

# Renewable and Battery Solution

UK & EU Battery Storage and  
Optimisation

**energyone**

The bottom half of the image features the EnergyOne logo in white text on a black background. The logo consists of the word "energyone" in a sans-serif font, with a stylized orange and yellow "y" character. To the right of the logo is a complex, abstract graphic of a network or data structure. It consists of numerous small, colorful dots (blue, pink, yellow, purple) connected by thin, light blue lines, creating a dense, interconnected web that resembles a molecular structure or a data network. The background of this section is black, and the overall aesthetic is modern and technological.

## Overview

Energy One provides innovative and flexible software to support battery assets. Our fully automated scheduling and nomination solution, underpinned by our technology platforms, allows customers to operate any combination of generation assets.

We have existing installations in this market and are actively expanding our battery storage and optimisation tool to serve the UK and European markets.

Energy One is dedicated to fostering confident and collaborative partnerships with our clients, both existing and potential.

Together, we strive to rapidly develop and refine innovative, comprehensive, and automated tools that seamlessly cater to a wide array of assets across diverse markets. Our solution aims to embody a fully integrated and seamless approach, drawing on the strengths of Energy One's established products including enFlow, enTrader, eZ-Ops, and enVoy.

## Background

The share of market demand supplied by renewable generation, including wind, solar, and biogas, continues to grow. Simultaneously, there is a rising adoption of storage assets like batteries.

Assets linked to the high voltage transmission grid must adhere to the regulations and procedures of the European and UK energy market. The specific rules to be followed depend on the categorisation of the market.

Batteries adhere to their own set of regulations and require a more intricate decision-making process to optimise dispatch. In every scenario a system for automating dispatch operations and decision-making is essential.

**Examples of actions undertaken by an automated dispatch system include:**

- Complying with directions from the UK and European electricity markets to operate the plant within certain operating envelopes
- Turning generation off when spot prices are negative
- Minimising exposure to frequency control charges
- Ensuring PPA commitments are satisfied
- Making decisions about optimal dispatch of a battery into the market

These tasks are executed in a manner that can be tailored to the unique needs of each portfolio, providing simplicity and enabling individuals to concentrate on more advanced decision-making. The configuration of all automated actions, rules, and decisions is accomplished through a visual process designer and rules engine. This approach ensures that users can easily comprehend, evaluate, and modify the logic of business rules in response to evolving market, plant, and business conditions.



## Solution Overview

The Energy One Renewable and Battery Solution is built using industry-leading products from Energy One.

### enFlow

Our enFlow process automation engine provides configurable automation of all necessary processes to send data to and from the System Operator via enVoy and eZ-Ops, integration with SCADA systems and other third-party systems such as local energy forecasting. enFlow also provides configurable dashboards for human interaction, including real time overviews of portfolio operations, alarming and alerting consoles and operator control screens.

### enVoy

enVoy, Energy One's accredited ECVN, EDT, and EDL communication tool for the UK power market, streamlines workflows by automating the management of physical notifications and bid-offer submissions to Elexon and National Grid. It offers an intuitive communications platform designed to simplify the exchange of energy industry data within the UK power market.

### enTrader

enTrader is a multi-commodity, multi-user, time-series based system that supports the full trade lifecycle from deal capture and risk management through to settlement processes. This Energy Trading Risk Management (ETRM) software allows users to evaluate portfolios in real-time including market and credit risk, cash-flows and P&L all subject to limit monitoring. enTrader is designed for European and UK energy market participants. enTrader will be seamlessly integrated into the battery solution, establishing connections with exchanges for futures and forward hedge trades. Additionally, enTrader will provide support for Position Management, Hedging/ Forward trading, Monte Carlo VaR, Credit Risk & Collateral, Straight-through-processing (STP), Trade Execution, Confirmations, Settlement, Regulatory Compliance, and MtM & P&L Reporting. enTrader provides seamless integration with enVoy, enFlow, and eZ-Ops, ensuring the consolidation and correlation of pertinent data, as well as facilitating accessibility, synchronisation, and data precision. This comprehensive integration serves as a key component within the Energy One product suite.

