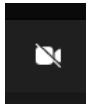
Scalable Complex Orders

Participant Kick Off Meeting

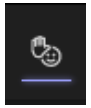
7th July 2021

Housekeeping Rules

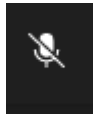
- Keep your video switched **off**



- Raise your hand if you have a question



- When asked to, unmute your line



Thank you for your cooperation

Agenda

- Background (15 min)
- Product Overview (20 min)
- Project Plan and Scope (20 min)
- Key Indicators for Product Analysis (10 min)
- Next Steps (10 min)
- Q & A (60 min)

Background

- Part of EUPHEMIA R&D work is to optimise the algorithm performance and reduce constraints, in order to “free up” space for new regions, new features (e.g. flow based coupling) by improving the algorithm solve times.
- ACER decided to remove Classical Complex Orders (CO) primarily for 15 min Market Trading Unit (MTU) and the forecast of performance constraints
- NEMOs together with TSOs started the R&D in SDAC beginning 2019
- Algorithm performance enhancements pursued are mainly (a) scalability with a focus on the time to find first high-quality solutions, and (b) proofs that can be given that market clearing solutions are close to the welfare optimum. (Scalable Complex Orders improve the algorithm in both dimensions.)
- Scalable Complex Orders (SCO) were found to give significant benefits to the algorithm performance
  - The SCO prototype was developed with the aim of removing the issues we saw in our EUPHEMIA trial where Complex Orders and Block orders reduce algorithm performance
  - SCO vs CO testing 1st iteration provided encouraging results but highlighted more work was needed to make the SCOs comparable in outcomes to CO.
- EUPHEMIA 10.5 was the first price coupling algorithm capable of supporting SCOs and was released in December 2020
- We will be using EUPHEMIA 10.6 as this will be the version available for members to use in production.

Background

- Scalable Complex Order (SCO) is a new order to increase scalability while keeping the flexibility for the bidders
  - Scalability: improving the time to first solution when this order is used instead of complex orders.
  - High indicators of improvement, specially on the calculation of the optimality 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 economic & operational advantages for bidders.

- SCOs may use same algorithm methods as for blocks orders, helping to harmonize algorithmic methods and improve scalability when used in combination with blocks.
  - It allows to model the behavior requested for curtailable blocks, attaching a fixed cost and ramp constraints. Note that SCO can clear different volumes for each period and optimizes the entire trading day for the Income condition.
  - Could help to mitigate the impact of introducing MIC-like orders in new bidding zones / having more MIC orders
  - When SCOs replace COs, improvements regarding the branch and bound search are expected. These improvements are more substantial when using 15 min MTU orders.

Background

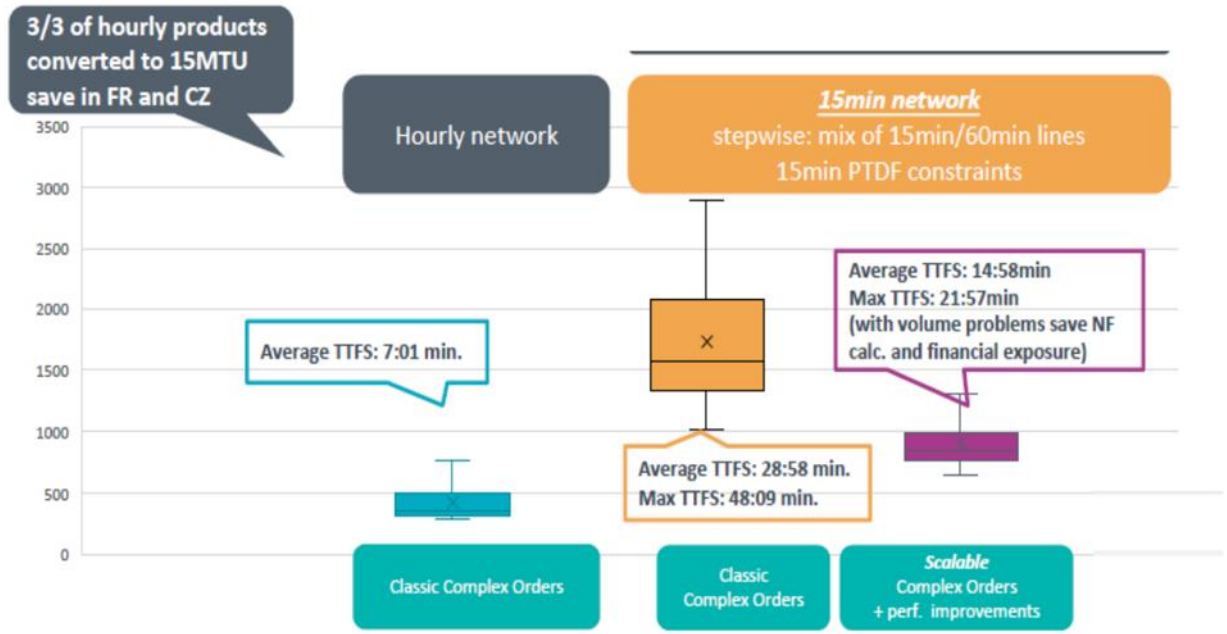
Scalable Complex Orders improve algorithm performances

Time to First Solution (sec.)
Production data – July to December 2020. Euphemia 10.6

Background

Scalable Complex Orders improve algorithm performances … even more with 15MTU data

