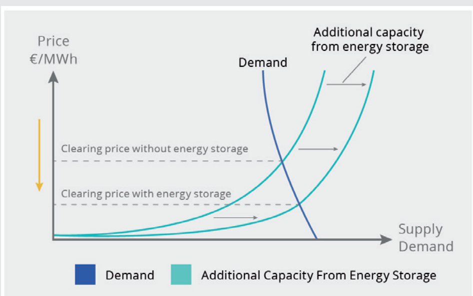
However, fast-ramping peaking capacity derived from various flexible technologies will be critical in the future as a corner-stone for the integration of large amounts of volatile renewable energy.

Today, surplus renewable generation (meaning renewable generation above the instantaneous load) must be stored and shifted from periods where production is higher than demand into periods where renewable generation is not sufficient to supply the full load. This can be achieved with a range of low-carbon flexibility technologies, including energy storage or demand response. However, today's reality is that instead much renewable energy is instead being curtailed, thus wasted.

The concept of energy storage as flexibility tool is not new to European power markets. Existing pumped-hydro resources in Europe already function as low-carbon peaking capacity. They reduce overall energy cost by shifting renewable electricity from daytime periods with low wholesale market prices to periods with high wholesale prices. It is critical to define policy to accelerate the integration of a new generation of flexible and low-carbon peaking capacity to meet the demands of the future energy system.

The business case of energy-shifting (or arbitrage), thus providing low-carbon peaking capacity, is based on price differentials in wholesale markets. Additional energy consumption during low price periods moves clearing prices in wholesale markets only slightly (graph - A). Moving this electricity as additional supply into high price periods has a strong effect on dampening prices during those periods, as it replaces high-cost peaking plants (graph - B). As the lower clearing prices apply to all energy traded in each period, arbitrage operations of flexibility assets result in overall system optimization and lower the cost of electricity for all consumers. In the long term, high shares of volatile renewable generation will drive intra-day volatility further, with the effects of REPowerEU accelerating this development.

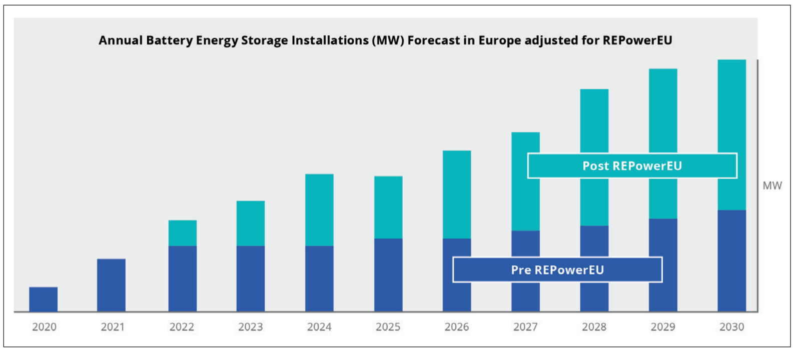




The investment challenge for energy storage as clean peaking capacity

In Europe, industry experts see the REPowerEU Plan and the current higher energy prices as a major accelerator for energy storage. Market intelligence providers have roughly doubled their forecasts for the energy storage buildout until 2030 to above 80GW. Member states to reduce energy bills for consumers.

In the medium- to long-term the European Commission is prioritising the accelerated build-out of renewable generation. To integrate higher levels of renewable energy into energy markets, regulators are working on a proposal to restructure European Electricity Market Design. The European Commission aims to



Credit: Fluence

Despite positive outlook, the business case of flexible assets has limitations for investors. They are fully merchant, and the investment case depends on forecasted wholesale market volatility. Without long-term revenue security, such assets are less bankable. This reduces access to low-cost capital funding for developers and owners of flexibility assets. Reducing revenue risk for flexibility assets will attract broader investments, reducing the cost of and increasing availability of capital. Without such levels of investment, there will be insufficient flexibility to integrate the increasing amount of renewable energy in our power system.

Reducing investment risk and, thereby, revenue risk for assets in our electricity system is not a new mechanism. Renewable generation assets benefit from feed-in-tariffs, renewable obligations or Contracts-for-Difference (CfD). Similarly, many European member states have Capacity Markets, remunerating the build-out of reliable capacity in power markets. These schemes address and guarantee decarbonisation and security supply – which are central to European energy markets.

Creating Electricity Market Design fit for the energy transition

In response to the energy crisis, the European Commission has taken a number of steps to stabilise the cost of electricity in the short term, including the introduction of price caps (on some generation technologies) in wholesale markets and mechanisms to allow develop a merit-order mechanism, under which wholesale markets operate, ensuring the low cost of renewable electricity filters through to consumers.

