



The Future of GB Power Trading

Looking Towards 2030

BRADY.

Introduction

This is the 2nd white paper in our short-term power trading series.

The first titled The Future of Short-term Power Trading in Europe, introduced the concepts of flexibility trading in short-term power markets and explained how markets were evolving.

In this paper, we discuss future energy trading scenarios in GB and how they may impact the way in which the National Grid (and local markets) operate.

Whilst many of our readers who are either power traders or supporting power trading operations will be very familiar with the topics discussed, we wanted this paper to be more accessible to the wider community.

Therefore, we have divided the paper into 3 parts:

(To quickly access the section you want to read, use the links below)

- ∴ **Part 1** sets the context of physical power markets and how power is traded.
- ∴ **Part 2** discusses the challenges of trading and balancing on the GB market today.
- ∴ **Part 3** presents our view on upcoming challenges, and what you will need to succeed in the years ahead.



Part 1: A quick overview of physical power markets

1

Frequency and transportation

The GB grid operates as an alternating current (AC) at 50 Hertz (Hz). This means that the voltage of the system moves from positive, to negative and back again 50 times every second.

AC power is extremely useful as transformers can be used to increase or decrease voltage with relative ease. This means that power from a power station can be transported over great distances at 110,000 volts, but when electricity reaches your home it has been easily stepped down to a more manageable 240 volts. Most of the electronic equipment in your home operates with direct current (DC) (i.e. voltage is constant) and something much closer to 12 volts, so again your laptop or phone charger will step down the power further and convert it to DC.

A key thing to note is that all this expensive equipment assumes that your input voltage is around 220-240 volts and the frequency is between 49.5Hz and 50.5Hz.

If it isn't, things might get a little expensive at home.

2

Synchronous

In our description of frequency above we talked about alternating current. So at one point voltage is at its full positive displacement, and 0.01 seconds (half a cycle later) it is at its full negative displacement. Across transmission systems (such as the GB National Grid), the whole system is at the top and bottom cycles at the same time – frequency remains **synchronised**.

This means that traditional generation (large spinning turbine attached to a magnet) all rotate at 3000 revolutions per minute (rpm) (50Hz times 60 seconds) in perfect phase and at the same speed.

There is some great work done by Reactive Technologies showing how, during times of system stress (e.g. where a power station may have shut down in an unplanned manner), local areas begin to fall behind (lag) the national synchronised frequency before being pulled back into phase.

However, if frequency and voltage are not managed both nationally and locally, then the system could become asynchronous and do a lot of damage.





Part 1: A quick overview of physical power markets

3

Supply and demand and kinetic energy

To balance an electricity system, supply needs to equal demand (or at least be quite close). Supply encompasses all the power stations, solar parks, wind turbines feeding energy into the grid. Demand encompasses all the businesses and homes using energy.

If supply is too high, then this energy needs to go somewhere – and it does.

As supply remains above demand the system begins to speed up, the frequency goes above 50Hz to 50.01Hz, to 50.02Hz. The angular velocity of active synchronous turbines increases, and with the excess electrical energy takes the form of increased kinetic energy within the turbines.

When demand exceeds supply the opposite happens, the shortfall in energy is made up by kinetic energy transferring into electrical energy, but frequency decreases.

4

Inertia

When supply does not equal demand, frequency changes. However, the rate of change of frequency (ROCOF) is dependent upon the rotating mass of turbines synchronous to the system. Imagine a sunny and slightly windy summer day when 90% of the market's energy is supplied by non-synchronous wind and solar generation, supplemented by some traditional generation like nuclear and combined cycle gas turbines (CCGTs).

A mismatch of 500MW is going to have a very sudden impact on frequency as there are only a few turbines spinning. However, compare this to a cloudy, still winter day, where 10% renewables and 90% nuclear and CCGT supply the grid. A 500MW mismatch would transfer energy to 10s of turbines, so frequency would change much more slowly.

This spinning mass on the system is known as **inertia**, the product of mass and angular speed. In addition to real inertia, the properties can be synthesised by allowing generators to become frequency responsive.

