sweet swiss energy research for the energy transition

PATHFNDR

Market + policy

Flexibility participation in wholesale markets

Work package 2

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1 OBJECTIVES

Displacing thermal generators requires the participation of various flexible resources in day-ahead and intraday wholesale markets.

- **Flexible Resources:** How to participate?
- **Market Design:** How to facilitate participation?

2 CONTRIBUTION TO PATHFDNR

This work **bridges WP1** (national/international scale) **and WP2** (district/city scale), focusing on how **local, flexible resources** can **contribute** their flexibility to the **power system at a national and international scale**, specifically the Swiss wholesale market within the European market coupling.

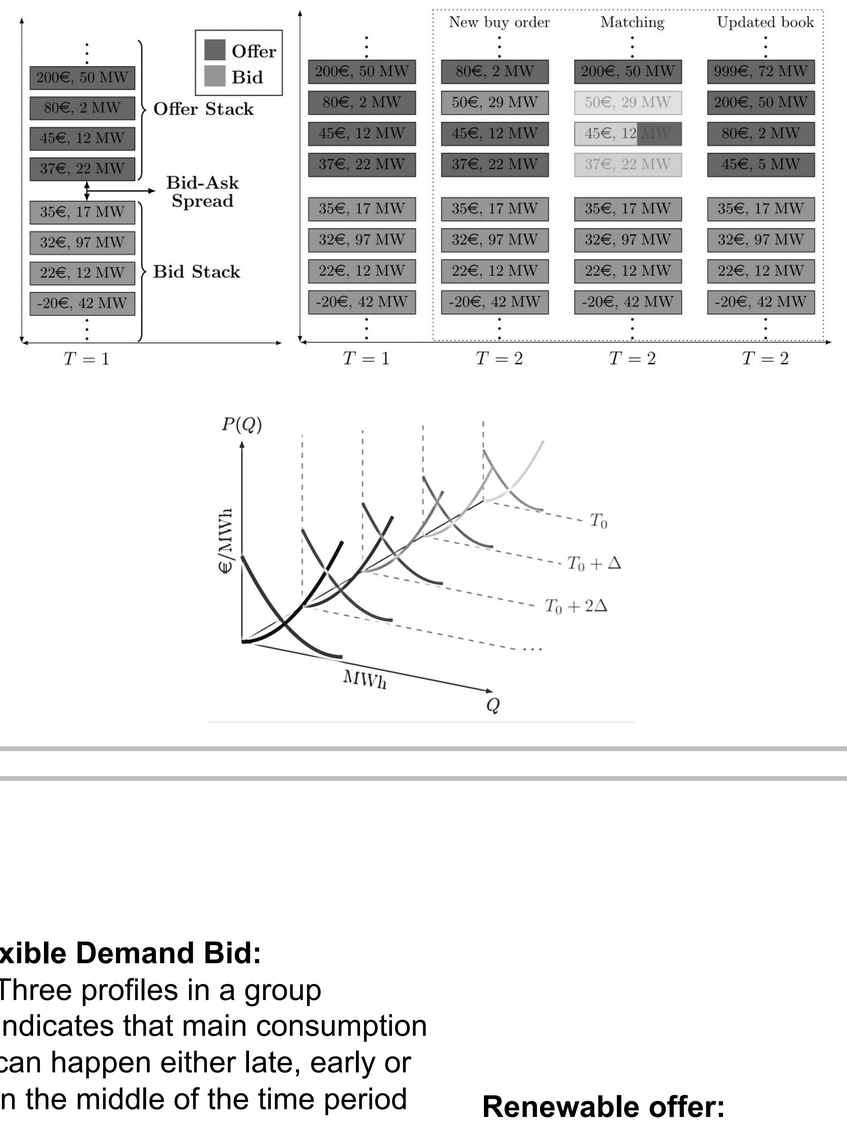
Flexibility aggregators supply local flexible resources with electric energy. Examples are utilities providing households with electricity for their heat pumps or fleet operators managing the charging of electric vehicles. Those aggregators need to **buy power at the Swiss wholesale market**. If they indicate a **flexible demand**, it can be **matched to renewable production**.