Rethinking European Electricity Market Design also opens the opportunity to rethink the role of flexibility in electricity markets. Failing to prepare for the build-out of flexibility technologies and grid infrastructure to match the pace of the roll out of renewables will result in increased congestion on power grids, curtailment of renewable generation, continued CO2 emissions from the power sector, and higher costs to consumers. At the same time, flexibility assets create opportunity to increase the efficiency of our power system, and ultimately lower cost to consumers. The question we need to answer now is: how to incentivise investment into flexible assets to enable this?

Recognising the need for Flexibility as part of the Electricity Market

In October 2022, Fluence launched a policy whitepaper with dedicated proposals for the European Electricity Market Design, that would establish market mechanism around the need for flexibility. The proposals could help create a market environment with stronger investment certainty for flexibility assets to foster renewable integration and reduce emissions in the power sector.

The policy proposal focusses on:

1) Reforming and decarbonising the capacity mechanism
2) Incentivising flexible and low-carbon peaking capacity

Decarbonising the Capacity Market

The Capacity Market or Capacity Mechanism (CM) is an integral part of European Electricity Market Design as a temporary measure to ensure the necessary means of resource adequacy in national electricity markets. Security of supply has become a critical area of focus during the current energy crisis.

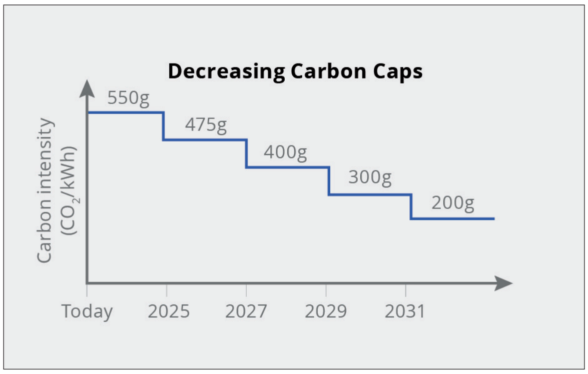
As renewable penetration increases, CM design should prevent an unsustainable lock-in effect of carbon intensive thermal generation assets. Otherwise, Europe will fail to meet emission reduction targets. We therefore propose three key changes to the CM:

1) Decreasing the existing carbon cap over time
2) Linking CM payments to carbon intensity
3) Providing longer contracts for new-build low-carbon assets

The three proposed changes will provide a clear path to owners and operators of existing CM assets as well as clear investment signals for new-build capacity to accelerate the decarbonisation of CM across Europe.

1) Decreasing the existing carbon emission limits in CM over time

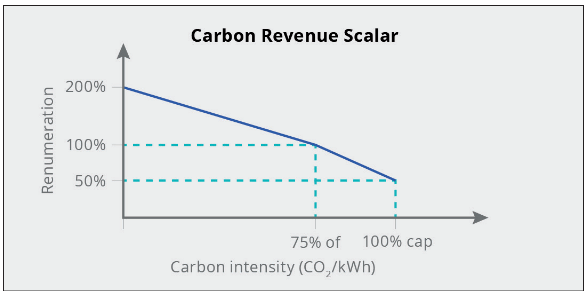
In Article 22 (4), the current CM design includes a carbon emission limit, or carbon cap, for assets to participate in the CM. To achieve a phased decarbonisation of generation assets in CMs, the carbon emission cap should be progressively reduced in pre-defined time-steps and based on carbon limits for emissions per kWh electricity produced as well as annualised emissions.



The currently established approach to CO2 emissions limits will provide an incentive to keep higher emitting generators online as back-up generators reducing their operating hours in electricity markets. This ensures Europe makes appropriate use of existing carbon-generation capacity as back-up resource and provides a clear timeframe and revenue slope for legacy carbon-generators and their operators. At the same time, emission caps need to be lowered progressively to ensure a timely market exit of high-carbon emitting assets to enable market integration of new-build low-carbon assets.

2) Link capacity mechanism payments to carbon intensity

In addition to fixed carbon emission limits, CMs should include market-based mechanisms to incentivise low- carbon assets to enter and high-carbon assets to exit CMs. Therefore, we propose scalars for CM payments based on carbon intensity. Market insiders know such scalar systems for example from the Irish ancillary service market (DS3). The advantage is that instead of defining targets for certain technologies, like zero-carbon technologies, a scalar system, allows different technologies to compete based on their merit, in this case their carbon intensity.



