

FLOWER. BESS Optimization Sweden 2022



FLOWER.

A Power Refinery.

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About FLOWER.

FLOWER. unleashes flexibility from power consuming, storing and producing assets using advanced statistical models. By pooling assets together, Flower's Power Refinery maximizes the value of each watt.

Founded in 2020, Flower's mission is to facilitate the energy transition. In 2021 the company won the award 'Startup 4 Climate', Northern Europe's largest impact competition. Today it has signed more than 30 MW of BESS, 70 MW of solar and 240 MW of wind.

The team behind Flower is creative, innovative and holistic. We embrace new approaches and find excitement in unraveling new solutions to existing issues in one of society's oldest industries. We believe that hard work should be driven by curiosity and joy as well as the desire to push our own and each other's limits of what we think is possible.

Flower is today actively participating in the Swedish TSO Svenska Kraftnät's markets for ancillary services with a portfolio of thousands of EV chargers, aggregated small-scale battery energy storage systems and, one of Sweden's largest solar parks.

Since its inception, the company has raised € 9M from renowned investors. In April 2022 serial entrepreneur Stefan Krook joined as Chairman of the board and Karl-Johan Persson (H&M) as an investor.

In May 2022, Ellevio, one of Sweden's largest DSOs invested a ten percent stake in the company. Ellevio and Flower also entered into a strategic partnership to accelerate the commercialization of innovative solutions. Together we strive to combat climate change with cutting-edge technology.

Chain of Value Creation.

Flower's trading strategy is driven by our proprietary database on the Nordic ancillary service market, in-house developed AI, and optimization algorithms. Flower allocates the available capacity to the relevant markets, such as the Nord Pool Spot Price Market, and the markets for ancillary services (FCR-D up/down, FCR-N, aFRR up/down, FFR, and local markets). The markets are weighted according to our machine learning price predictions. The bids are placed on D-2 and D-1 markets.

A larger and more diverse portfolio reduces the risk of overestimating capacity, e.g. due to imperfect weather forecasts or sudden changes in consumption patterns. The portfolio effect makes it possible to trade with a larger share of the available capacity and thus increase the value of each asset.

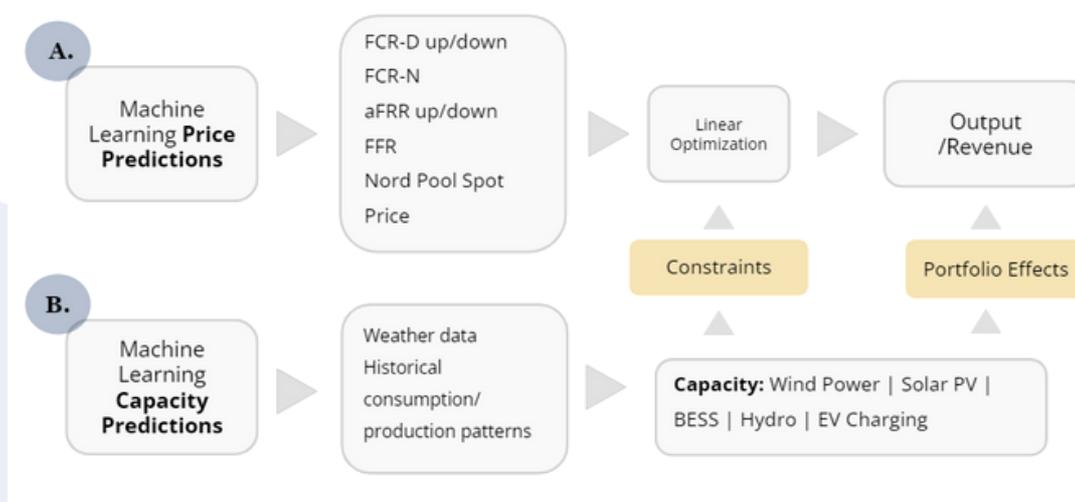


Illustration of the Chain of Value Creation through Flower's optimisation of assets in a diversified power portfolio (Flower, 2022).

Leveraging Market Knowledge.

Flower's core is to develop machine learning algorithms to predict power capacity from variable power production and - consumption sources. The data-driven AI optimization finds predictability for assets with sporadic consumption and production profiles.

The information asymmetry in the markets makes it possible for Flower to outperform competitors. By carefully balancing exploration and exploitation we both earn money today and pave the path for even better trading in the future.