For example, if frequency was above 50Hz, a battery could charge, mimicking the transfer of kinetic energy into a turbine. Similarly, if frequency were below 50Hz the battery could discharge (akin to the transfer of kinetic energy from a turbine back into electrical energy).

Products such as firm frequency response are often referred to as **synthetic inertia**.



GB market opening

On March the 27th 2001 the GB market for energy trading launched, with the following market design:

- ∴ Each energy company has an energy account (or two) which operates like a chequing account:
 - » Energy generated credits the account at half hourly intervals.
 - » Energy consumed by their customers debits the energy account.
 - » Purchases from the market (trades) credit the energy accounts whilst market sales debit the energy accounts.
 - » If your account remained in credit on delivery the system operator would sell the power cheaply for you by asking others to turn down their power stations and receiving a 'below market' price.
 - » If your account remained in debit on delivery the system operator would buy the power at a high price for you by asking others to turn up their power stations and paying them an 'above market' price.
- ∴ You were allowed to run your power stations how you liked but had to lock in a schedule 3.5 hours ahead of delivery.
- ∴ You offered flexibility in the Balancing Mechanism by stating ex-ante prices at which you would be willing to turn up and turn down generation.
- ∴ Large coal and gas generating stations would have to offer mandatory frequency responsive services to help maintain frequency.
- ∴ Traders did a couple of trades an hour, rescheduled their large cumbersome power stations once or twice a day and worked on 1 of about 10 trading desks each of which had significant fixed assets.

The rules of yesterday still shape the market we have today. Only 4 major changes have occurred:

- 1** The 3.5 hour limit on rescheduling changed to an hour in the early 2000s.
- 2** The price for not being in balance changed in mid 2000s and then again around 2016 with a single price being awarded for additional or shortfalls in power.
- 3** Lots of frequency responsive services have been overlaid.
- 4** A capacity market was created as a long-term price signal.



Part 2: The challenges today

How traders help to balance the system today

Trading desks provide 3 key products into the market to ensure a fair economic outcome is achieved and a market price is determined for each half hour:

1. They buy and sell power as economically as possible when their intermittent (wind and solar generation) varies from forecast.
2. They decide whether their batteries should provide frequency responsive services or short-term flexibility by deciding which market is likely to give them the best value.
3. They offer their flexibility at the best price that they can achieve assuming that they operate in a competitive market (i.e. they do not have the ability to price gouge or create an 'abusive squeeze').

By doing this the GB energy system has been able to:

1. **Decarbonise with flexible assets:** As traders determine the fair market price flexible assets charge to supplement intermittent assets.
2. **Decarbonise with low inertia:** As traders determine the fair value at which assets add synthetic inertia when traditional assets are not economic to operate.
3. **Maintain a fair market price by competition:** With the recent high market prices as a result of political unrest and low gas supplies, far higher prices would hit the consumer without traders actively hedging (hedging is trading to reduce the risk of a position – like selling earlier to ensure a fixed price is achieved) their position (just look at the escalating losses when the government decided not to hedge Bulb positions).

In practice

An example of this is when we recently had very high gas prices. High gas prices meant that CCGTs did not operate.

With no CCGTs the inertia on the system lowered. With lower inertia, the grid needed to buy more synthetic inertia. So the high gas price led to very high prices for frequency services like dynamic containment (DC) and dynamic reserve (DR) for battery operators.

The Russia-Ukraine war resulted in high returns in late summer of 2022 for battery owners.

To achieve this they traded hundreds of times an hour, operated batteries to move in milli seconds, not half hours, using algorithms or rules to improve their transaction speeds and continuously updating their position to see if they needed to buy or sell.

The market maybe 22 years old but the rules have hardly changed. 2023 is a million miles away from 2001.



Part 3: The challenges ahead

What's around the corner?

Key challenges we see occurring today are:

1. Traders need to have a much stronger decision-making criteria on what markets to put their assets into:

- » If I go into dynamic containment (DC), I can't do dynamic reserve (DR) or wholesale.
- » If I go into DC/DR I don't need to react if there's a capacity market event.
- » If I remain in wholesale then I can use my own flexibility to manage the uncertainty on my intermittent assets.