### eZ-Ops

eZ-Ops provides a solution for Gas & Power short-term position management: nominations, asset scheduling communication, balancing, auction bidding and algo-trading for European energy markets. This SaaS energy platform focuses on automating physical gas and power logistics, and short-term portfolio balancing in Europe. Algorithmic energy trading, energy position management, gas and power nominations and power generation scheduling are part of its key functionalities. Similar to enTrader, eZ-Ops offers out-of-the-box integration with major spot markets. Algo-trader/ Auto-bidder has connectivity with EPEX M7, Nord Pool Continuous, SEMOpx, HUPLEX, Cropex, and IBEX.

### eZ-Ops for Batteries

eZ-Ops manages nominations, balancing, auction bidding and algorithmic trading for European energy trading and operations. Energy One facilitates and maintains communication channels with virtually every Transmission System Operator (TSO), System Support Operator (SSO), interconnectors, Hub, Exchange, and Market Operator in Europe.

The functionality for power and gas portfolio management provides a comprehensive view of the physical position, calculated at both detailed and aggregated levels. Users can ensure their positions are balanced before nomination and scheduling. Additionally, users can gain detailed insights into the origins of flows and volumes.

An automated power and gas nominations module provides comprehensive workflow management, enabling users to submit their nominations effortlessly, without concern for operator-specific technical intricacies. This automated process grants access to all necessary details through a user-friendly interface, facilitating monitoring and resolution of potential issues.

For power generation asset scheduling, the system automates communication workflows with TSOs, covering long-term schedules, availability information, offers, and real-time activation for tertiary reserve/ mFRR.

The Auction Bidding module automates processes for day-ahead and intraday auctions across various platforms including EPEXSpot ETS, Nord Pool, EXAA, and CROPEX. Creating linear and block orders can be automated, as well as their submission to the exchanges. Upon the publication of market results, they are seamlessly integrated into the solution, ensuring that the allocated volumes are factored into the position and are readily available for nominations.

The Algorithmic Trading module (auto-bidding) enables optimisation of intraday positions and available flexibilities using algorithms and parameters. The full process can be automated and is fully integrated with the scheduling and nominations module. Connectivity to virtual power plants and TSOs for FCR and aFRR, to fully cover the possibilities for assets and batteries optimisation are on the product roadmap for the near future.



## Co-located Assets

There is an increasing demand to support co-located assets, such as wind or solar farms situated at the same grid connection point as a battery system.

These assets are often referred to as 'DC Coupled,' indicating that the solar farm and battery share the inverter responsible for converting power from DC to AC.

The objectives include:

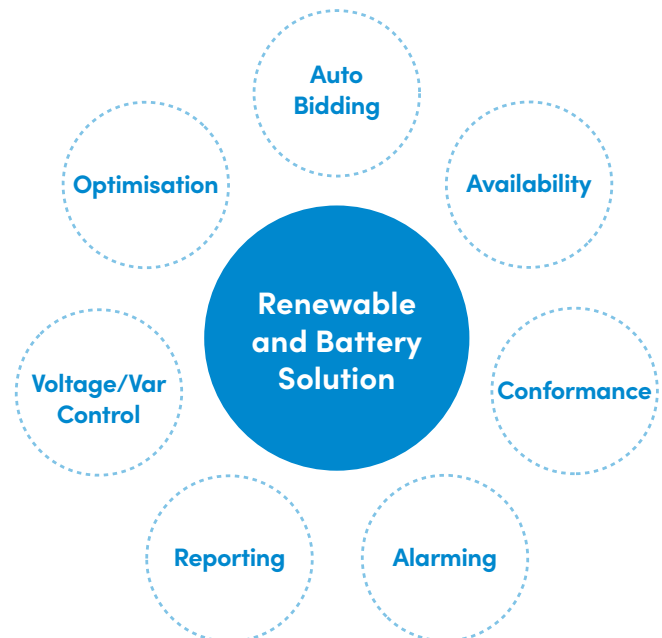
- Allowing for one or more generation sources to be co-located with a battery.
- Optimising output from a co-located variable generation source (such as wind or solar) with a marginal cost for generation that may be zero or even negative, where expected generation comes from source forecasts.
- Optimising output from a co-located controllable generator with a non-zero marginal cost but without startup/ shutdown constraints.
- Allowing for a joint capacity constraint (e.g., inverter or other grid constraints) for the co-located assets.
- Incorporating expenses for battery losses and site auxiliary load charges into optimisation.
- Including income from green certificates and similar incentives in optimisation.

The Co-located Assets solution has been developed for the Australian National Electricity Market (NEM) and Energy One is adapting the functionality for the European Union (EU) and United Kingdom (UK) markets.