Feb. 2021: Simulation on 15 min MTU prototype (future Euphemia 11.1)



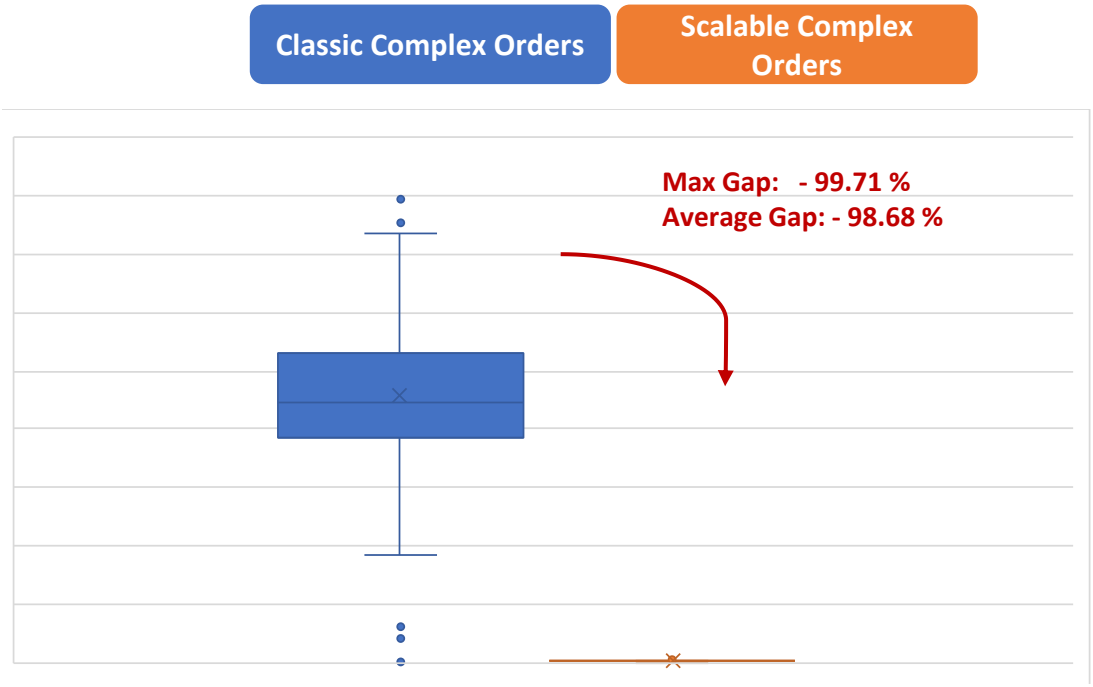
Stepwise approach: Batch with partial conversion to 15' in SDAC save in FR and CZ with 60' products

*TTFS = Time to First Solve

Background

Scalable Complex Orders enable to better certify the near-optimality of the solution

Optimality gap (€)
Production data – July to December 2020. Euphemia 10.6



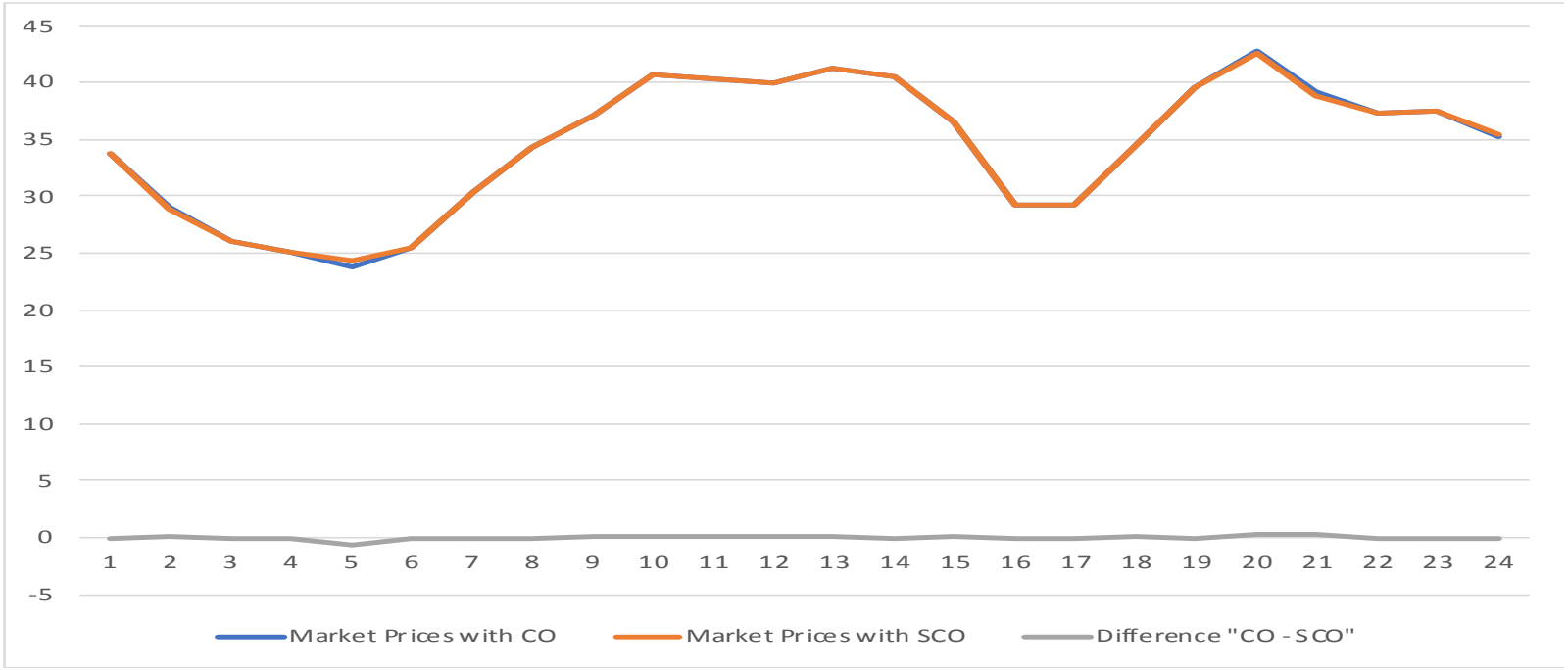
Important: The higher gap with Classic Complex Orders does *not* mean that the solutions obtained are largely suboptimal.
Certificates of near-optimality are more difficult to provide without advanced strategies to reduce so-called upper bounds on best welfares.

