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Scalable Complex Orders

08/04/2020

Supporting document for the DA products list public consultation

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Introduction

This presentation aims to introduce the Scalable Complex Orders (SCOs), provide details for their understanding and share some additional information regarding how similar they are with currently existing orders.

In order to understand this document, it's desirable that the reader is familiarized with the content of public description of the price coupling algorithm.

Why Scalable Complex Orders?

- **Scalable Complex Order (SCO) is a new order to increase scalability while keeping the flexibility for the bidders**
  - Scalability improvement, improving the time to first solution when this order is used instead of complex orders.
  - High indicators relevance improvement, specially on the calculation of gap.
  - Complexity of development is moderate as most of the characteristics are coming from well known requirements
- **SCOs are an alternative to complex orders**, preserving most of the economical & operational advantages for bidders.
- **SCOs may use same algorithm methods as for blocks orders**, helping harmonizing algorithmic methods and improve scalability when used in combination with blocks.
  - It allows to model the behaviour requested for curtailable blocks, attaching a fixed cost and ramp constraints
  - Could help to mitigate the impact of introducing MIC-like orders in new bidding zones / having more MIC orders
  - If scalable complex orders replace complex orders, improvements regarding the branch and bound search are expected, which shall be confirmed by future investigations.

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Summary

- Technical description
- Technical Comparison with Complex Orders
- Technical Comparison with Blocks
- Implementation details

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Scalable Complex Orders Technical Description

SCOs features

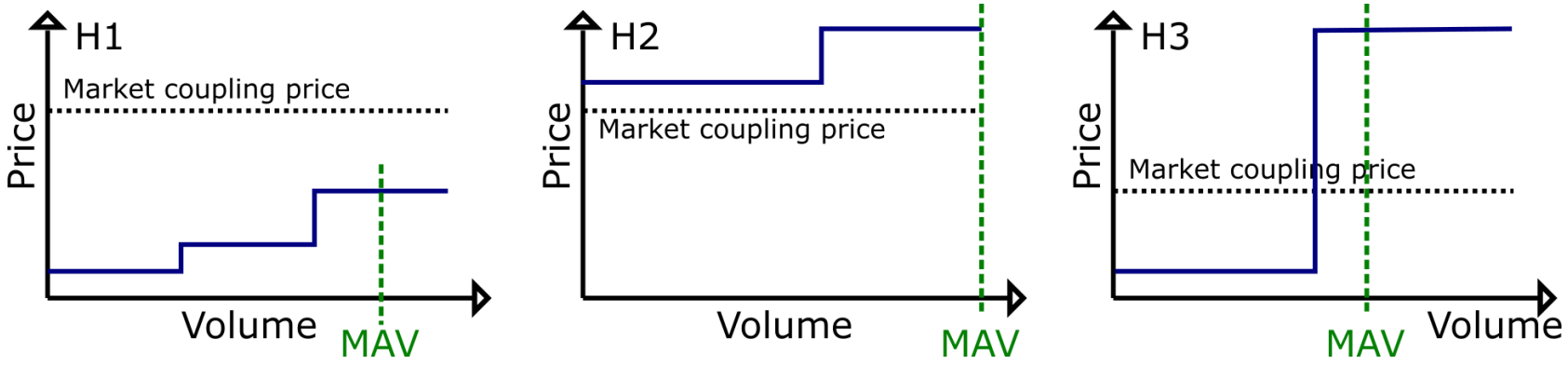
Scalable Complex Order (SCOs)

- Different rates of acceptance per hour: stepwise curves are defined for each one of the periods.
- Load gradients (ramp constraints)
- Fixed term (FT) **in welfare objective**
- Marginal cost curves
- **Minimum acceptance volumes per hour (MAV)**
- Can be out-of-the-money for some hours as long as in the money for the whole day (considering **bid curves** & FT)
- Demand side version with a Maximum Payment Condition is supported
- Scheduled stop condition