## Functions

Energy One's Renewable and Battery Solution offers a comprehensive suite of functions designed to meet both the mandatory System Operator requirements and critical risk management needs.

Our preconfigured solutions allow for seamless adaptation of workflows and processes to meet the unique needs of each asset, portfolio, and customer requirement. The solution effortlessly integrates with the suite of products offered by Energy One. This includes: enTrader (Energy Trading Risk Management system); enFlow (Sending and receiving energy industry data in the European power and gas markets); enVoy ((Market interactions with National Grid ESO (EDL/EDT) and Elexon (Nominations/ECVN)); and eZ-Ops (short term position management, market interaction with European TSOs, trade execution on Auctions and Continuous market).



# Solution

Energy One has developed a strategic approach for the European and UK markets aimed at enhancing battery scheduling efficiency.

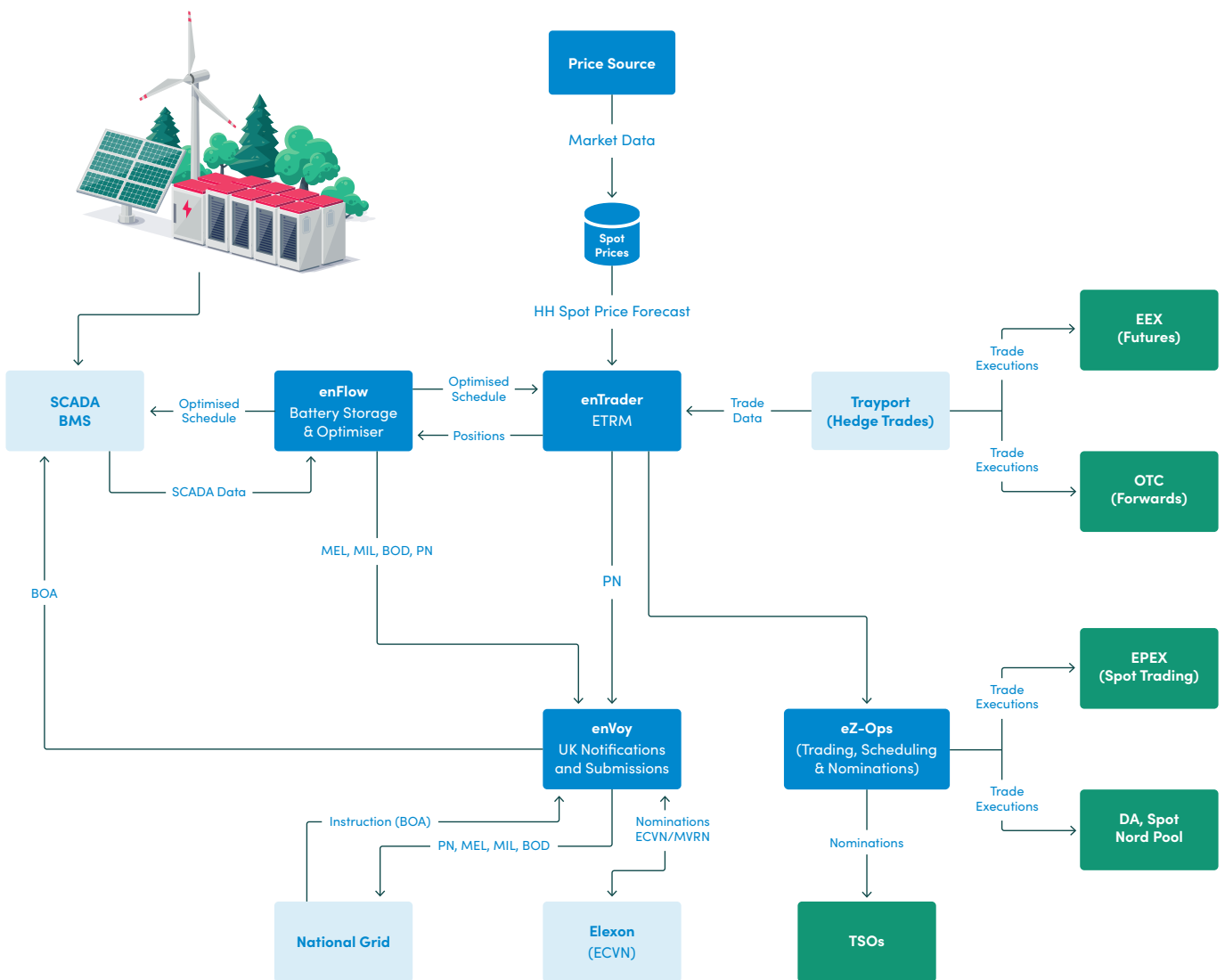
This approach considers a range of parameters, including forecasted daily prices for arbitrage, battery limitations, capacity, state of charge, cycle limits, maximum/minimum charge, generation cycle cost, load cycle cost, charge/discharge loss factors, and Frequency Response/Frequency Containment Reserve (FCR), with a granularity of 30 minutes