Background

Impact on market prices is in general very small

Detailed updated statistics are being prepared

Comparison of Market Prices (€/MWh)
Production data – July 1st to December 2020. Euphemia 10.6



SEM (SEMOpx Zone)

Product Overview

Advantages	Challenges
SCOs behave more like blocks and therefore potentially removes the constraints where SEMOpx members are limited to Complex and Simple Orders only	Conversion Rules for commercial offer data (COD) SEMOpx and the industry to develop understanding through this project
Increased Social Welfare of the solutions found	Reducing the impact with the adaptation of the Minimum Income Condition (MIC) on scheduling outcomes. Price Steps used in place of Variable Term in the MIC condition.
Scalability of the product	Understanding the benefits of this type of product and how best to modify commercial offer data to achieve these benefits through the implementation project

Product Overview

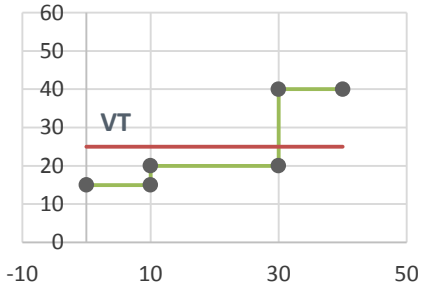
- Like the classical complex orders, the scalable complex order allows hourly sub-orders to be provided, allows load gradients to be defined;
- Unlike the classical complex orders that can impose a minimum income condition expressed using a fixed cost + a variable cost, the scalable complex orders drops the variable cost, and instead uses the prices of the hourly suborders as variable cost on top of a fixed cost.
- New functionality allows the use of a Minimum Acceptance Volume (MAV) for each period.
- The theoretical merit of the scalable complex orders over classical ones, is to improve Euphemia performance;
- This merit can only materialize if the scalable complex orders will eventually replace (not complement) the classical complex orders

Product Overview:
Classic Complex Orders: Minimum Income Orders (MIC)

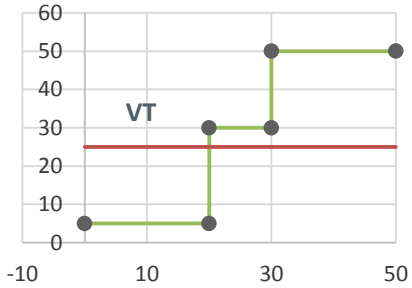
Stepwise hourly orders with two terms:

- FT: **Fixed term** in Euros ➔ Fixed costs of the whole amount of energy traded in the order
- VT: **Variable term** in Euros per MWh (accepted) ➔ Variable costs of the whole amount of energy traded in the order *(average variable cost information besides variable cost information in bid curves)*

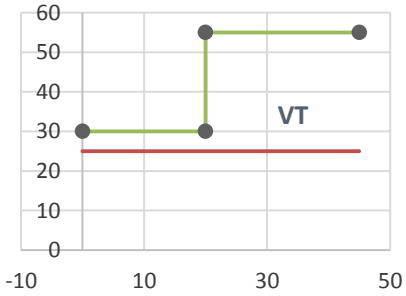
Period 1



Period 2



Period 3



Revenue received by an activated CO must be greater or equal to Fixed Term + Variable term x Energy matched

$$\sum_t PRICE_t * QUANTITY_t \geq FT + VT * \sum_t QUANTITY_t$$

Flexible formulation for bidders

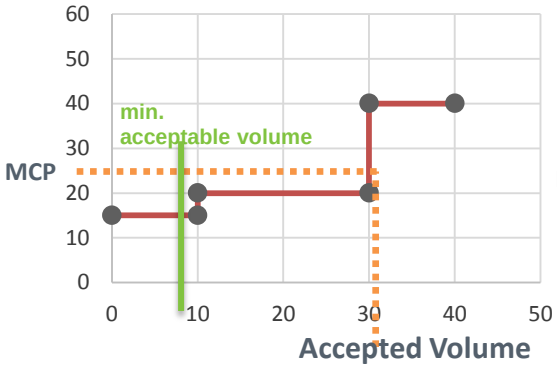
- ☑ Different rates of acceptance per hour
- ☑ Load gradients (ramp constraints)
- ☑ Fixed term FT ~~***in welfare objective***~~
- ☑ Marginal cost curves
- ☑ Variable cost **VT** *besides cost curves*
- ~~✘ *Minimum acceptances per hour*~~
- ☑ Can be out-of-the-money for some hours as long as in-the-money for the whole day (considering **VT** & FT)
- ☑ Demand side version with a Maximum Payment Condition