De-rating of assets depending on certain characteristics, such as availability is a common theme in implementation of CM across Europe. A scalar based on carbon intensity is therefore in line with existing CM implementation.

CM payments could be structured as follows:

a. 200% payments of CM clearing price to assets that emit zero carbon
b. 100% payment of CM clearing price to assets that emit 75% of the maximum allowed carbon emissions
c. 50% payment of CM clearing price to assets that emit the maximum allowed carbon emission

3) Provide longer contracts for new-build low-carbon assets

Multi-year contracts awarded to new low-carbon assets in CM, would incentivise a faster build out. Providing revenue certainty increases low-interest rate capital availability to those projects. We propose offering CM assets, which emit a maximum of 10% of the carbon emission limit for the respective year, with long-term contracts of at least 15 years.

Providing long-term contracts for certain assets is a CM design mechanism already implemented in various member states. Basing long duration contracts on carbon intensity is therefore in line with existing mechanism and targeted at the decarbonisation of the CM.

Building flexible and low-carbon peaking capacity

We further propose two key changes to the Electricity Market Design that will enable flexibility options via a market mechanism to balance generation and demand on the grid, reducing curtailment of renewables and replacing peaking capacity with low-carbon peaking capacity. These options include:

1) Mandatory Renewable + Storage auctions
2) Contract for Difference (CfD) for flexibility and curtailment prevention

1) Mandatory Renewable + Storage auctions

The balancing of generation and demand in renewable-driven power systems can take place at various locations in the grid: connection with load, with generation, or via standalone assets. The future energy system will require an optimised mix of flexibility options across all locations.

The combination of flexibility options, such as energy storage with renewable generation assets, creates socio-economic benefits in the power system that are currently not accurately captured and rewarded. These include:

- Higher utilisation of grid connections, resulting in lower requirements for grid reinforcement
- Higher grid utilisation, resulting in lower grid fees
- Reduction of renewable curtailment
- Increased investments in renewable assets by reducing exposure to negative or low-price periods (renewable cannibalisation effect)
- Acting as dispatchable assets, feeding electricity to the grid when the residual load (load minus renewable generation) is highest
- Energy storage adding capability to provide system services and other grid benefits such as active voltage and reactive power management, frequency regulation and inertia services, and short-circuit contributions

While some of these benefits are remunerated, others such as prevention of renewable curtailment or increasing transmission utilisation are not incentivised in most markets. Creating policy and market mechanisms to reward hybrid assets for their contributions would require complex Market Design and renumeration mechanisms.

It would be more practical to encourage the installation of hybrid renewable-plus-storage sites in member states via mandatory co-location auctions. These auctions could take different forms: as auctions for co-located assets; as minimum shares for co-located projects to be awarded in renewable auctions; or as standalone storage auctions, if operated as part of a renewable portfolio.

While not yet widely adopted in Europe, such auctions have proven successful, for example in Germany's Innovation Auctions. Member states should define how the hybridisation of renewable assets with storage could best be incentivised by:

- Adjusted/higher renumeration for power produced under auction mechanisms
- Faster access to grid connections
- Reduced cost for grid access and/or lower grid fees
- Other suitable mechanisms

At the same time, member states could define operating guidelines for hybrid to ensure they provide additional,


A BESS supplied by Fluence to a project in California.

Credit: Leonardo Moreno, AES, via LinkedIn non-remunerated benefits to the grid. This could include a requirement to cap solar peak feed-in; bans on exporting power to the grid from storage during periods of local grid congestion or negative wholesale market prices; or other guidelines to define grid-beneficial usage of hybrid assets.

It is important to clearly define such regulation to not disadvantage or prevent co-located assets from participating in other parts of the electricity market. It is imperative to take a market-driven approach that allows investors and asset owners to find the best locations and business cases for co-located assets.

2) Two-sided Contract for Difference (CfD) for flexibility and curtailment prevention

A novel approach to incentivise flexibility in European power markets is to create a dedicated market product. Similar to the Capacity Market, which procures a minimum share of flexible capacity for security of supply, a two sides CfD for Flexibility and Curtailment Prevention could secure sufficient levels of flexibility in power markets.

The proposed Contract for Difference (CfD) for Flexibility would provide long-term revenue certainty through a revenue floor for providing power during daily peak demand periods, while also capping revenues above a strike price threshold.