With extensive forecasting of prices, local consumption and/or production, robust trading strategies are developed and refined.

Flower has been selling ancillary services to the Swedish TSO for approximately a year (June 2021). Hence, we have gained insight into how the TSO's markets are designed today but also what they will look like in the future.



The distribution of bids on the Svk market FCR-D down. The picture shows Flower's current strategy of combining knowledge about mean prices with an explorative approach, by sending frontiers to find and chase the optimum (Flower, 2022).

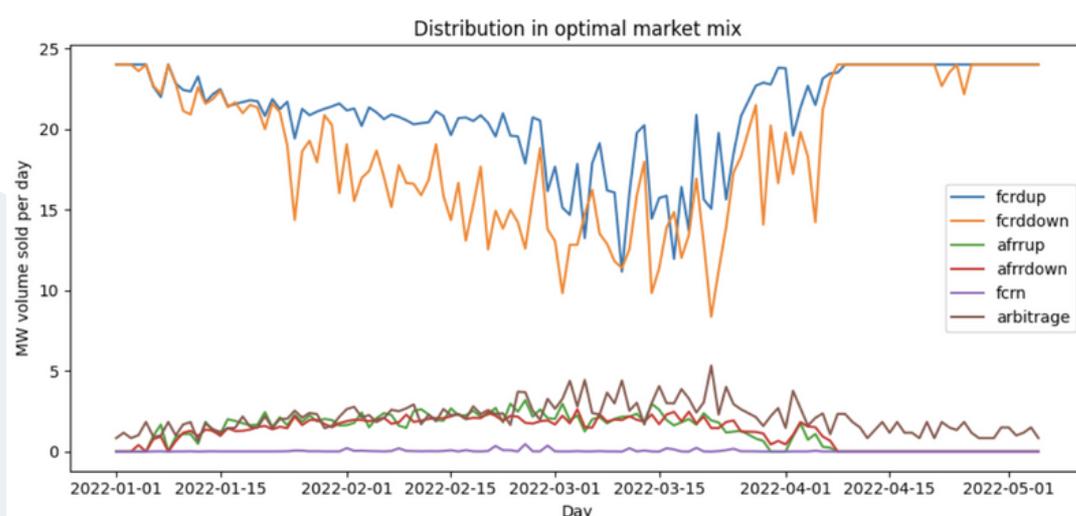
Multi-Market Optimization (MMO).

BESS (battery energy storage systems), are very versatile and hence suitable for multi-market optimization. Flower predicts prices for several markets and linearly optimizes the asset's available capacity each hour.

By combining markets the regulatory risk is reduced as well as the exposure to supply shocks. The vast majority of power producers and consumers can only participate in either the up or down market.

Between January to June 2022 our multi-market model heavily weighted the FCR-D markets (see graph below). The FCR-D prices were relatively high compared to the other markets, however, the optimal weight varied largely during the period.

Flower's trading strategy would have yielded on average 13.4% higher earnings (01/2022-06/2022) when simulating a multimarket optimization compared to only participating on the FCR-D up/down combination only.



Linear optimisation between five different markets for ancillary services and arbitrage trading for a 40 MW battery (Flower, 2022).

Prequalification of Assets.

Flower has successfully prequalified battery systems, EV chargers and a solar power plant to deliver ancillary services in Sweden. We have accumulated the rare expertise in the extensive prequalification processes during the last 1.5 years. Flower has been active on Svk's markets since June 2021, and was the first actor in the Nordics to deliver frequency containment reserve for disturbances (FCR-D up) from EV chargers. Flower is also proud to be the first in the Nordic to be trusted to deliver ancillary services on the FCR-D down market from a solar park.

The prequalification process includes many steps. A technical review with a specification of all interacting hardware equipment and IT architecture is required. A large focus is put on security, hence the robustness of the frequency measurement, data transmission and control signals. We also perform endurance and maximum capacity test according to Svk's requirements.