Product Overview: Scalable Complex Orders

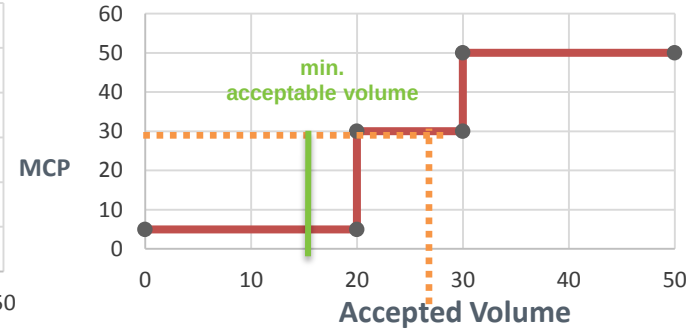
New product

- FT: **Fixed term** in Euros and ***costs in bid curves*** **(or utility on the demand side)**
- ***Minimum acceptance volume*** can be specified (param. *can vary per hour!* → more flexible than curtaible blocks)
- **Ramp conditions** (called load gradients) can be specified, see next slides

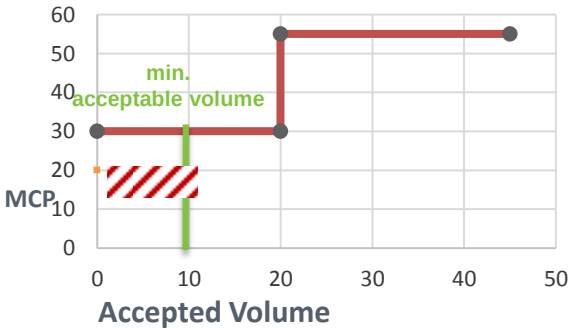
Period 1



Period 2



Period 3



Revenue received by an activated SCO must be greater or equal to Fixed Term + Marginal Costs*

*Marginal Costs = areas below bid curves for accepted volumes

$$\sum_t PRICE_t * QUANTITY_t \geq FT + Marginal\ Costs\ (bid\ curves)$$

Flexible formulation for bidders

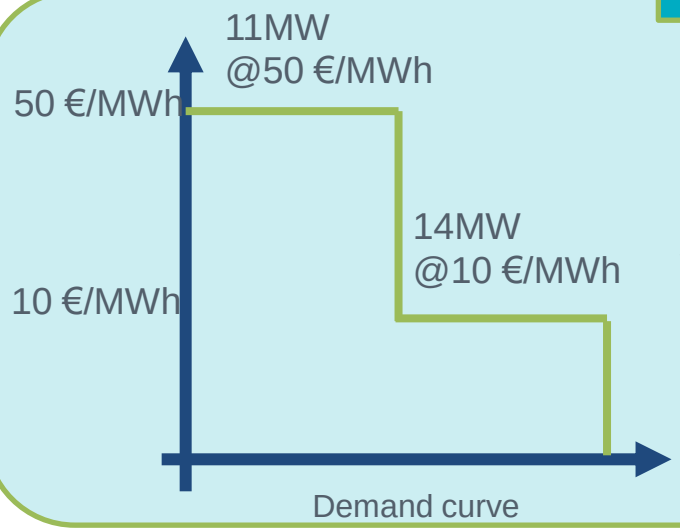
- ☑ Different levels of acceptance per hour
- ☑ Load gradients (ramp constraints)
- ☑ Fixed term FT ***in welfare objective***
- ☑ Marginal cost curves
- ✘ ~~Variable cost **VT** (besides cost curves)~~

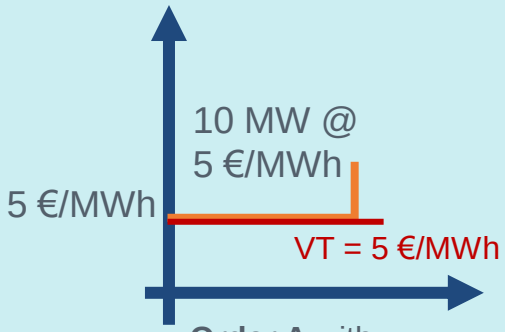
- ☑ **Minimum acceptances per hour**
- ☑ Can be out-of-the-money at some hours (due to min. acceptance) as long as in-the-money for the whole day (considering **bid curves** & FT)
- ☑ Demand side version with a Maximum Payment Condition

Algorithmically easier and more scalable than Classic Complex Orders!

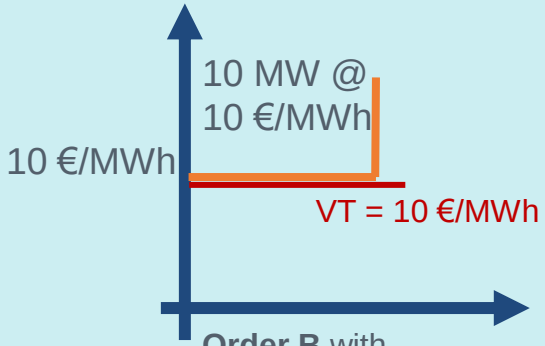
Product Overview:
With SCOs, Fixed Terms are accounted for in the welfare optimization

