Energy Insights Issue 4

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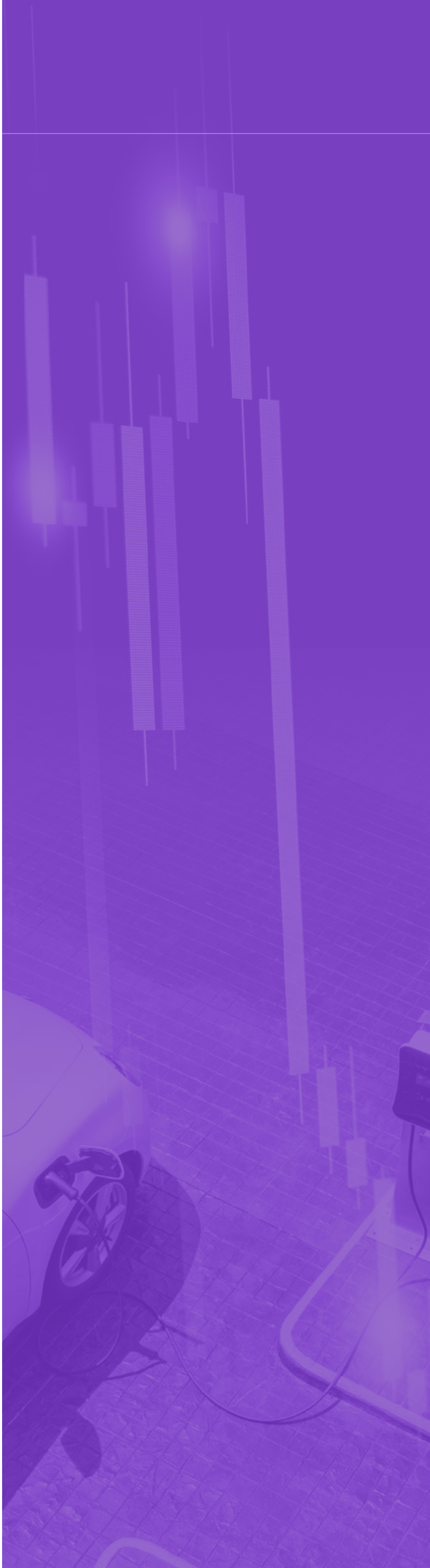
Electric vehicles as dynamic assets

Integrating flexibility and trading in a renewable future



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As the global energy landscape shifts towards sustainability, the role of electric vehicles (EVs) is evolving beyond mere transportation.

This white paper explores the potential of EVs as pivotal assets in energy flexibility markets, highlighting their capacity to balance the grid and generate income for owners.

EVs offer unique advantages for grid services and frequency balancing. By entering flexibility contracts, declaring availability, and utilising advanced trading systems, EVs can be integrated into the energy market. This involves real-time optimisation, algorithmic trading, and dynamic re-dispatching of charging schedules.

The integration of EVs into energy markets is not without challenges. Regulatory complexities, 'range anxiety' among EV owners, and the limited time EVs spend charging are significant hurdles. However, with the right strategies and technological advancements, these challenges can be mitigated. This paper delves into the daily processes required for EVs to become traded assets, from contracting and forecasting availability to real-time market adjustments and settlement.

As renewable energy continues to develop and power trading evolves, EVs are set to play a crucial role in sustainable energy management. By leveraging their flexibility, EVs can help balance the grid, reduce local constraints, and provide fast, responsive energy solutions. This white paper aims to provide a comprehensive overview of the potential and processes involved in transforming EVs into valuable assets within the energy market, ultimately contributing to a greener and more resilient energy future.

The shifting landscape of flexibility and trading

As Europe continues its journey towards decarbonisation, balancing the electricity system becomes increasingly challenging. The System Operator (SO) must maintain a frequency of 50Hz by ensuring that supply and demand are roughly matched.

To achieve this, a series of tradable instruments are used, ranging from the long-term procurement of capacity (Capacity Markets) to ensure sufficient generation is built, to market price signals (traded products from three years to intraday delivery), balancing markets, and the procurement of ancillary services like frequency response.

Traders participate in each market on behalf of assets

- The SO purchases flexibility, which means securing a guarantee that an asset will be ready and can be instructed to adjust its output.
- Traders use energy trading and risk management (ETRM) platforms to manage their long-term trading positions, and typically bespoke solutions for short-term trading management.

Historical context

Historically, flexibility has come from various sources. In Britain, vast coal reserves made it economical to build coal power stations, while in the Nordics, hydro power stations were an obvious choice due to the network of rivers. As huge North Sea gas reserves were tapped, combined cycle gas turbines (CCGTs) were built so quickly in the UK that in 1998, the government introduced a moratorium on new gas stations. Later, as coal units became more expensive to operate due to restrictions on sulphur dioxide (SOx) and nitrogen oxides (NOx) emissions, and the introduction of a price for carbon emissions, coal units were closed and CCGTs provided the SO with flexibility.

