

Part 1: SEMOpx Auctions Clearing

Part 2: SEMOpx Intraday Continuous

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Version 4



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Part 2: SEMOpx Intraday Continuous

Learning Objectives

Topic 1: Introduction to SEMOpx clearing of trades

Topic 2: Recap of M7 overview

Topic 3: Clearing of Trades

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Topic 5: Overview of order types for intraday continuous

Topic 6: Course Summary

Part 1: SEMOpX Auctions Clearing



Learning Outcome

- This document will give you will have an understanding of:
 - The clearing process for SEMOpx trades
 - How each order clears in the auctions
 - Overall process from bidding to nomination

Topic 1: Introduction SEMOpx Clearing of Trades

SEMOpX Trading

- SEMOpX is a NEMO for Ireland and Northern Ireland:
 - Responsible for trades, market coupling etc.
- SEMOpX provides trading services to the following SEM ex-ante markets:
 - Day-ahead auction
 - Intraday auctions
 - Intraday continuous trading
- SEMOpX have procured EPEX as service provider for these services:
 - Operate the trading systems for auctions and continuous trading
 - Perform auctions and other operations
 - Provide reporting services related to trading (e.g. REMIT)

Glossary of trading terms

Term	Description
Order	<ul style="list-style-type: none">• Bid to buy or offer to sell• Submitted by participants to SEMOpx for auctions and continuous
Product	<ul style="list-style-type: none">• A pre-defined way of inputting orders to SEMOpx• Multiple products exist, each offering a different way to bid• Different set of products for different market segments
Transaction	<ul style="list-style-type: none">• Order which has been accepted• Not yet a contract; not binding on the participant

Clearing Definition

Term	Definition
Clearing	The process of equalling supply (in this case, generation of electricity) and demand (in this case, consumption of electricity) in a market. In electricity markets, clearing depends on the prices – the cheapest generation will be accepted to match the consumption willing to pay the highest prices, until these are equal.
Clearing Price	The price determined from the highest accepted offer to sell and the lowest accepted bid to buy, the price which causes quantities of supply and demand in a market to be equal.
Clearing Volume	The volume at which offers to sell (ordered from cheapest to most expensive) and bids to buy (ordered from highest price willing to purchase to lowest), are equal. Beyond this volume, participants offered too expensive a price to sell, or too low a price to buy, which were not accepted (not “cleared”) by the market.

Trading Steps – Basic Steps

- The same high level steps apply to auctions and continuous trading.
- Participant submits their order:
 - Bid to buy or offer to sell
 - Orders must use a pre-defined set of products
- SEMOpx performs a matching process:
 - Process to determine if an order is cleared or not
 - Different process for auction and continuous trading
- SEMOpx determines the set of cleared orders
- SEMOpx sends cleared orders to ECC for settlement:
 - On sending to ECC, the cleared trades become contracts

Flow of a trade - Diagram

Order (Participant)

Bid to buy or offer to sell

Submitted by the participant SEMOpx



Transaction (SEMOPx)

Order which has been accepted by SEMOPx (i.e. will form a contract)