Input data



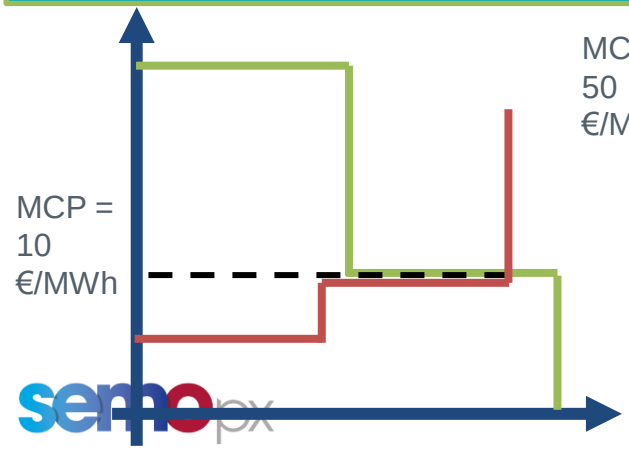


Order A with
FT = 400 €
VT = 5 €/MWh = price of the marginal cost cure

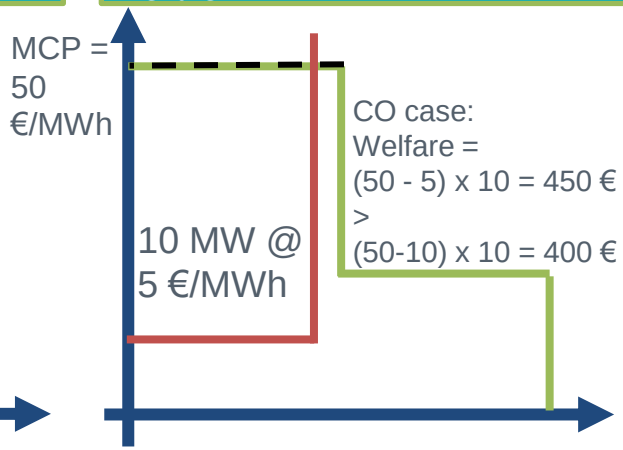


Order B with
FT = 100 €
VT = 10 €/MWh = price of the marginal cost cure

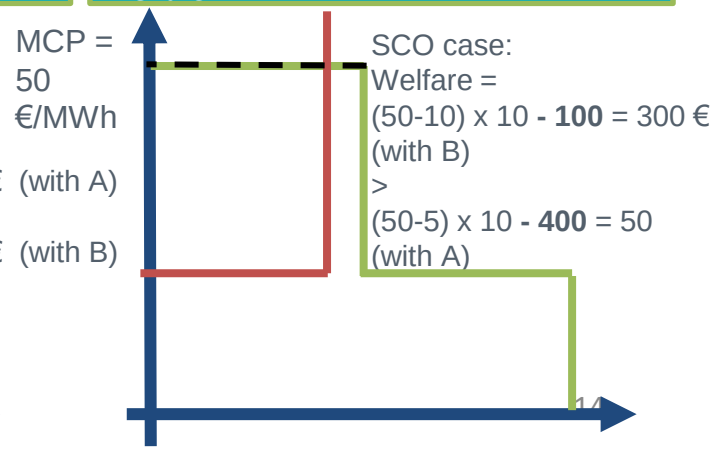
Matching 1: impossible to match both orders A & B → income conditions of A and B not satisfied because MCP = 10€/MWh too low



Matching 2: Best matching **with CO → match A**
→ Fixed Term not counted in optimized welfare



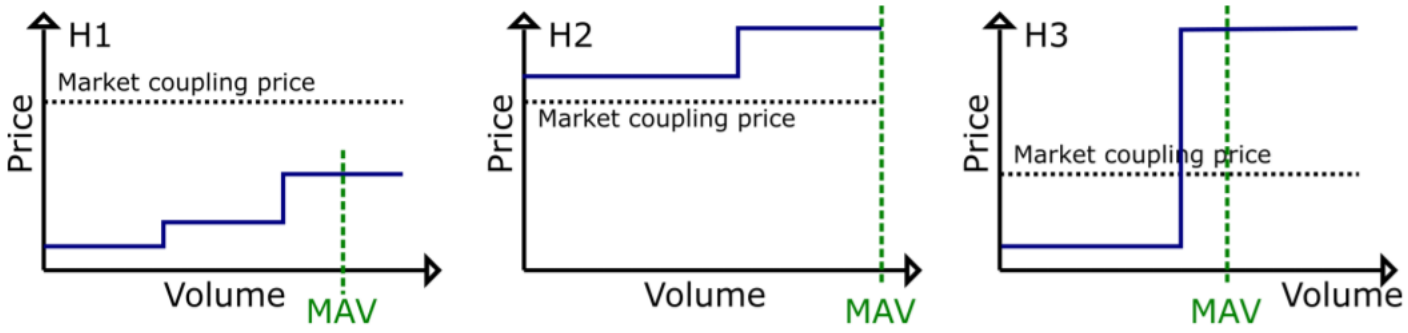
Matching 3: Best matching **with SCO → match B**
→ Fixed Term *is counted* in optimized welfare