This initiative lays the groundwork for a comprehensive application that caters to all storage optimisation and dispatch needs of asset owners. It is designed to maximise returns on storage assets while providing flexibility in input parameters for optimisation and scheduling.

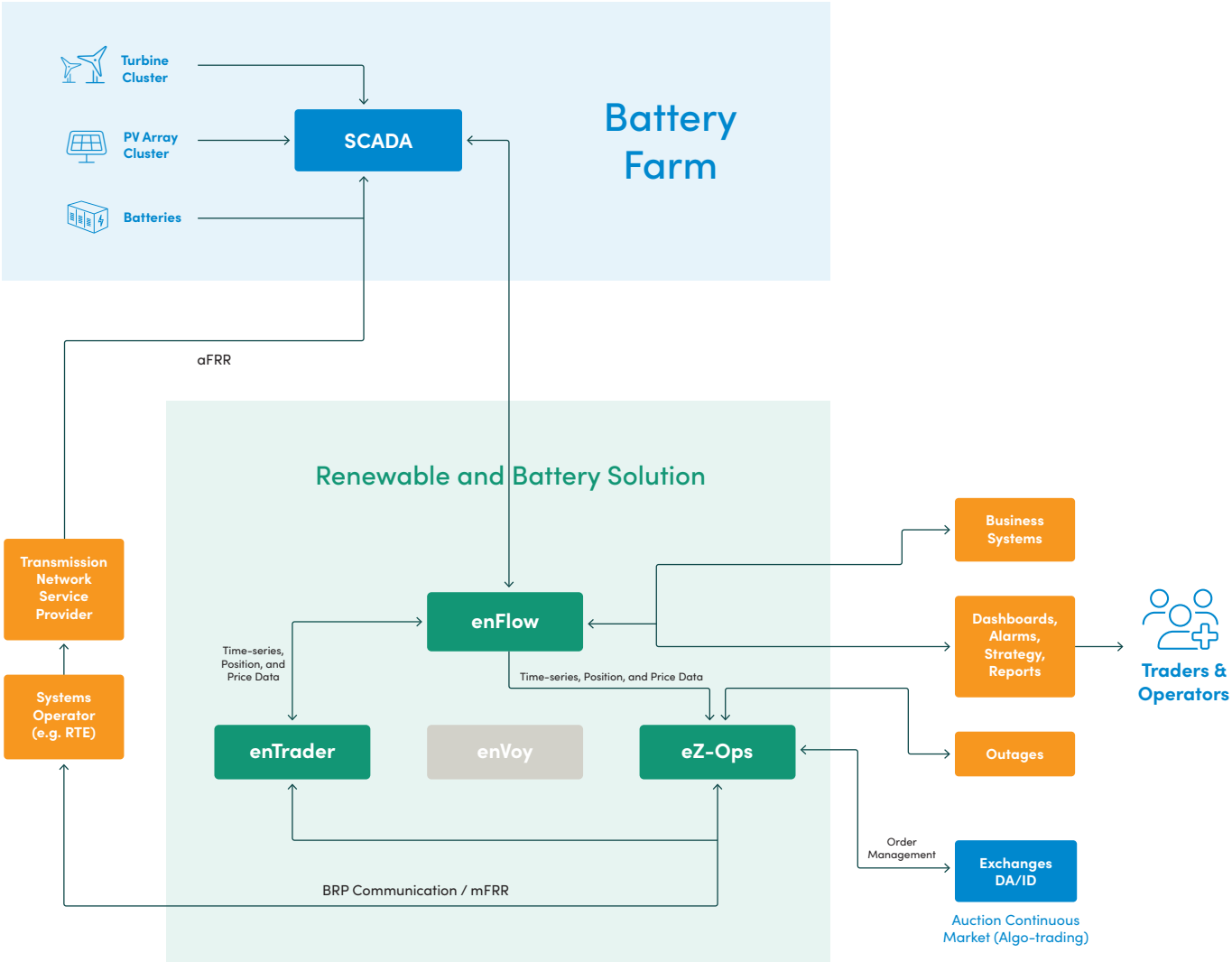
Moving forward, our focus is on refining this solution in close collaboration with our customers, ensuring it addresses their specific requirements. We are dedicated to delivering a resilient and scalable product that enables our customers to capitalise on emerging opportunities across diverse markets.