The continued expansion of renewable energy, with its inherent intermittency, has increased the SO's demand for flexibility. Notable developments in the UK over the last decade include:

- The introduction of supplementary balancing reserves to keep coal power stations open longer, resulting in price spikes in 2016.
- The introduction of long-term Firm Frequency Response (FFR) and Enhanced Frequency Response (EFR) contracts to stimulate battery construction.
- The introduction of Optional Downward Flexibility Management (ODFM) to manage oversupply during COVID-19.

However, policymakers have also reduced the value of flexibility through measures such as:

- The Targeted Charging Review, which removed benefits of flexibility for small, locally installed assets.
- The Significant Code Review, which assessed forward charges for using the system.
- The introduction of the Medium Combustion Plant Directive, which stopped the use of standard diesel backup generation for commercial purposes during tight winter periods.
- The consideration of P462, a modification that could undermine the business case for short-term flexibility by removing the subsidy payment from a renewable generator's cost stack when offering to reduce output.

As a result, the flexibility markets are constantly being adjusted, with the generation mix evolving. Recently, the battery market has suffered from falling prices, causing many projects to stall and developers to withdraw.

Despite these constant changes, the method of trading has remained consistent: an asset (battery, CCGT, coal unit) is represented in the trader's generation plans, typically using an energy data management platform such as Brady's PowerDesk Data Manager. This production is compared to the contracts sold or bought on a platform like Brady's PowerDesk (short-term power trader's dashboard), allowing the trader to determine whether they need to buy or sell.

What's the next source of flex and how will it be traded?

Alongside hydrogen production, the most frequently cited source of future flexibility is the EV. This could be achieved through either:

V1G

Where charging is interrupted when power is needed elsewhere or activated when there is an excess of renewable energy.

V2G

Bi-directional charging, where your EV can return some of its charge back to the grid.

There are many advantages to using plugged-in EVs for balancing the grid:

Zero CAPEX

EVs are primarily used for transport, so they are considered zero capital expenditure in the flexibility business case.

Local connectivity

EVs are connected at the local level, helping to reduce local constraints at the supply level.

Fast and responsive

Essentially portable batteries, EVs are quick and responsive.

However, there are challenges as well:

Regulatory complexity

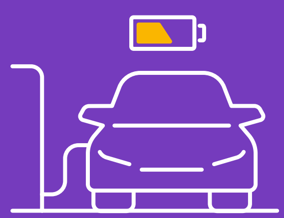
Separating EV flexibility from the standard electricity bill is complex from a regulatory standpoint. Questions arise about whether you are the supplier, or if a virtual metering methodology should be used to treat the charge outside of the supply contract.

Range anxiety

Owners concerned about their EV's range may be wary of the impact on their battery, especially with V2G.

Limited charging time

EVs spend very little time actually charging, making the period that V1G can be utilised small and unpredictable.



But if done correctly, a fleet of 1,000 7kW home chargers is no different from a 7MW battery. When EVs are connected and charging, a central control could interrupt 7MW of demand and sell back the power.

Grid services and frequency balancing

Beyond the simple buying and selling of electricity, the system is balanced using ancillary services, particularly frequency-responsive services. In these services, you enter into an agreement with the SO to adjust your generation or demand in a pre-agreed manner based on system frequency or direct signals.

For more dynamic schemes, the output of batteries is adjusted at least once per second, discharging when the SO frequency is below 50Hz and charging when it is above 50Hz, similar to the UK's Dynamic Containment. This is often referred to as synthetic inertia and helps the SO balance the system in real time. Other markets operate on longer timescales, such as the manual Frequency Restoration Reserve (mFRR) in the Nordics, where a series of pre-agreed conditions allow the SO to request real-time adjustments.

To offer such ancillary services, traders must provide a 'baseline' to the SO, describing their expected operations if not asked to help maintain frequency. This baseline could be a simple energy time series held in Brady's PowerDesk Data Manager solution, synchronised with its front office PowerDesk module. Traders must balance their energy trading against their baseline schedule, and the nature of the ancillary services offer depends on this baseline.

For example, if a hydro plant with a 10MW capacity is scheduled to run at 7MW, then 3MW of upward and 7MW of downward flexibility can be offered to the Transmission System Operator (TSO). If prices rise and the asset is dispatched to 9MW, the trader would use PowerDesk to re-offer 1MW of upward and 9MW of downward flexibility to the TSO after selling power and increasing output.

The same principle applies to EV charging. Instead of just adjusting the schedule based on price movements, the baseline must be updated in real-time as the forecast of 1,000 EV customers charging becomes a reality and is adjusted accordingly.

The delivery and settlement of contracts can be modelled in PowerDesk Data Manager's settlement and calculator module, with any ancillary service contract being modelled as a simple time series with rules on actual settlement. Similarly, for EVs, a forecast baseline can be created and stored in PowerDesk Data Manager. Using meter aggregation trees, high-level zonal forecasts can be created and synchronised into the PowerDesk time-series, representing the virtual aggregated EV asset. As the forecast increases, PowerDesk would show the trader a shortfall in the position, prompting them to buy power on the wholesale market or increase generation at their hydro assets.