Product Overview

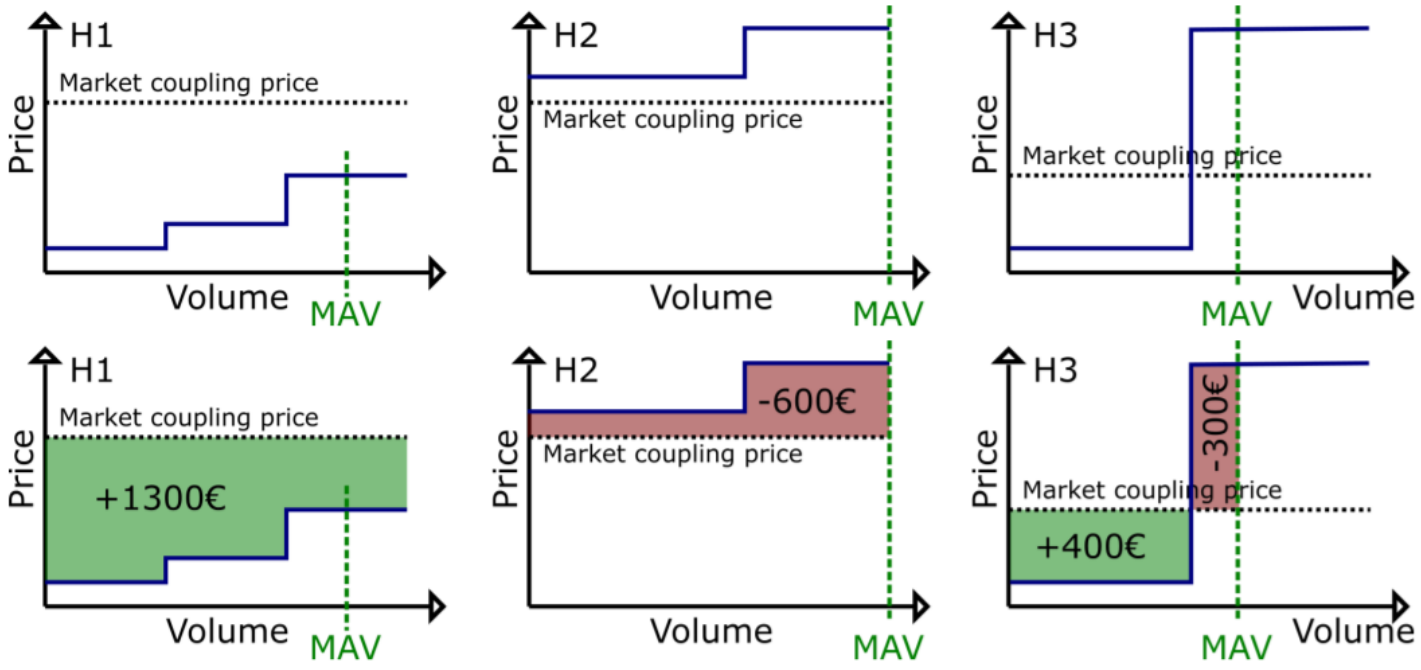
MAV effect on SCO acceptance

- Minimum acceptance volumes per hour (MAV) for SCOs will have a similar behavior 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.



Product Overview

MAV effect on SCO acceptance



Fixed Term > 800 € implies rejection

Product Overview

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

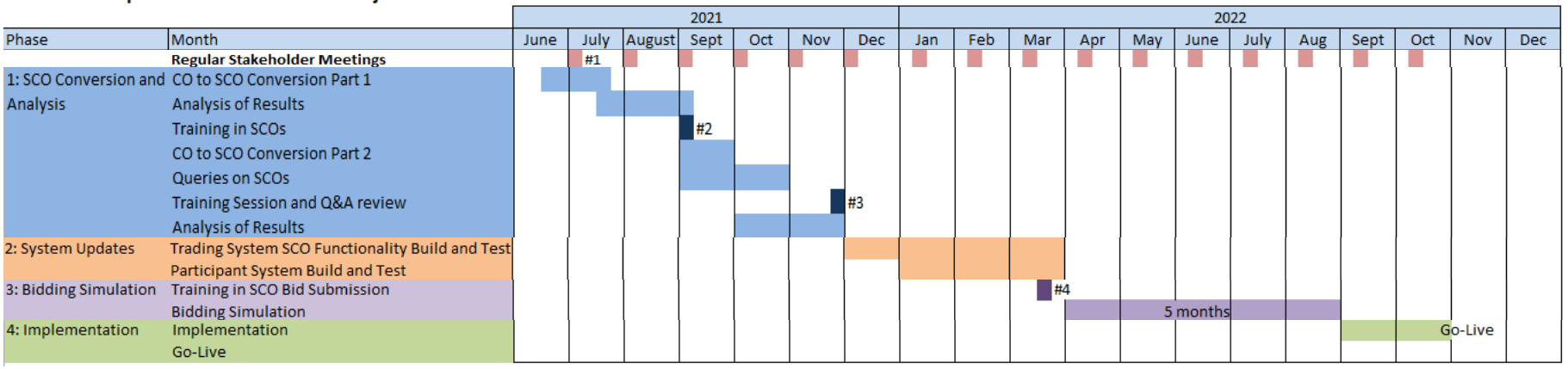
Complex orders (COs)	Scalable Complex Order (SCOs)
Contribution to welfare is the welfare of each one of the steps of the curves defined for each period. For supply CO this is modeled as: $-ACCEPT_{m,co,h,o} q_{m,co,h,o} p_{m,co,h,o}$	**Contribution to welfare** is the welfare of each one of the steps 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: $\left(\sum_h \left(MARKETPRICESORDERS_{m,h} \cdot VOL_{H_{m,sco,h}} - \sum_o (q_{m,sco,h,o} \cdot p_{m,sco,h.o})\right) - FixedTerm_{sco}\right) \geq 0$

Product Overview

- In case there are two “same-but-Fixed-Term” SCOs, Euphemia will behave in the sense that it automatically gives 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 behavior than for curtailable block orders).

