

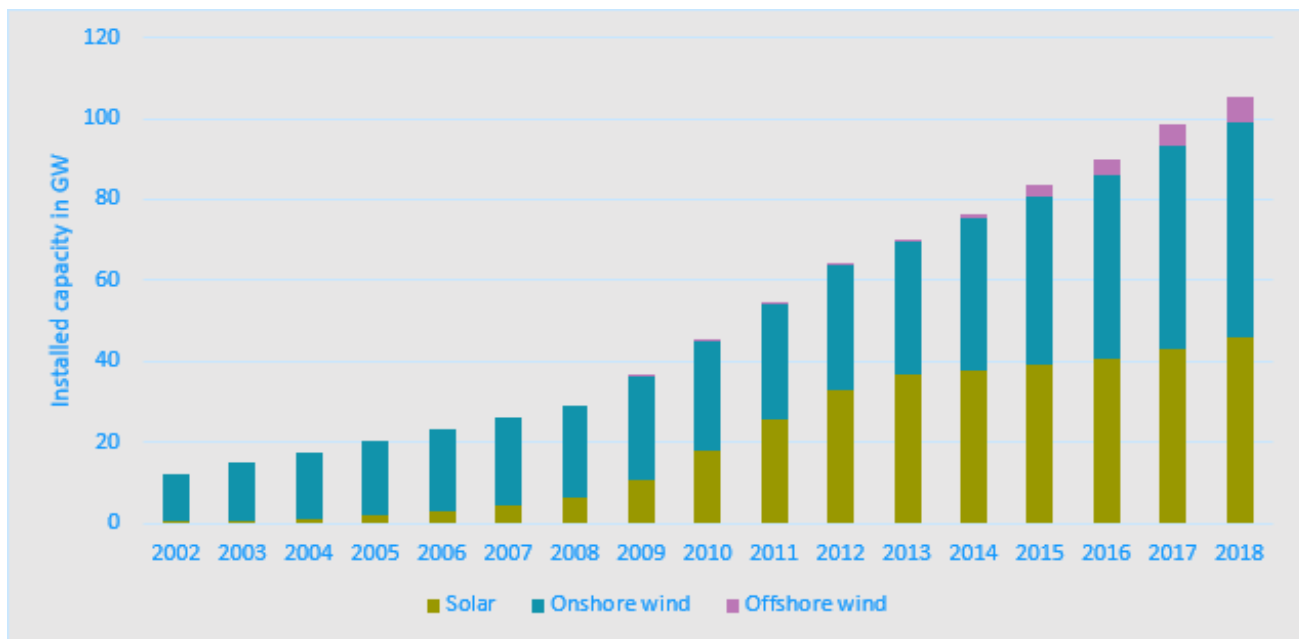
## German battery storage sparks into life

With approximately 200MW of new storage added in 2018, Germany now has an installed capacity of 370MW – more than half the US's total. Utilities are making a strong entrance, paving the way to attractive stacked business models

Driven by ambitious climate targets, energy storage is set to be an integral part of the Germany's Energiewende.

In 2018, renewable sources produced 40.4% of the country's electricity generation, an increase from 8.6% in 2002. By 2050, Germany has pledged to meet at least 80% of its electricity needs with renewable electricity.

### Germany's renewable energy installed capacity, 2002-2018



Source: Fraunhofer ISE, inspiratia

According to Germany Trade & Invest (GTAI) – the country's state-backed economic development agency – 2018 saw the installation of 199MW of new, large-scale battery storage projects.

A project that stole the headlines is the 48MW/50MWh EnspireME project – a joint venture between Eneco Group and Mitsubishi Corporation – commissioned in May [2018], and to date considered the largest battery storage system in Europe.

The installation, which is located in the Jardelund district in the extreme northern part of the country, will participate in the Primary Control Reserve (PCR) market, with 38MW already qualified for participation. Integration with local farms will also be explored.

## Large-scale battery storage capacity in Germany, 2012-2018



Source: GTAI, inspiratia

A large-scale hybrid demonstration storage project, comprised of 7.5MW/2.5MWh lithium-ion batteries and 4MW/20MWh sodium-sulphur batteries in Varel, Lower Saxony started operations in November [2018].

The project is backed by the Ministry of Economic Affairs, Employment, Transport and Digitization in Lower Saxony, together with the Japanese industrial development agency New Energy and Industrial Technology Development Organization (NEDO).

The aim is to stabilise the grid in an area which produces twice the amount of renewable energy it consumes, through the provision of primary and secondary control reserve, balancing services and reactive power supply.

This demonstration will last until February 2020, intending to showcase the effectiveness of bringing the two different battery technologies together. Notably, lithium-ion enables quick access to the stored energy, while sodium-sulphur offers more long-term storage capabilities.

The project is financed by the state of Schleswig-Holstein and the EU.