As part of our commitment to environmental sustainability, we aim to develop a cutting-edge solution capable of optimising battery assets to achieve maximum returns in our journey towards net-zero emissions.

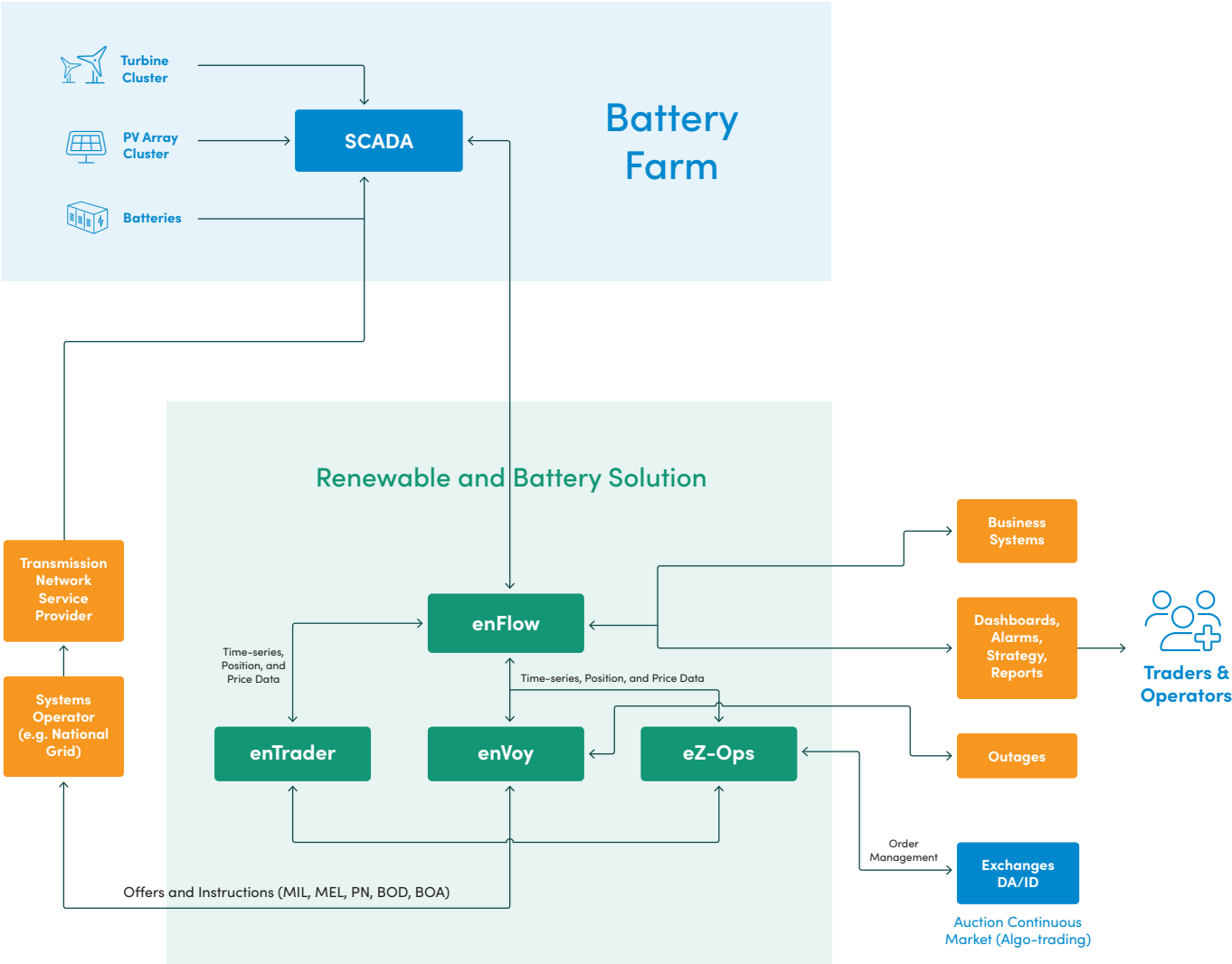
## Battery Solution: Architecture



# Battery Solution Overview: EU Market



# Battery Solution Overview: UK Market



# Features

## Auto Bidding

Generators in the European or UK energy market may face considerable losses when they generate during periods of negative spot prices.

