Energy Market Information System (SIME) optimization module

David Jambois, Michaël Gabay, Laurent Billet, Damien Jeandemange, Guillaume Verger, Arnaud Lazare
Artelys
{david.jambois, michael.gabay, laurent.billet, damien.jeandemange, guillaume.verger, arnaud.lazare}@artelys.com

Key words: *Mixed Integer Linear Programming (MILP), balancing markets*

1 Introduction

Energy supply is a major economic and societal challenge involving many players: producers, consumers, Transmission System Operators (TSOs), and so on.

To ensure that power systems function smoothly, supply and demand must be always balanced, and it is therefore necessary for participants to have access to a wide range of energy exchange windows, from the longest term (to cover economic risk) to the shortest term (to adjust production volume and demand). Energy is therefore traded on different markets: long- and medium-term markets (over-the-counter, via futures or options, or on futures markets, from several years to one day in advance), short-term markets (day-ahead or intraday, 48h to 1h in advance) and balancing markets (1h in advance to real time).

Participants can refine their estimates and trade energy up to one hour in advance. Below one hour, the main issue is to ensure network stability, and the balancing managers (in Europe, these are the TSOs) are responsible for balancing supply and demand up to real time.

To do this, they can activate energy reserves with a relatively short activation time (in the order of seconds to half an hour). Previously, these reserves were managed nationally, directly by the TSOs, generally by contracting generation (and consumption) capacities in advance and then activating them according to forecast or observed deviations on their own networks.

However, the European power system is interconnected and synchronous. European coordination is therefore necessary for the smooth operation of the network. This coupling of power grids is also a considerable economic opportunity, since it is possible to exchange reserves or directly settle imbalances without activating an order (the demand for reserves can be both upward and downward).

The economic interest of a common, coupled market for the acquisition and activation of manual and automatic frequency restoration reserves (mFRR and aFRR) has been estimated at between 212 M € and 817 M €, depending on the level of market integration [1].

As a result, the European Union's guidelines on balancing the electricity system [2] call for the gradual introduction of markets for the various reserves, with the implementation of MARI [3] and PICASSO [4] projects.

As part of MARI and PICASSO initiative, REN, the Portuguese TSO, planned to connect to both platforms to exchange FRR demands and bids with European TSOs. Hence the need of a new Energy Market Information System application (SIME) to manage and operate mFRR and aFRR products.

Artelys has been working on this application and is responsible of the development of the optimization module embedded in SIME, which include a local Activation Optimization Function (MARI AOF) to select the mFRR bids and algorithms to allocate power on the physical units considering operational constraints.

2 SIME optimization module

The Optimization module developed for the SIME projects ensure two main functionalities: a market clearing algorithm to clear mFRR products like the MARI AOF and a physical dispatch engine to dispatch power to the physical units.

Various optimization techniques have been used in the different algorithms depending on the complexity and the operational expectations, from multi stage MILP to heuristics.

2.1 Local MARI AOF

The local MARI AOF is a local market clearing engine used to optimize the selection of mFRR bids and demands in Portugal. The algorithm aims at activating the mFRR bids and demands optimizing several objectives (social welfare, traded volume) and computing the market clearing price while respecting a set of market rules.

Two different algorithms have been developed and are run in parallel: the full-fledged optimization algorithm which considers all constraints and all objectives, and a fallback algorithm that solves a simplified problem.

2.2 Physical dispatch engine

The aim of the physical dispatch engine is to find the best dispatch instructions to send to physical units given a power to allocate considering the local constraints on the grid and on the physical units. The physical dispatch engine provides three main functionalities: it disaggregates the MARI activated bids towards the physical units, it supports operators to maintain balance and solve grid issues when needed by adjusting manually physical unit dispatch, and it adjusts Portugal net position with Spain in case there is a negative ATC situation.

2.3 Operation Solution

The software solution must be robust, efficient, maintainable, and scalable. When implementing such a project, these imperatives are considered right from the start, including in the choice of modeling and optimization techniques. After all, it is not enough to implement a highly efficient algorithm; it must also be understandable, maintainable, and scalable within very short timescales.

The architecture of the solution is a key element, as are the reliability of the technologies used and the validation of all software components.

In this talk, we will present these challenges and the various algorithmic and computational techniques used to meet them.

References

[1] Laurent Fournié, Christopher Andrey, Julian Hentschel, Greg Wilkinson. *Integration of electricity balancing markets and regional procurement of balancing reserves*. European Commission Energy Studies, 2016

[2] European Commission. Electricity Balancing Guideline. Official Journal of the European Union, 2017. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32017R2195

[3] Description of the MARI project, https://www.entsoe.eu/network_codes/eb/mari/

[4] Description of the PICASSO project, https://www.entsoe.eu/network_codes/eb/picasso/