Has not yet been notified to ECC, not a binding contract

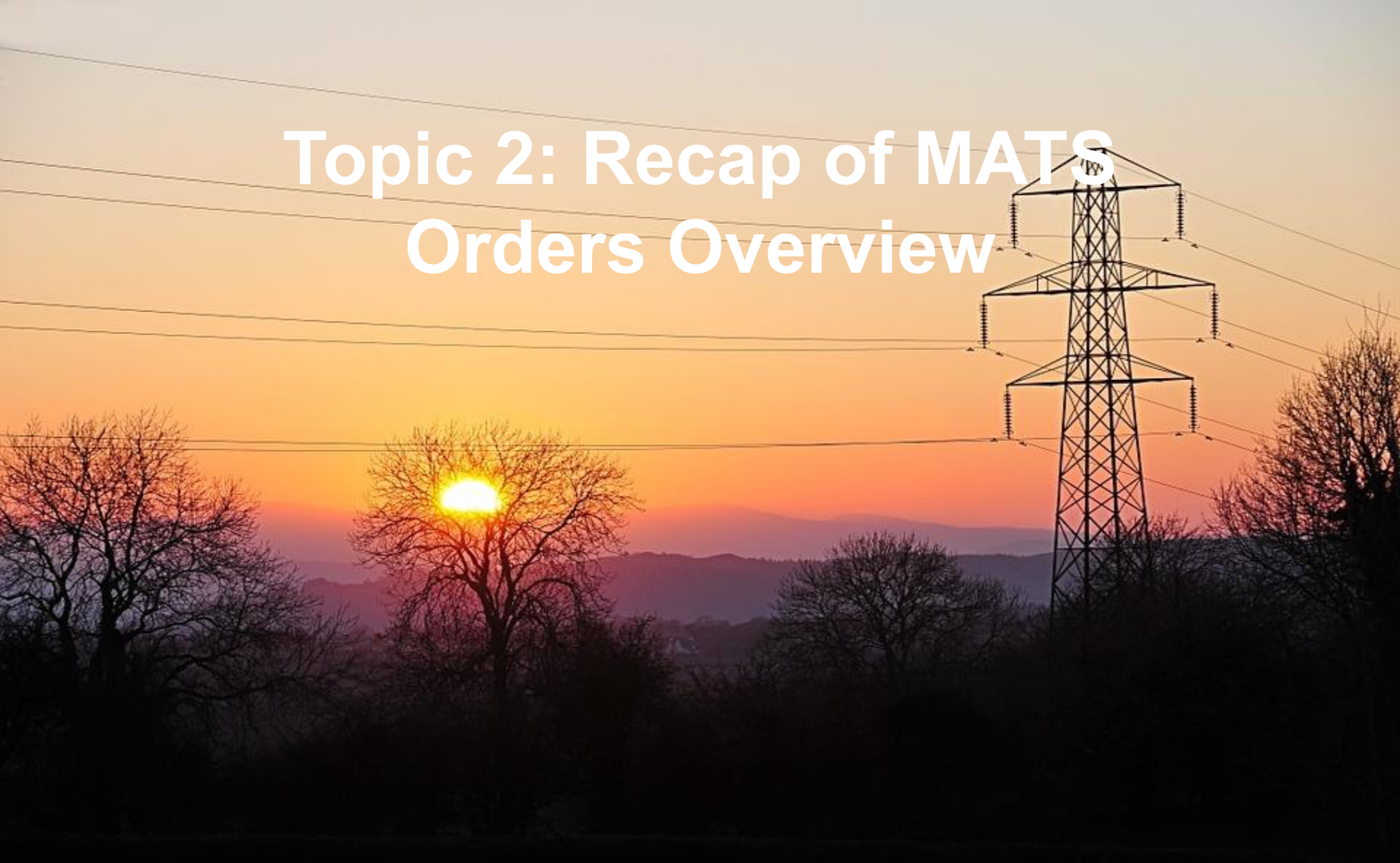


Contract (ECC)