MAV and acceptance

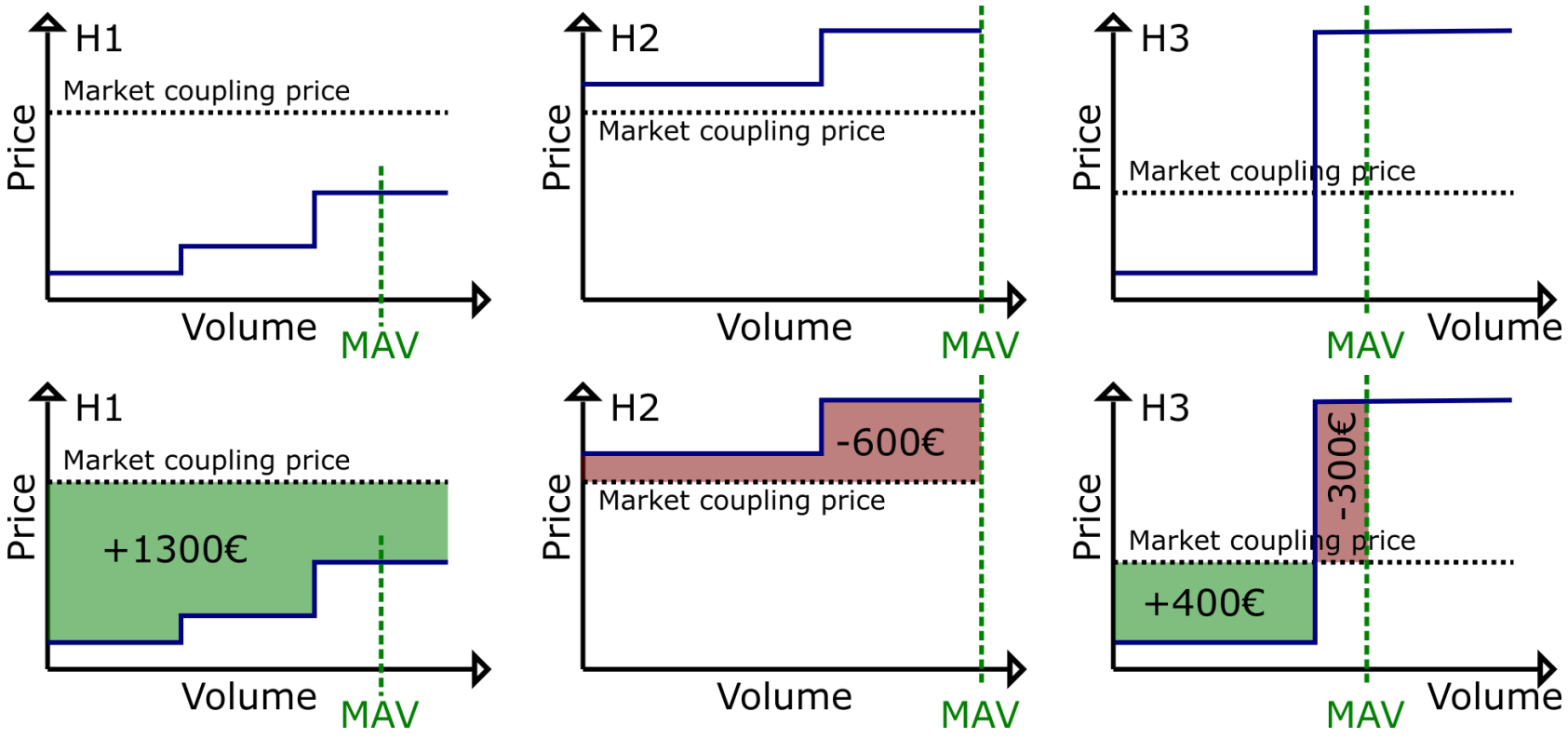
MAV effect on SCO acceptance

- Minimum acceptance volumes per hour (MAV) for Scalable Complex Order (SCOs) will have a similar behaviour than minimum acceptance volume (MAV) for blocks, with the difference that with SCOs a different MAV may be specified for each one of the periods.
- In the example below, the steps in blue are all the steps of a SCO in 3 different periods, and the market coupling price that has been calculated in the matching process. This SCO has declared three different MAVs at each hour.



MAV and acceptance

MAV effect on SCO acceptance



Fixed Term > 800 €
implies rejection

Behaviour of SCO requirements

- In case there are two "same-but-Fixed-Term" SCOs, Euphemia will behave in the sense that it automatically give priority in the primal problem (and tree exploration) to the one having smaller Fixed Term. This is because the welfare objective will be greater if the SCO with lower fixed term, so priority is given to it.
- In which cases acceptance of steps out-of-the money from a SCO may happen?
  - When the load gradient is limiting (being binding) the increase or decrease of production from one period to the next.
  - When the steps defined in a period are under the minimum acceptance volume condition and their price are above the market coupling price for that hour (similar behaviour than for curtailable block orders).

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Scalable Complex Orders Technical Comparison with Complex orders

Comparison

Complex orders (COs) and Scalable Complex Order (SCOs)

Complex orders (COs)	Scalable Complex Order (SCOs)
Different volumes may be accepted at each hour	Different volumes may be accepted at each hour
Load gradients (ramp constraints)	Load gradients (ramp constraints)
Fixed term (FT) in Euros	Fixed term (FT) **in welfare objective**
Marginal cost curves	Marginal cost curves
Variable cost (VT) in Euros/MWh	~~**Variable cost (VT)**~~
~~**Minimum acceptance volumes per hour (MAV)**~~	**Minimum acceptance volumes per hour (MAV)**
Can be out-of-the-money for some hours as long as in the money for the whole day (considering **VT** &FT)	Can be out-of-the-money for some hours as long as in the money for the whole day (considering **bid curves** &FT)
Demand side version with a Maximum Payment Condition is supported	Demand side version with a Maximum Payment Condition is supported
Scheduled stop condition	Scheduled stop condition

Comparison

Complex orders (COs) and Scalable Complex Order (SCOs)