Given the 24 x 7 nature of this market, it is essential to have automatic processes that:

- Monitor market conditions and prices
- Monitor current and forecast plant output
- Apply business rules that calculate the cost or benefit of delivering power subject to plant constraints and costs
- Determine if a change in plant output is appropriate
- Automate change in plant output by sending signals to plant SCADA

Our system offers automated processes that execute and transmit control signals to plant control systems (SCADA) when unfavourable market conditions, such as negative spot prices, arise. Additionally, market offers are automatically resubmitted to maintain compliance.

The automation rules can be easily customised to suit the requirements and strategies of specific plants and portfolios. Auto-bidding is essential for all operators of wind and solar farms to prevent unforeseen market losses.

## Dynamic Ramping

Dynamic Ramping necessitates that under specific conditions, semi-scheduled plants decrease their output linearly to reach a specified dispatch target by the end of a half-hour dispatch interval.

This process involves extracting crucial data from plant SCADA and the system operator, then transmitting signals to SCADA to ensure adherence to market dynamic ramping regulations.

## Outage and Availability Management

enVoy will feature an outage management capability that facilitates submissions to MODIS (REMIT and ETR).

This will include the following capabilities:

- Ability to input/ maintain outages up to five years into the future
- Define and submit changes in actual availability from EDL MEL submissions
- MODIS publication supporting formats for:
  - REMIT
  - PUGU
  - AAGU
- Submission via EDT D+5 onwards + adding suitable ramps front and back
- Consume ACK/ NACK from MODIS
- Complete the round trip with a TIBCO interface



## Conformance and Economic Alerts and Alarms

The rules and operating procedures of the UK Electricity Market establish different operating standards for scheduled plants, including adherence to dispatch limits, which can be customised within enFlow.

Negative prices also pose financial risks. A suite of processes and dashboards is provided for alarms, encompassing:

- Non-conformance of plant with operating procedures and condition
- System Strength Constraints
- Adverse economic conditions such as negative energy prices or high prices (FCR prices)

Alarms on portfolio specific conditions such as operational rules prescribed in power purchase agreements (PPAs) can be easily defined using the configurable business process and rules engine.

Alarms can be delivered to a customisable dashboard, via email or SMS. Conformance requirements such as system strength constraints can also be used to send automatic control signals to plant SCADA.

## Reporting

Configurable mechanisms are present for delivering data for reporting on financial performance and market compliance.

Reports can be delivered via email or reporting tools such as Kanvas or PowerBI.

## Battery Dispatch Optimisation

Batteries offer a range of dispatch options for their services, such as charging, discharging, or providing frequency control services.

Similarly, solar and wind farms with suitable plant and control capabilities may have the ability to curtail energy to offer frequency control services. These decisions can be adjusted every 30 minutes and must consider plant constraints as well as current and forecasted market conditions.

The Renewable and Battery Optimisation solution incorporates various features to optimise the dispatch of batteries to the Network Operator.

The solution includes an optimisation module that accounts for:

- Forward estimates of price changes in energy market
- Forward estimates of prices for frequency control services
- Current battery charge state
- Lifecycle costs of charging / discharging and determine an optimal forward schedule for charging, discharging or provision of frequency services.

The module can also execute the strategy for the current interval by automatically modifying bids and offers in the market and sending control signals to plant.

## Features Cont.

### European and UK Batteries: Spot Markets

'Spot' refers to Day Ahead and Within-Day Markets.