2. Cash-out is highly volatile as the assets setting prices can delivery for shorter and shorter periods

- » How do I make money from this and how do I keep up?

3. Position accuracy

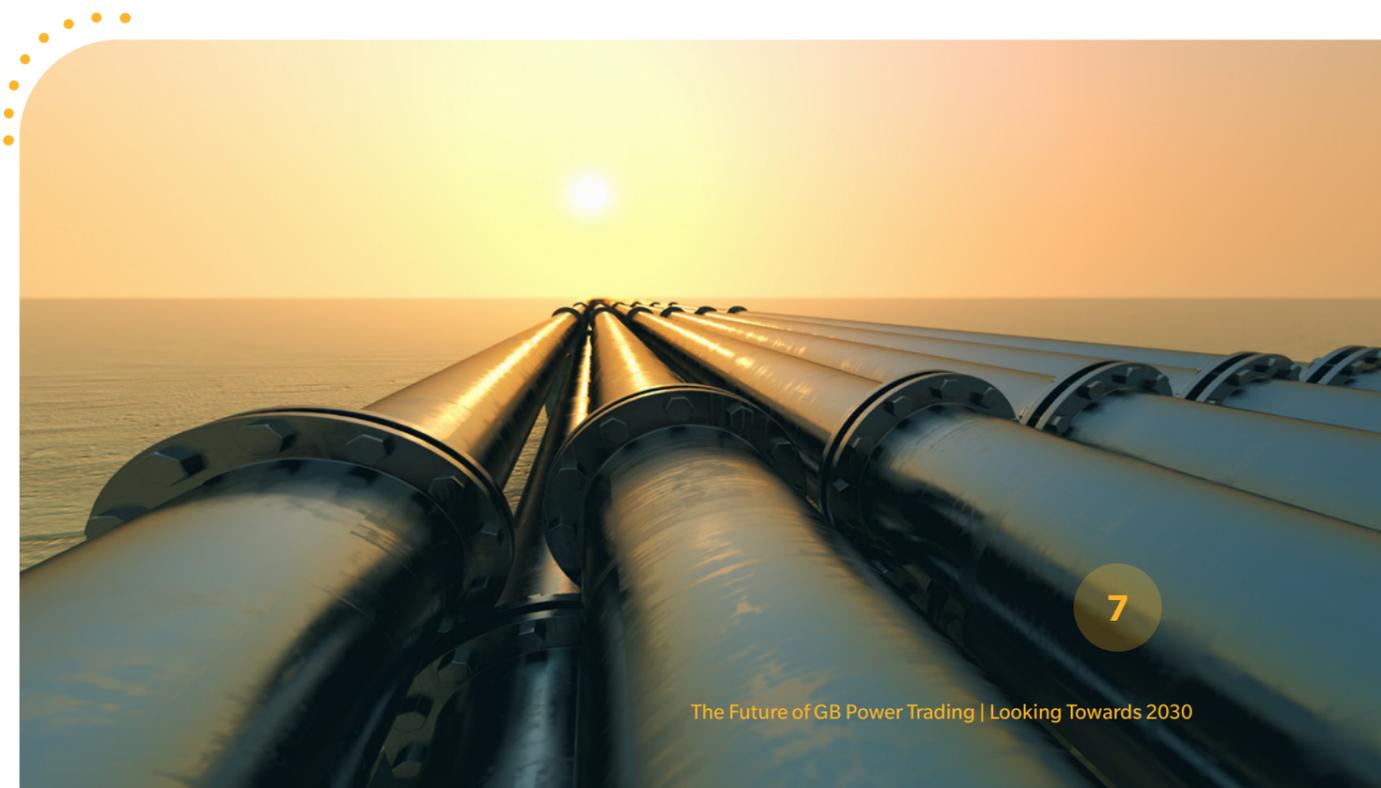
- » I am doing hundreds of trades, is my position report accurate?

4. Compliance

- » What's the compliance position around automated trading?

These challenges have led to the following requirements and key changes for older trading desks in 2023:

1. Investment in software to manage short-term power trading. Legacy ETRM systems just don't cope anymore.
2. Investment in simple automatic trading, yet ensuring a human interface remains in control – a little like auto-pilot cars.
3. Automation of workflow to ensure that re-optimisations occur and automated links from bespoke IP (battery optimisers, CCGT dispatch) into generic tools like trader dashboards.