Project Plan

Scalable Complex Orders - Overview Project Plan



Project Phase 1 – SCO Conversion and Analysis

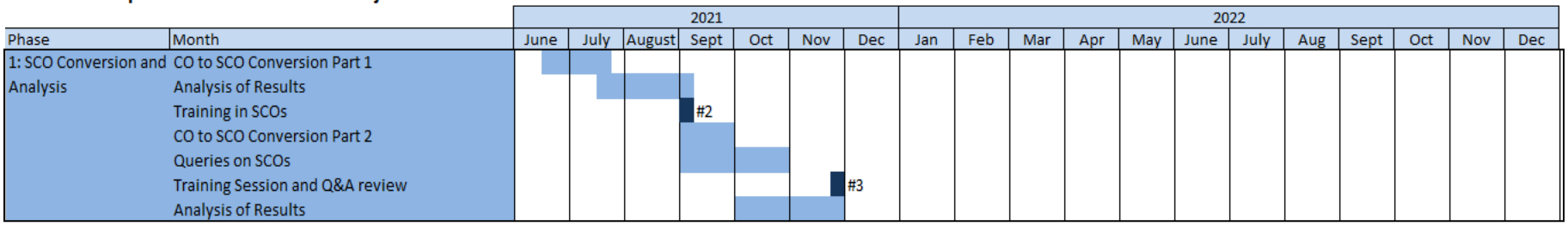
- Data conversion – previous 12 months of Complex Order data (replace CO technical parameters with SCO's) will provide comparison

- Conversion in 2 batches (using 1 year of CO data):
- (Conversion 1) July 2021: with standard conversion
  - Conversion analysis presented to members along with key indicators for analysis.
  - Members can provide feedback based on independent analysis
- (Conversion 2) November 2021: with adjusted conversion

- N-Side support available during the conversion phase

- 3 Training Sessions Scheduled
  - #1 7th July: Kick-off Meeting
  - #2 1st September: Presentation of initial conversion, key indicators of analysis, discuss data sets and follow up questions (Conversion 1)
  - #3 24th November: Presentation of revised conversion, queries on adjusted conversion and application (Conversion 2)

Scalable Complex Orders - Overview Project Plan



Project Phase 2 - System Updates

- Trading System Design Phase - Market Trading Systems and Member Systems

- Market Trading Systems
  - Dec ‘21 – Feb ‘22: Design to include SCO whilst exclude CO features
  - Feb ‘22 – Mar ‘22: Testing on functionality and procedural application

- Member Trading Systems
  - Jan ‘22 – Mar ’22: Support provided to members, local trading systems align with new functionality

- 1 Training Session Scheduled:
  - Mar ‘22: Outline new system functionality, impacted API’s and new submission criteria for ETS

Scalable Complex Orders - Overview Project Plan

		2021							2022											
Phase	Month	June	July	August	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2: System Updates	Trading System SCO Functionality Build and Test																			
	Participant System Build and Test																			

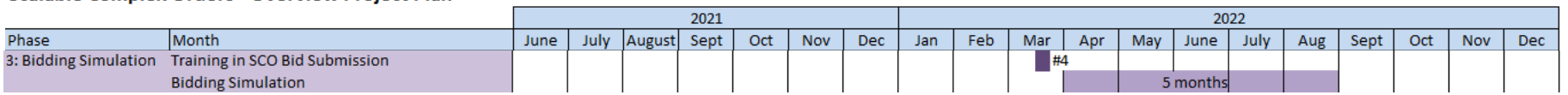
Project Phase 3 - Simulation

- Simulation Environment
  - Apr ‘22 – Aug ’22: Simulated Auction facilitated
  - Weekly simulated auctions (2 per week)
  - Weekly communication, coordination and scheduling details tbc

- Training in SCO Bid Submission
  - Develop understanding of features of the SCO product
  - Allows for analysis of results and changes to trading strategy
  - Familiarisation with new trading system functionality

- Products available
  - Simple Orders and SCO’s can be utilised throughout
  - CO’s are no longer accessible

Scalable Complex Orders - Overview Project Plan



Project Phase 4 - Implementation

- Focus on Go-Live Readiness (Sep '22 – Nov '22)
  - Continuation of monthly meetings (12th Sep, 10th Oct tbc)
  - Awareness of SCO products and features
  - Awareness of the updated system functionality
  - Final Confirmation of local system alignment

- Market Trading System Readiness
  - Focus on the deployment of the Trading System release
  - Communications expected in advance of go-Live

- Provision of a final report
  - Expected changes to all impacted regulatory and technical documentation
  - Overall review of the project

Scalable Complex Orders - Overview Project Plan

		2021							2022											
Phase	Month	June	July	August	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
4: Implementation	Implementation																			
	Go-Live																	Go-Live		

Project Working Group

- Monthly Meetings Scheduled (Jul ‘21 – Oct ‘22)
  - SEMOpx to provide progress status of overall project deliverables
  - Discuss ongoing activities specific to members
  - Participation not mandatory, but recommended, for Complex Order using members