- The main European spot power market is the European Power Exchange ("EPEX"). Almost all European markets (including UK) are covered by EPEX. EPEX is part of the EEX group.
- The 2nd largest Spot Market is Nord Pool. Nord Pool covers the Nordic countries (Sweden, Denmark, Norway & Finland), Western Europe (UK, France, Germany, Netherlands, Belgium), Baltic countries (Estonia, Latvia, Lithuania) and Eastern Europe (Poland). Nord Pool is part of the Nasdaq group.
- Both exchanges provide Auction markets for Day-Ahead and Intraday trading, as well as a continuous market for within day.
- 'Continuous' trading is bilateral, Pay-As-Bid trading for individual hours and sub-hourly delivery periods. Each period has a hard 'gate closure' when trading ends.
- 'Auction' trading generally uses the merit-order principle where the price for all trades is set by the last accepted bid i.e. everyone gets the same price. Auctions can be hourly or at set times during the day. Auctions are for individual hours and 'Blocks' of hours (e.g. 2 hrs, 4 hrs, 24 hrs etc). On EPEX, the day-Ahead market closes at 12 noon.
- Both enTrader and eZ-Ops provide out-of-the-box integration with the major spot markets

### European and UK Batteries: Balancing Markets

All European power markets have some form of "Balancing Market" that is used by the Market Operator to ensure that supply always meets demand at the network and to provide a commercial framework for the provision of balancing services from participants and penalise participants that are out of balance.

- Participants are obliged to provide advance notice of their expected production, consumption and trade volumes via "Nominations" to the Market Operator. Nominations can be updated any time up to the Gate Closure of each period.
- Generally, participants will use the Day Ahead markets to ensure they have matched their inputs to and outputs from the network. However, forecasts are rarely 100% accurate so there will inevitably be within-day deviations in supply and demand from the DA plan, even allowing for within-day trading.
- Most balancing services are procured via a pay-as-bid mechanism. Participants will submit tiered Bids & Offers to increase/reduce production/consumption along with any technical constraints (e.g. €100.00 for +10MW with 10mins notice etc)
- The grid operator will initially accept the cheapest price and work up through the merit order until the imbalance is completely offset.
- The price charged (or paid) to out of balance participants is calculated from the cost of procuring the necessary balancing services.

Get in touch with Energy One

 +44 (0)845 838 6848

 [sales@energyone.com](mailto:sales@energyone.com)

 [energyone.com](http://energyone.com)

## European and UK Batteries: Ancillary Services

All Power Market Operators procure ancillary services from participants to ensure that the power delivered to end users is of the required quality.

In European Markets ancillary services fall into 5 main types:

- **Frequency Response** – to maintain the target frequency e.g. 50Hz in UK
  - **Reactive Power** – can be considered as the energy required to move power from generator to consumer
  - **Voltage Management** – to maintain the target Voltage level (e.g. 400kV on UK transmission grid)
  - **Reserve Power** – fast response back-up in the event of unforeseen changes in demand or generation
  - **Black Start** – to provide power to enable other power plant to start up in the event of local grid failure
- Ancillary Services contracts are awarded by the Grid Operator via either an annual tender process or a long term bi-lateral contract (when the asset is of strategic value to the GO because of its nature or location).
  - Note: It is widely considered that the market for Ancillary Services across Europe has already been saturated by the batteries currently connected, so this may not be a significant income stream for most battery installations going forward.

## European and UK Batteries: Portfolio Trading

Another potential value stream for batteries is through integration with other physical assets (both production and consumption) and/or portfolio trading.

- It is already quite common across Europe for batteries to be co-located on generation or consumption sites where the battery is charged during low price periods and discharged when the price rises.
- As the battery capacity available in the market increases, they will become of increasing interest to other market participants (e.g. suppliers) who will see that they can use batteries to store long positions when the price is low and fill short positions when the price is higher.
- The battery will also be used to minimise imbalance charges across the portfolio.
- This trading of battery flexibility from a trading portfolio appears to be the battery income stream that has the most potential for growth in the future as the other streams require other participants to have larger not smaller imbalances in the future.

## European and UK Batteries: Optimisation

Battery Optimisation will be initiated Day Ahead and then reviewed constantly within-day.

The inputs to the Optimisation calculation will generally include:

- Opening charge level
- Spot Price Forecasts at lowest granularity e.g. 15 mins in Germany, 30 mins in UK
- Balancing Market Price forecasts
- Any active Ancillary Services contracts
- Position forecasts
- Weather forecasts (if battery has limited cooling)
- Technical constraints
- EPEX Day Ahead prices are available from 12 noon

- Initial optimisation run will happen shortly afterwards and be re-run as price, position and weather forecasts are updated.

Optimisation results will include:

- Charging profile and where from (e.g. portfolio or EPEX)
- How much capacity to reserve for Ancillary Services
- How much capacity to reserve for Balancing Services
- Discharge profile and where to (e.g. portfolio or EPEX)
- Expected MtM and P&L by period

Powering the transition to renewable energy with software and services.

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