The future view 2025 to 2030

Markets that operate on large trading hubs have worked well until now. They consolidate more assets and more traders into one area, price discovery increases, liquidity increases, competition increases and the requirement for regulator intervention is minimised.

However, as the requirement for local voltage and energy balancing increases the hub price no longer accurately reflects the cost of power with some areas much higher and some areas much lower. At this point hubs need to be split and a more nodal balancing model adopted.

A multi nodal model means exponentially more work for the trader, multi nodal means automation.

Volatility will increase as the fundamentals change. When power stations move slowly and sell high fixed priced contracts, prices don't move much. If assets can move at sub second speeds, wind forecasts change every 5 minutes, systems display low inertia and local nodes need balancing, we should expect the value of power to be very low when there's oversupply and very high when there's shortages. **Battery build out will mitigate this but traders need to be ready for massive price swings.**

When grids were designed the fundamental principle was forecast demand and move generation to match. The internet of things, combined with build out of electric vehicles (EV) are now facing a generation base of wind and solar, flexibility has moved from one team to the other. Whilst the concept of virtual power plants has been around for a while the value has never been compelling. However high ancillary prices and higher volatility will make aggregation of EV chargers and heat pumps (which will replace gas boilers) start to generate significant value. **Trading desks will be controlling EVs and heat pumps that look larger than coal power stations.**

The disjointed markets for energy trading, for ancillary markets will need to consolidate and interact. Bidding in your portfolio to either energy trading or DC/DR needs the trader to predict where a market will clear and offer into one or the other. However the logic each desk uses to decide could easily be expressed like linked blocked bids – a kind of 'if this then that' approach. For example if DC is above £24/kW then I need £20,000 from wholesale to place my asset into the energy auction. **IFTT linked ancillary and wholesale bidding will lead to a better overall economic outcome.**

Traders will no longer click to trade. The pace, volume and complexity of the markets will lead to nearly all trades being executed by trader defined rules or more autonomous algorithms. Traders will be recruited from a quantitative analyst or data science background and monitor algo performance. **The trader role will not be click to trade, it will be as the controller of automation.**

There will be more smaller desks alongside different large desks. Oil and gas entries will replace dying utilities and light asset desks taking advantage of automation and low OPEX will prevail. The traders from 2001 go live will retire leading to a new analytical community with totally different challenges and toolkits.

Ultimately, no one will trade from a spreadsheet...



Chris Regan (Author)

Chris leads the strategic direction of Brady's PowerDesk suite of solutions for European power trading markets, including the development of Brady's next generation energy algorithmic trading software initiative.

As an energy trader, Chris was present at two market openings before heading up EDF Energy's Trading and Operations capabilities between 2009 and 2017. As Vice Chair of the Power Trading Committee and Chair of Energy UK's Wholesale Markets Subcommittee, Chris helped create the current GB energy market today, making changes to the energy trading products, negotiating the mandatory market making rules and making changes to allow customer's assets to be re-optimised closer to real-time.

In 2017 Chris delivered a distributed trading capability (Powershift) into EDF, allowing customers to access markets alongside EDF's own fleet of power stations and batteries. EDF's Powershift is now a leading player in the UK flexibility market, optimising batteries, engines and DSR on behalf of EDF's customers and is part of the international group's flexibility offerings.

Chris has a background in Physics and complements this with an MBA from INSEAD.



About Brady

Brady Technologies enables energy market participants to profit in new ways from the green energy transition, supporting Environmental, Social & Governance (ESG) requirements. We provide software solutions to support above market returns, resilient risk management and scheduling in volatile markets.

Our customers include globally renowned organisations from utilities, independent power producers, renewable asset developers, energy trading firms, oil & gas companies, state power grid operators and commodity trading firms. Whether engaged financial or physical trading, on major exchanges or over-the-counter, we help market participants to realise revenue growth across the trading life cycle.

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**Let us help you run your power trading
operation in GB successfully today**

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