2 Mechanisms of Day-Ahead and Intraday Markets [1]

Forecast changes in renewable production are revealed in day-ahead and intraday markets through new buy bids and sell offers. Flexible resources must participate in these markets to react to new information given by owners of renewable power plants. There are two market mechanisms:

Continuous Trading
- Bids and orders are matched on a first-come-first-serve basis
- Incentivizes speed, thus giving plenty of opportunities to exercise market power
- Companies without an active trading desk are likely to pay a premium

Frequent Auctions
- Bids and orders are collected and cleared on a social welfare maximisation basis (e.g. every 15 min)
- Makes participation simple and safe for smaller companies



The current intraday market primarily uses continuous trading, initially intended for minor adjustments to day-ahead positions. With the rise of renewables, intraday markets play an increasingly crucial role. **Frequent auctions**, rather than continuous trading, **would simplify flexibility participation**.

3 Bid Formats in Auctions: How to communicate flexibility? [2,3]

Flexible resources are usually subject to **intertemporal constraints.** For instance, a shiftable load wants to consume power either in hour x or y but not both, and a storage system can only discharge if it has been charged before. To communicate these intertemporal constraints, flexible resources can use profile bids:

Profile Bid
- Buy or sell a power profile $x=(x_1,\ldots, x_T)$ at a price p

To indicate flexibility, agents can bid multiple profile bids. By grouping them in an exclusive group, agents can indicate that, at most, one should be accepted:

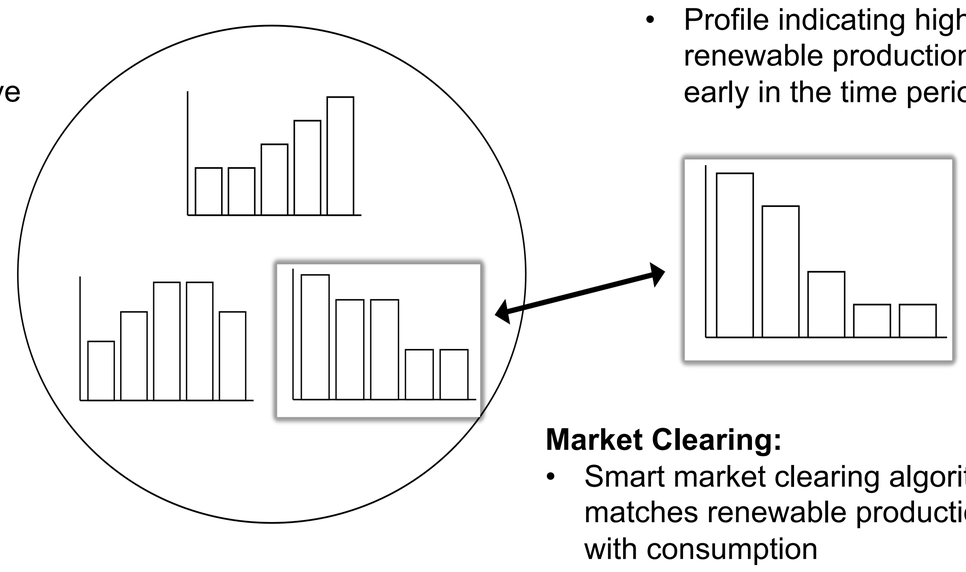
Exclusive Group of Profile Bids
- Multiple profile bids with the condition that at most one is accepted
- Also known as *XOR bid* and commonly used in *combinatorial auctions* in other domains
- More profile bids in a group signals higher flexibility

Intelligent market clearing algorithms, such as EUPHEMIA in the day-ahead auction, **automatically select the profile that best matches cheap renewable production**.

An exclusive group of profile bids is a suitable bid format for resources to communicate flexibility while ensuring that intertemporal constraints are met. Those bid formats make participation safe and easy. By **increasing the number of profile bids in a group** (currently 24 bids per group), market designers can incentivise agents to communicate higher flexibility.

Flexible Demand Bid:
- Three profiles in a group
- Indicates that main consumption can happen either late, early or in the middle of the time period

Renewable offer:
- Profile indicating high renewable production early in the time period



Market Clearing:
- Smart market clearing algorithm matches renewable production with consumption

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