- Monthly Meeting Forum
  - Facilitate discussion around the SCO product
  - Discussion for general queries and responses
  - Evaluation of analysis
  - Provide a support mechanism to enhance understanding
  - Provide support regarding shared troubleshooting issues around deliverables
  - Platform to provide feedback to SEMOpx Coordinators on any aspect of the project

Scalable Complex Orders - Overview Project Plan

		2021							2022											
Phase	Month	June	July	August	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
	Regular Stakeholder Meetings		#1																	

Key Indicators for Product Analysis

A product analysis based on the following key indicators is being performed to compare in detail Complex Orders and Scalable Complex Order from a market impact perspective:

- **Revenues of market parties:** comparison of incomes and costs of CO vs. SCO
- **Market prices:** price differences when SCO replace CO
- **Cleared Volumes:** differences in cleared volumes (per order) when SCO replace CO
- **Number of Paradoxically Rejected Order**s: number of (Scalable) Complex Orders that are rejected though they would be profitable given the market prices

Important: market impacts depend on how the conversion of a CO to a SCO is made.

Conversion rules will be re-analyzed and refined in light of the market impact analysis, and can be used by market parties as a support tool for the transition.

Next Steps

- Publication of SCO Project Scope Document (21st July)
- SEMOpx to provide initial Conversion 1 results to Members for analysis (26th July)
- Members to perform analysis on Conversion 1 data and submit questions/queries (26th July to 23rd August)
- Setup regular project meetings (starting early August)
- Workshop with N-Side/SEMOpx on main queries (early September)
- Conversion 2 started (early September)

Q & A

Questions?

Appendices

Current conversion rule of a CO to a SCO in a nutshell

Main objective is to adapt the Fixed Terms since Minimum Income Conditions, and hence Fixed Term recovery conditions, are different:

CO

$$\sum_t PRICE_t * QUANTITY_t - \boxed{Variable\_Term * \sum_t QUANTITY_t} \geq Fixed\ Term$$

versus

SCO

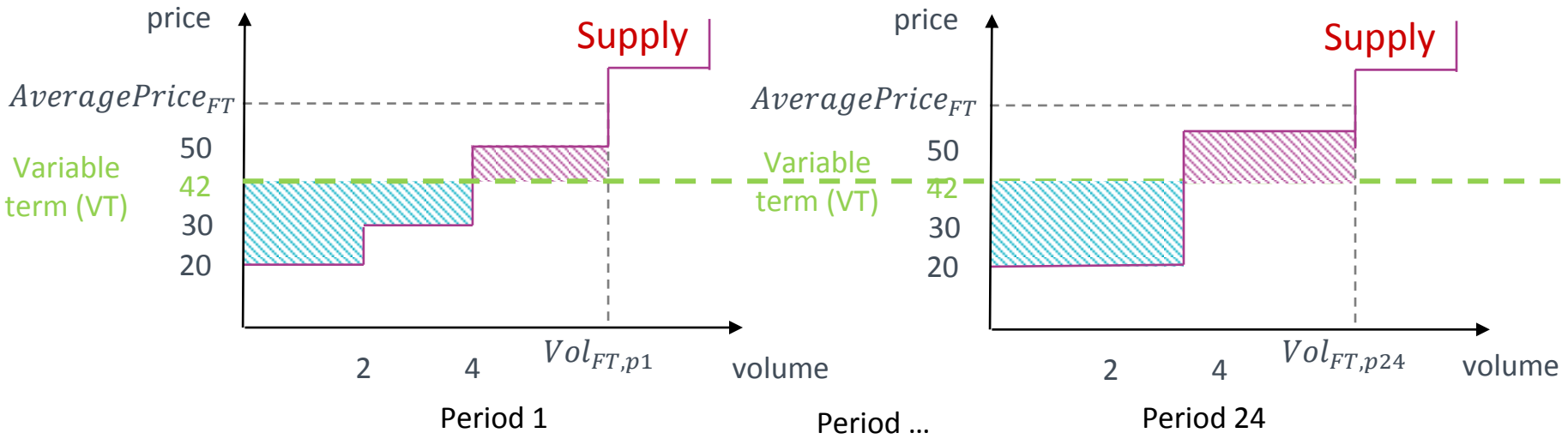
$$\sum_t PRICE_t * QUANTITY_t - \boxed{Marginal\_Costs\ (bid\ curves)} \geq Fixed\ Term$$

Differences in Variable Costs will be accounted for in the change of Fixed Term

Current conversion rule of a CO to a SCO in a nutshell

Main objective is to adapt the Fixed Terms since Fixed Term recovery conditions are different

Adaptations consist in shifting *an estimation* of differences in "Variable Costs" (see previous slide) to the Fixed Term



Conversion rule

1. SCO Cost Curve = CO Cost Curve
2. CO Variable Term (VT) dropped → no VT in SCO
3. SCO Fixed Term = CO Fixed Term + Area – Area

Area = areas below Variable Term and above Curves

Area = areas above Variable Term and below Curves

Curves → which estimations (cleared volumes + impact on variable costs) for the left-hand side computations ?

Underlying assumption to ease computations is that the Fixed Term and Variable costs based on VT (CO case) would be recovered thanks to revenues resulting from a same unique market price over all periods, *and associated cleared volumes*

$AveragePrice_{FT}$ and *associated cleared volumes* are chosen so that if $AveragePrice_{FT}$ = price in all periods,

$$\text{Revenues} - \text{Variable Costs}(VT) \geq \text{CO Fixed Term}$$