Trade which has been notified to ECC

Forms a binding contract for payment and delivery

Topic 2: Recap of MATS Orders Overview



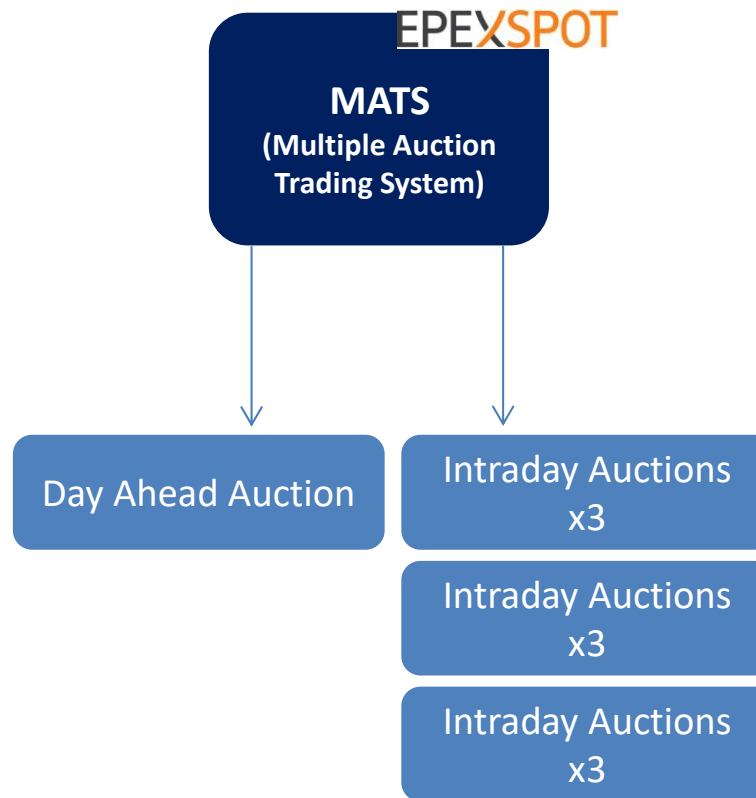
Recap of Auction Timings

The table below summarises the SEMOpx auctions:

Market Name	Trading System	Gate Window Closure	Delivery Periods	Market Coupling
DAM	MATS	11:00 (D-1)	23:00 – 23:00 (24 * 1 hour)	Local trading only
IDA – 1	MATS	17:30 (D-1)	23:00 – 23:00 (48 * ½ hour)	Coupled with GB
IDA – 2	MATS	08:00 (D)	11:00 – 23:00 (24 * ½ hour)	Coupled with GB
IDA – 3	MATS	14:00 (D)	17:00 – 23:00 (12 * ½ hour)	Local trading only

MATS Orders

- Orders are submitted through MATS for auctions:



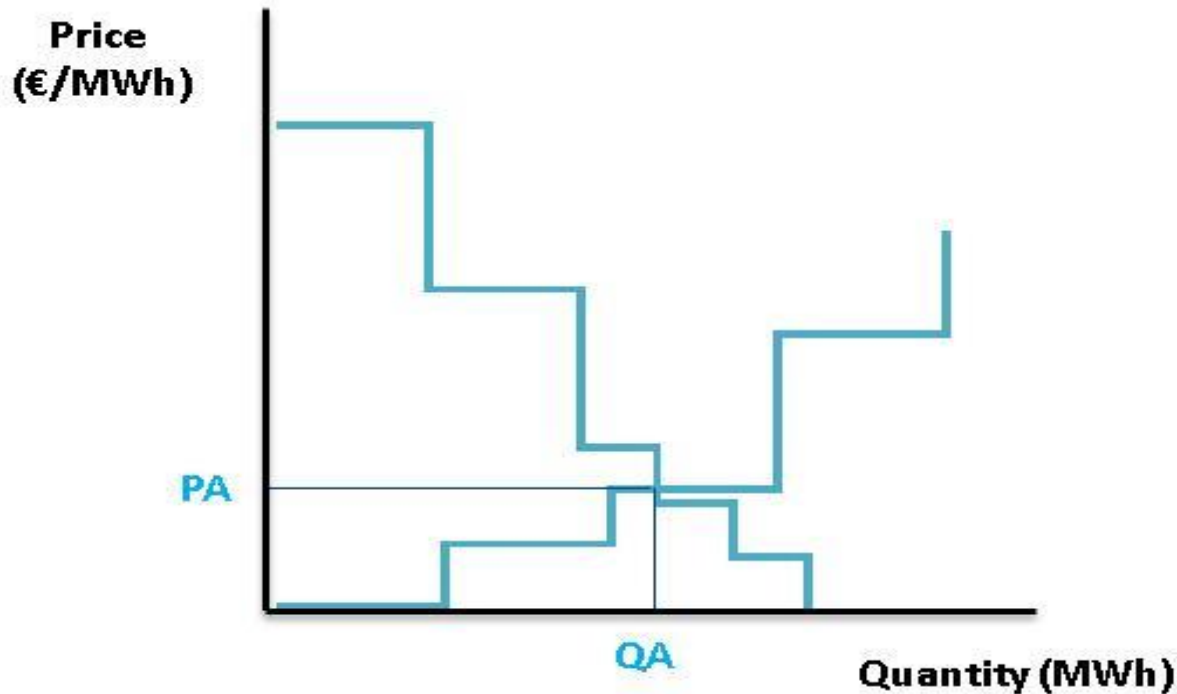
Topic 3: Clearing of Auction Trades



Auction Clearing

- In the day-ahead and intraday auctions, market participants submit orders (bids to buy, offers to sell) to their respective Market Operator. After auction gate closure, all bids and offers are aggregated into two curves for each delivery hour; an aggregate demand curve and an aggregate supply curve.
- The goal of the centralised price coupling platform is to decide which orders to execute and which to reject and publish prices such that:
- The social welfare (consumer surplus + producer surplus) generated by the executed orders is maximised.
- The flows resulting from the executed orders do not exceed the capacity of the relevant network.
- The price for each hour is determined by the intersection of the aggregate supply and demand curves which are representing all bids and offers for the entire price coupling region. All producers that are cleared to produce, and all consumers that are cleared to consume, in a specific hour are paid/pay according to the market price.
- This is a marginal pricing approach, where the price received and paid by all cleared participants in an hour represents the price of activating the last MW of power.

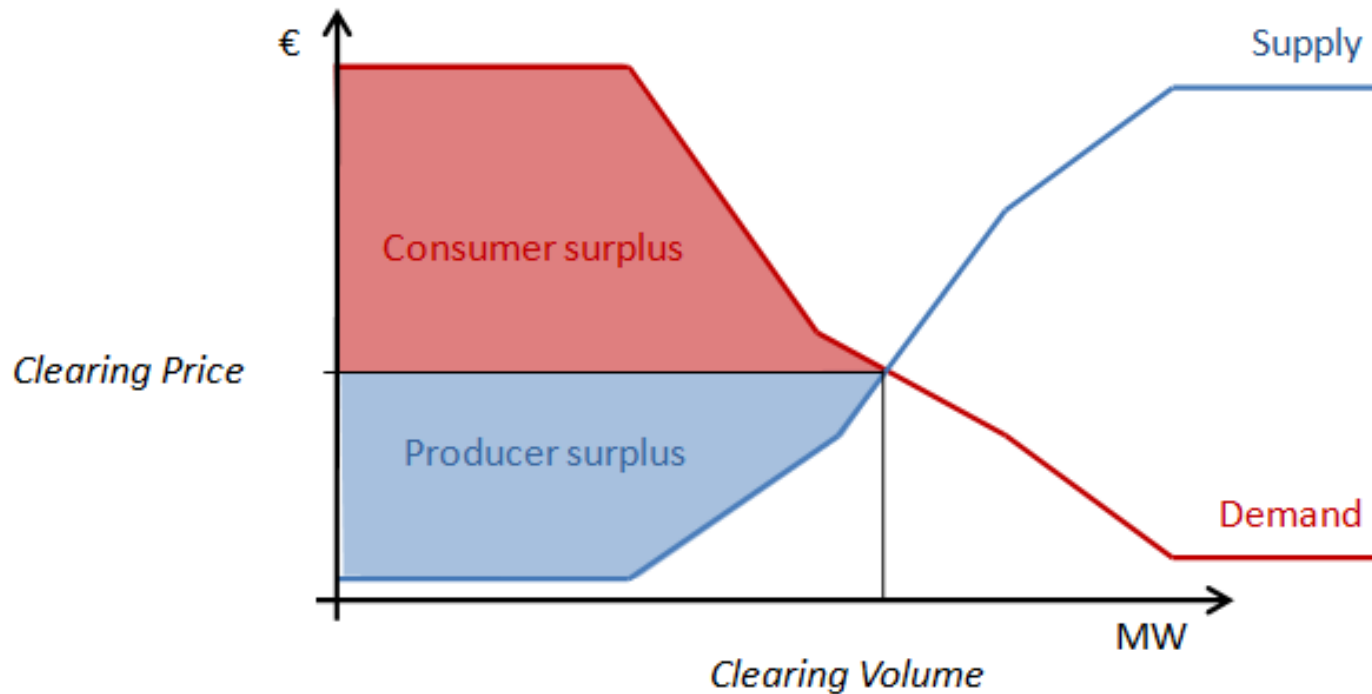
European Power Markets – Double Sided Auction