### Utilities step up their game

In 2018, one of the major trends in the German energy storage market was increased investment from local utilities.

The availability of revenue streams from grid services, such as the provision of primary control power, and the avoidance of grid charges through peak shaving and load shifting are said to allow amortisation periods of four to eight years.

In April [2018], Enel Green Power commissioned the first phase of its first storage plant in Germany, namely the Cremzow plant. In September [2018], the utility started construction of the second phase of the project, which has been recently completed, allowing the plant to reach its 22MW/34.8MWh final operational size.

The last section of the plant is now under the pre-qualification process with the transmission system operator and full operation expected by the end of April 2019.

Eleonora Petrarca, head of business development energy storage at Enel Green Power, says that the major driving force behind utility-scale investment in storage is the advantages it can bring to both the power grid and the renewable assets themselves, especially when coupled with renewable energy plants.

"The location of wind assets concentrated in the north of the country increases power grid congestions and the need for battery storage," she says. "Especially when coupled with renewable energy plants, the advantages it can bring to the power grid and the renewable assets themselves make an attractive proposition," she adds.

Petrarca explains that these advantages include greater asset flexibility and improvement in the operating capabilities of the grid to match supply and demand, reducing the use of back-up generation and therefore the cost for the overall system.

She also stresses that storage systems also allow generation assets to better respect the scheduled production forecast, reducing penalties that would otherwise be applied.

The Cremzow plant is co-located next to Enertrag's wind power plants, with the prospect to later explore the advantages of using its capabilities to reduce wind production imbalances and production curtailments.

The project may also enable the storing of wind power when available and inject it into the grid during peak demand hours to realise energy shifting – a function that will add another revenue stream by improving grid operations.

Through its 11 operationally independent units, the Cremzow plant will participate in the PCR market.

"In the long run and with the appropriate regulatory framework, the battery fed with renewable electricity, through an intelligent feed-in grid, has the potential also to allow black start services – an emergency application which leverages on generating assets that can deliver power to the grid without needing any energy to start operating following grid shutdowns," Petrarca adds.

In June [2018], RES Deutschland started construction of a 10MW/15MWh battery storage project for the energy supplier Versorgungsbetriebe Bordesholm (VBB), after the company won a tender at the beginning of 2018.

The asset is set to provide back up to the local grid in case of a power outage, participate in the primary reserve market, and ease the integration of renewable electricity into the local grid. Notably, the region produces 75% of its electricity needs by renewable energy sources already.

## Primary Control Reserve market

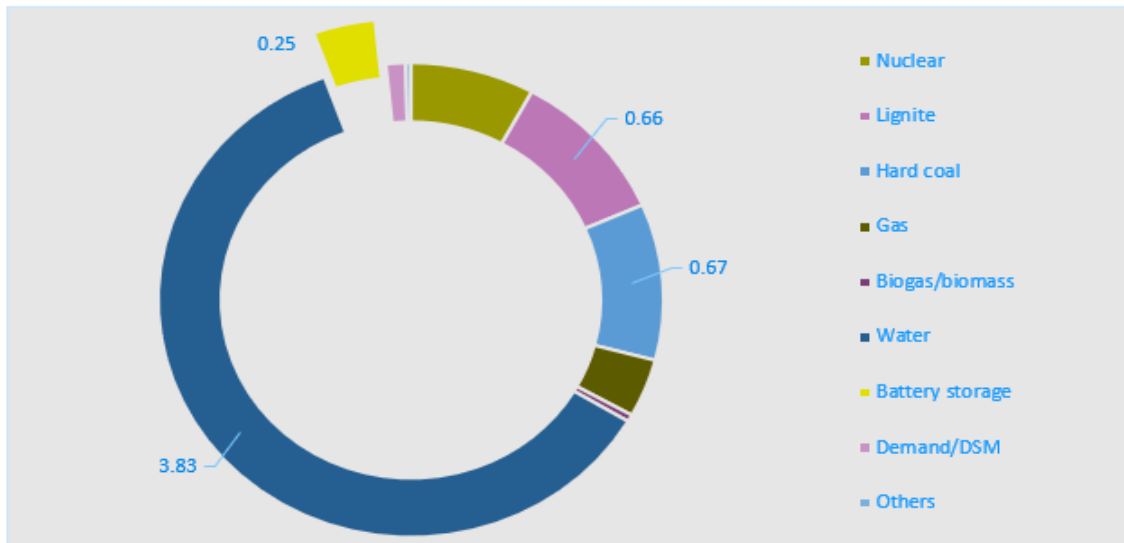
The PCR market is a form of frequency regulation aiming to keep the German grid within its 50Hz operating frequency. It is one of the three tiers of Germany's Primary Operating Reserve.