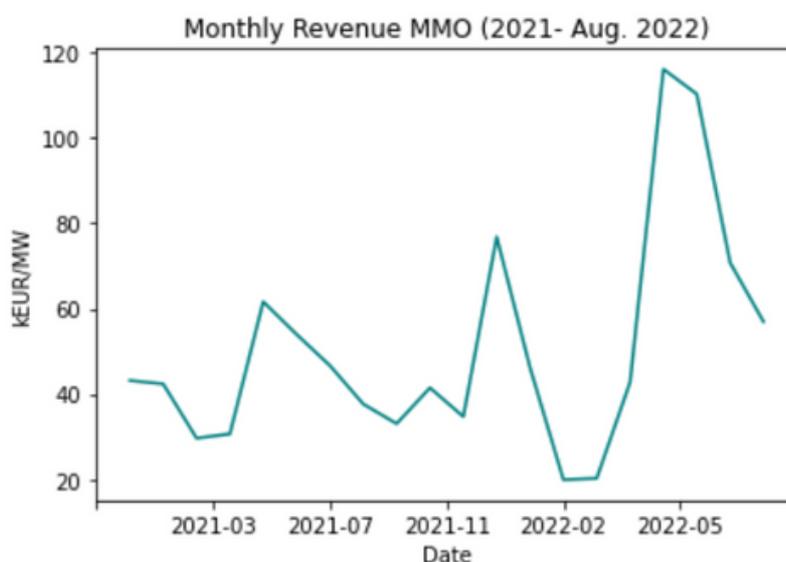
The prequalification process with all the required documentation is carried through solely by Flower but is submitted to Svk for approval in the name of the balancing responsible party (BRP), with Flower as the subcontracting party.

Simulated MMO Earnings. (2021-2022 (08))

Model Assumptions:

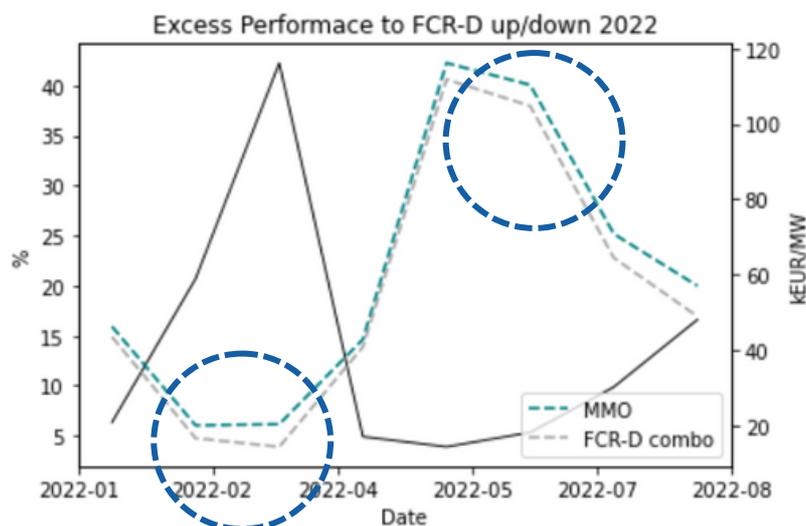
- MMO includes: FCR-D (up/down), FCR-N, aFRR (up/down) and buy/sell on Nordpool's spot markets. FFR not included in this version since it is procured in advance, but Flower view this market as important as well.
- Only mean prices.
- No cost for additional cycling and hence faster battery degradation included.
- MMO assumes 100% availability.
- MMO assumes a 1c BESS located in SE3.

Summary Monthly Revenue MMO (2021-2022(08))	
Monthly Mean	50 700 EUR
Monthly Max	116 100 EUR
Monthly Min	19 900 EUR



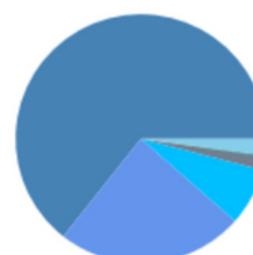
Flower's MMO vs FCR-D up/down.

Summary excess performance MOO to FCR-D up+down combo 2022 (01-08) [gray full line]	
Monthly Mean	13.7%
Monthly Max	42.2%
Monthly Min	3.9%



February 2022
Earnings per market

In February 2022 the MMO increased its exposure to the aFRR markets and Nordpool's spot market, as a result of relatively low FCR-D prices. Thus, the MMO managed to yield 22.7% higher earnings than the FCR-D combo in February.



June 2022
Earnings per market

In June 2022 the MMO heavily weighted the FCR-D markets which are reflected in the earnings above. However, the aFRR up prices were also high during June. The MMO managed to combine the market's technical restrictions in a manner that resulted in 5.3% higher earnings than the FCR-D combo during June.

Some of Flower's Partners.

ELLEVIO



volue

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