As virtual assets deliver ancillary services, there remains a residual requirement to balance energy. System frequency can remain below 50Hz (or above) for extended periods, meaning that in each 15 or 30-minute settlement period, the trader might still need to buy or sell power to balance. Additionally, since batteries are less than 100% efficient, even if charges and discharges are symmetrical, the state of charge will eventually erode, necessitating the purchase of power to reinject the state of charge.

A day in the life of your EV on the trading desk

For EVs to become traded assets, the following daily process (or a similar one) would be required:

1. Contract

The EV owner must enter into an agreement with either their supplier or an external vendor to receive payment for offering flexibility. Currently, there are tariffs that offer cheap charging at certain times, and we are seeing the emergence of interruptible agreements as an early version of V1G.

2. Availability

The EV owner will need to declare when they intend to have their vehicle plugged in and when they would like to charge (or specify a desired charge level for the future). However, it is more likely that a data scientist at the supplier will model the EV fleet availability more reliably than relying on users. This data may be stored in their data management system.

3. Contract energy at day ahead

The supplier will use the forecast of availability to buy wholesale energy to charge your vehicle, using either longer-dated products or the day-ahead auctions (Nord Pool/EPEX) accessible through their trading software like PowerDesk.

4. Contract for ancillary services

The trader might find more value in selling frequency control contracts based on your EV. For V1G, they might sell low-frequency services by having sufficient charging vehicles that could be interrupted and high-frequency services by starting to charge partially charged available EVs. For V2G, the plugged-in car can be offered all day for symmetrical services without materially changing the charge level.

5. Re-trade your charging within the day

If, for example, an interconnector shuts down unexpectedly, prices for power within the day will move significantly. If the interconnector was importing, prices might spike up significantly. These wholesale market prices could be fed from your trading application (such as Brady's PowerDesk) into your supplier's EV optimisation algorithm. This would determine the cheapest time to charge, time-shifting the electricity demand to later, and allowing the trader to sell high-priced power (no longer needed for charging) and purchase low-priced power at a later time to ensure you have enough range in the morning to get to work and back.

6. Link your flex to algos

Your trader might want to link the EV optimiser output to an algorithmic trading solution such as Brady's PowerDesk Edge. Edge could be set up to trade your position based on its machine learning view of likely price movements, market liquidity, and cost of imbalance. Given its machine learning approach to hyperlocal learning, it is far more likely to predict price movements than its human counterpart and make more money for you.

7. Redispatch your charging

The final physical activity is the dispatch of your EV. It might be scheduled to stop charging when it was expected to charge or start charging when it was idle. However, to monetise its flexibility, the EV needs to be willing to do something different from the original plan, making your charging less predictable.

8. Settlement

Your trader will need to review all the value created with long-term trades in their ETRM (like Brady's Igloo SaaS), the short-term volatility traded through Brady's PowerDesk, and all the value created and logged into their Energy Data Manager (like Brady's PowerDesk Data Manager), and then send you the money!

If regulation follows a logical path, if renewables continue to develop, and if power continues to be traded, then your EV (future or present) will be traded in Brady's software to help offset some of the costs of transportation and possibly even some of the lease costs.

Conclusion

EVs are poised to become significant assets in energy flexibility markets. By entering contracts for flexibility, declaring availability, and leveraging advanced trading systems, EVs can help balance the grid and generate income for owners. This involves real-time optimisation, algorithmic trading, and dynamic re-dispatching of charging schedules. As renewable energy grows and regulations evolve, EVs will play a crucial role in sustainable energy management, making them valuable beyond just transportation.

About the author

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Managing Director – Short-Term Power

Chris leads the teams responsible for delivering Brady's PowerDesk suite of solutions for power trading markets, which includes pioneering algorithmic trading software development. With a background in Physics and an EMBA (distinction) from INSEAD, he possesses significant experience as an energy trader.

From 2009 to 2017, he served as the head of EDF Energy's Trading and Operations.

Chris played a pivotal role in shaping the GB energy market through his work with the Power Trading Committee and Energy UK.

In 2017, he spearheaded the development of EDF's Powershift, a prominent player in the UK flexibility market.

Chris maintains a presence in the Energy market working closely with battery asset developers and offering battery trading consultation.

About Brady Technologies

At Brady Technologies, we are at the forefront of the energy transition, helping market participants navigate new challenges and opportunities with confidence. Our advanced software solutions bring clarity to complex problems and processes, enabling customers to enhance their trading and operations and meet tomorrow's energy needs.

Our product suite serves a diverse client base, including utilities, independent power producers, renewable asset developers, and energy and multi-commodity trading houses. We also provide solutions for oil & gas companies, particularly as they develop their power businesses, state power grid operators, hedge funds and investment management companies.

Our software solutions support critical decision-making and help these regional and global leaders optimise their trading, power operations, and manage complex risks. Our technology facilitates increased automation and efficiency in the face of changing market dynamics including decentralisation, decarbonisation, diversity of generation assets, volatility and evolving regulation.

We are proud of the spirit of partnership we have with our customers, many of whom have been with us for a decade or more. Furthermore, we are committed to our values of collaboration, innovation and delivery, to ensure we continue to meet their and the energy market's needs in the future.

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