Primary Operating Reserve			
Tier	Primary Control Reserve	Secondary Control Reserve	Tertiary Control Reserve (aka Minutes Reserve (MRL))
Reaction time	15 seconds	5 minutes	15 minutes
Required availability	up to 15 minutes	up to 1 hour	at least 15 minutes
Procurement	Weekly	Weekly	Daily

The PCR has the fastest response time and the shortest required deployment period of the European Network of Transmission System Operators (ENTSO-E).

Among the three tiers of the German frequency regulation programme, it is the scheme with the highest requirements and accuracy of regulation, which justifies the suitability of stationary battery storage systems, whereas other forms of storage and generation are more suitable for the other two tiers.

## Breakdown of prequalified capacity by energy source for PCR as of November 2018 (in GW)



Source: Regelleistung.net, inspiratia

During the weekly tender for delivery for the week 11 March [2019], the capacity procured was 1,387MW, indicating that the 250MW share of battery storage is estimated at 18%.

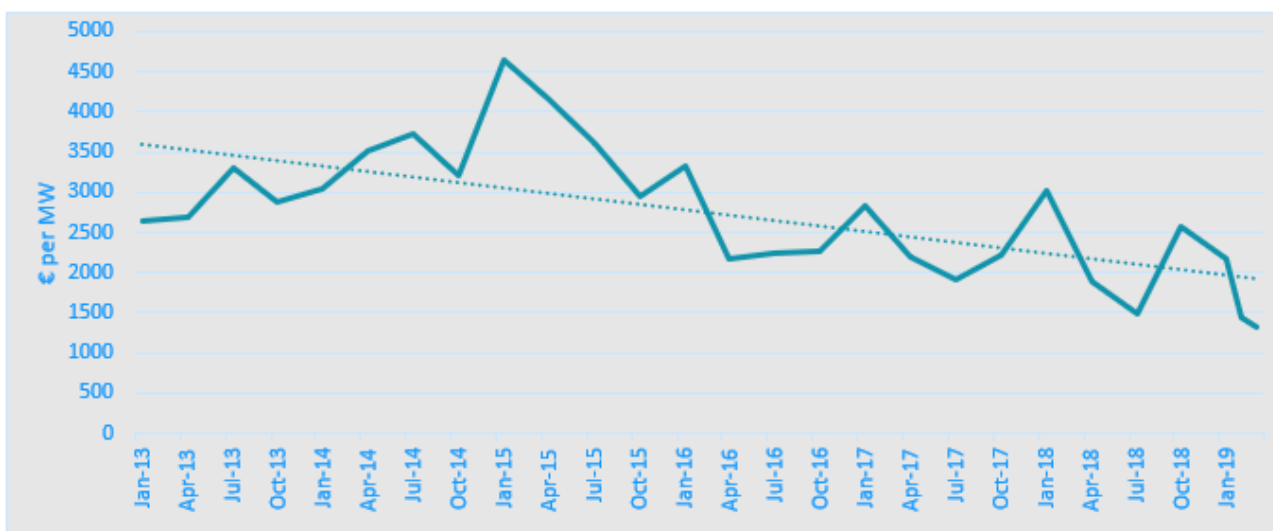
The increase of battery storage projects receiving pre-qualification status for PCR sparked modest excitement among the German storage industry.

GTAI suggest that a battery storage project costing below €870 per kWh participating exclusively in the control power market could effectively recoup expenditure in 10 years, assuming that the minimum PCR price doesn't drop below €2,500 per MW, an interest rate of 5% and operating costs of 2%.

However since January 2013, the average price of €2,631 per MW fluctuated between a high point of €4,647 per MW in January 2015 and a record low of €1,331 per MW in the first tender of March 2019.

Christian Bauer, of counsel at Norton Rose Fulbright Germany, says that during the past months a number of projects did not manage to move past the planning phase mainly due to the drop of PCR prices.

## PCR average capacity price, 2013-March 2019



Source: Regelleistung.net, inspiratia

## Financing trends

Despite battery storage assets being very well suited to serve the PCR market due to their fast reaction, its merchant nature and the volatility of cash flows makes debt financing of projects challenging.

Klaus Bader, partner at Norton Rose Fulbright in Germany, says that the main reason is the lack of multi-use business cases.

"Grid stabilisation is one thing; the main role of battery storage at the moment is providing primary and secondary reserve control power," he says.

"Lenders are very reluctant to rely on this single source of income at this time. The number of participants is increasing, and the prices are hard to predict for the next 10-15 years," Bader adds.

Bader and Bauer both suggest that interested third parties should look into private equity venture capital opportunities.

"This is something we are already seeing happening in the market," they note.

All the projects commissioned and announced within the past 24 months all plan to generate revenues from PCR, but it is worth noting that the majority of the projects which have disclosed their financing structure comprise either equity, public funding or both, and have series a business models in the line.

Moving forward, the German government has pledged to proceed with amendments in regulation which are expected to make stacked business models more feasible.

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