Complex orders (COs)	Scalable Complex Order (SCOs)
Contribution to welfare is the welfare of each one of the steps of the curves defined for each period. For supply CO this is modeled as: $-ACCEPT_{m,co,h,o} q_{m,co,h,o} p_{m,co,h,o}$	**Contribution to welfare** is the welfare of each one of the steps of the curves defined for each period and the effect of the Fixed Term if it is activated. For supply SCO this is modeled as: $-ACCEPT_{m,sco,h,o} q_{m,sco,h,o} p_{m,sco,h,o} - B\_ACCEPT_{sco} \cdot FixedTerm_{sco}$
Acceptance criterion For supply COs, they are accepted when the earning at each period, defined by the product of matched volume times the market coupling price is equal or greater than the Minimum Income Condition (requested earning), equal to the Fixed Term plus all matched energy times the Variable Term : $\left(\sum_h \left((MARKETPRICESORDERS_{m,h} - VariableTerm_{co}) \cdot VOL_{H\,m,co,h}\right) - FixedTerm_{co}\right) \geq 0$	**Acceptance criterion** For supply SCOs, they are accepted when the earning at each period, defined by the product of matched volume times the market coupling price is equal or greater than the Minimum Income Condition (requested earning), equal to the Fixed Term plus price of each step times the volume matched of each step: $\left(\sum_h \left(MARKETPRICESORDERS_{m,h} \cdot VOL_{H\,m,sco,h} - \sum_o (q_{m,sco,h,o} \cdot p_{m,sco,h.o})\right) - FixedTerm_{sco}\right) \geq 0$

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Scalable Complex Orders Technical Comparison with Blocks

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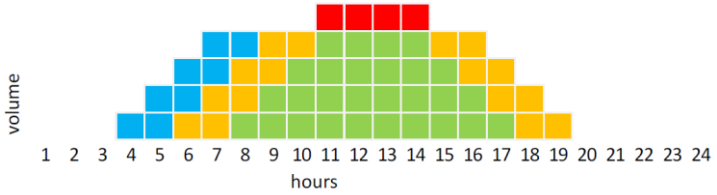
Comparison

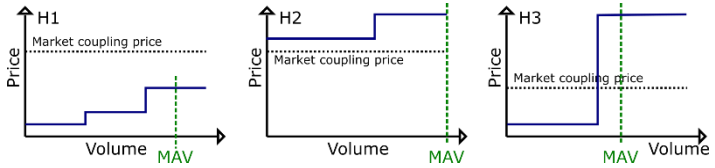
Block Orders (BOs) and Scalable Complex Order (SCOs)

Block Orders (BOs)	Scalable Complex Order (SCOs)
Different volumes may be accepted at each hour but all the volumes will be accepted with the same ratio.	**Different volumes may be accepted at each hour**
~~**Load gradients (ramp constraints)**~~	**Load gradients (ramp constraints)**
~~**Fixed term (FT) in Euros**~~	**Fixed term (FT) in welfare objective**
For each hour only a single volume is offered. Blocks can be linked in families or grouped in exclusive groups.	**Marginal cost curves are defined per hour.**
Unique minimum acceptance ratio equal for all hours (MAR). If the BO is accepted, its acceptance is at least the MAR.	**Minimum acceptance volumes (MAV) are defined per hour. If the SCO is accepted, all hours should match at least match the MAV at that hour.**
Can be out-of-the-money for some hours as long as in the money for the whole day (considering price of the block)	Can be out-of-the-money for some hours as long as in the money for the whole day (considering bid curves &FT)
Demand side version exists	Demand side version with a Maximum Payment Condition is supported

Comparison

Linked block Orders (LBOs) and Scalable Complex Order (SCOs)





- Linked blocks allow to take into account financial and technical constraints of power plants (start-up costs in the first block and then higher costs such as fuel costs in the other linked block) but this should be done:
  - By linking different blocks
  - Costs should be expressed in the price of the block order
  - One single minimum acceptance ratio (MAR) applies to all the volume offered at each hour.
- Linked blocks allow to design complex structures (several "generations" and/or "large families").

- Scalable complex orders allow to express in one order most of the technical constraints for blocks
  - Fixed Term (FT) applies to the whole order
  - Minimum acceptance volumes (MAV) are defined for each hour.
  - No linking is needed as the SCOs define marginal cost curves per hour
  - SCOs allows to define load gradients in order to limit the volume matched between two consecutive hours.
- Note that acceptance criterion is different than for linked block orders.

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Implementation details

Implementation details

It's foreseen that Euphemia 10.5 will be the first price coupling algorithm capable of supporting Scalable Complex Order (SCOs)

- **Euphemia 10.5 is expected to be available in September 2020.**

All the other requirements regarding **order types previously supported are maintained.**

- This will allow to perform, using the same version of the algorithm, more in detail studies that will allow us to compare the Scalable Complex Order (SCOs) with other types of orders: Complex Orders (COs) and blocks.

Once the E10.5 is available, **NEMOs shall progress in the following topics**:

- Assuring reliability of this new type of order: functional tests, behavioural tests.
- Analyse the impact on the markets: impact on prices, performance improvement.

=> Only when this product is positively tested, in term of functionality and performance, **then NEMOs may request to start using it.**

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