The revenue floor and strike price are to be defined based on a daily or weekly arbitrage spread or absolute revenue number in €/MWh of energy production or consumption shifted. Assets would operate on a merchant basis in the existing markets. The floor price guarantee or strike price would apply retroactively, in case flexibility assets fail to achieve revenues within the revenue band. The floor guarantee of an arbitrage spread offers a bankable baseline revenue reducing the cost of capital for projects. The cap is to be designed to prevent excessive profits for those assets. Still the cap should only apply to 80% of revenues above the cap, incentivising owners to optimise their flexibility assets above the strike price.

Participation in the flexibility CfD could be linked to a discharge obligation during a pre-defined price peak period, such as during the 4-hour evening price peak. The obligation to discharge power could also be defined in a more flexible way, as long as it is guaranteed that the assets can still participate in the relevant market, including ancillary service markets, such as FCR and aFFR, as well as Day-Ahead and Intraday Wholesale market.

Curtailment Prevention Mechanism

This flexibility CfD could include a curtailment prevention structure, where assets are awarded an additional premium (in €/MWh), if they charge with electricity that would otherwise be curtailed. Here it will be important to define a methodology that ensures the tracking of otherwise curtailed energy, e.g. via notification by grid operators about renewable curtailment in specific gird areas. This would also add much needed transparency on renewable curtailment in Europe, which is missing in most markets. The curtailment prevention mechanism would provide an incentive to capture otherwise curtailed energy, which in various member states must be compensated via renewable support schemes. It would also provide a locational price signal. The structure would therefore result in additional socio-economic benefits of reducing network reinforcement and increase the utilisation of existing grid infrastructure.

Auction design for Flexibility CfD

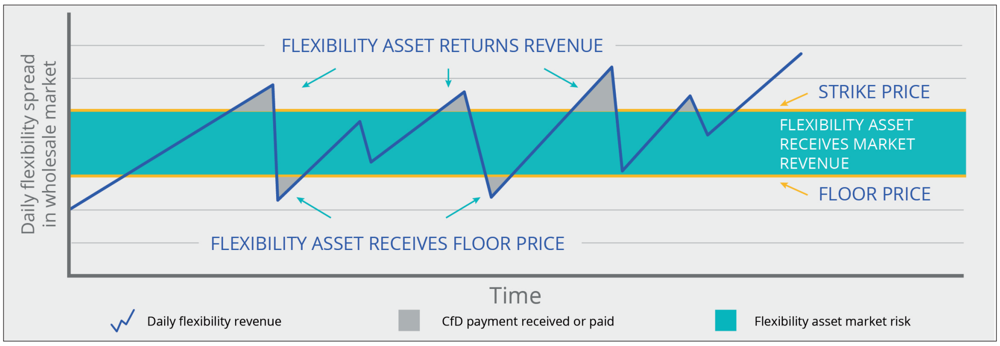
Contracts for a flexibility CfD could be awarded via auctions for existing and new assets with 10–20-year contracts. This would guarantee a market-based procurement of flexibility services. An auction mechanism would provide member states with a tool to control and incentivise the amount of flexible peaking capacity required to be integrated in their electricity market. At the same time, assets could be built outside of the CfD structure as well, leaving potential investors the option to pursue fully merchant flexibility assets as well. This would mirror the mechanisms used to procure capacity via capacity auctions in several European markets today.

Technical requirements could additionally be defined in terms of carbon emissions allowed from those assets, including carbon intensity of electricity stored by energy storage assets. Further start-up and ramping requirements could be defined to ensure that such assets have the capability to support steep ramps required for the integration of volatile renewable assets.

An auction-based Market Design with a CfD structure can provide additional revenue certainty to investors without resulting in cost to electricity consumers or taxpayers. It will provide revenue certainty for investors, based on price levels that are reflective of the expected long-term price volatility in energy markets.

European energy strategy needs to address flexibility

Europe today stands at a crossroad. Based on the unprecedented challenge in our energy markets, we decided to accelerate renewable build out, which in time will result in a lower-emission, more resilient, and more affordable energy system for European citizens. Still, as we chart the course of a renewable based energy system, we need to pre-empt future challenges and already define solutions to the future challenges of our energy transition ahead of time. Defining the need for flexibility and creating market mechanisms for flexibility is a key part of Europe's future renewable powered energy system. ■



Authors

Julian Jansen is growth and market development director and Lars Stephan is policy and market development director for the EMEA region at Fluence, a global energy storage technology company and products and services provider. Julian and Lars work to support growth in energy storage markets, working in the policy and regulatory space as well as business development with stakeholders including transmission system operators.