- This means that both producers offer to sell and retail suppliers bid to buy
- The market clears where the demand and supply curves meet

Auction Clearing

- Auction Clearing supply and demand curves:



The price for each hour is determined by the intersection of the aggregate supply and demand curves which are representing all bids and offers for the entire price coupling region

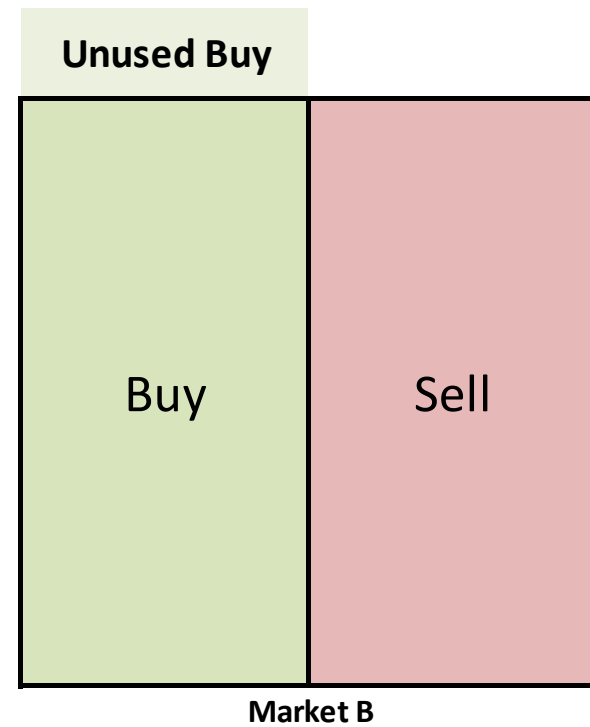
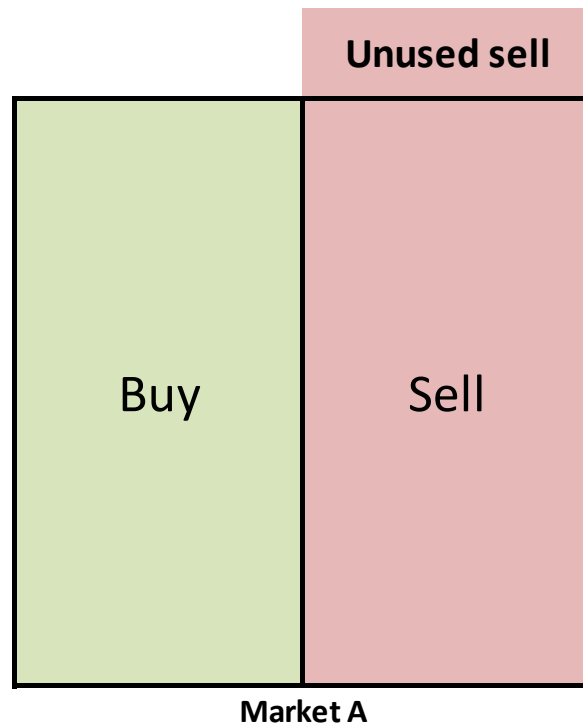
Auction Clearing – Market Coupling

- System of linking markets together:
 - Local Auction for the DAM and IDA3; with GB for IDA1 and IDA2
 - Central body produces single set of results across all markets
 - Single set of market prices, volumes and interconnector flows (for coupled auctions)
- Coupling solution provides a global solution:
 - Transfers social welfare (i.e. consumer or producer surplus) between markets
 - Arrives at the solution with highest welfare across all markets
 - This includes scheduling the interconnectors to transfer energy
 - Typically means export from cheap market to more expensive market

Market Coupling – No Coupling

- Without coupling markets work in isolation:
 - Market A will find solution for market A
 - Market B will find solution for market B
- Will only find best local solution:
 - In the example there are unused buys and sells
 - Generators are sub-optimal in market A
 - Suppliers are sub-optimal in market B

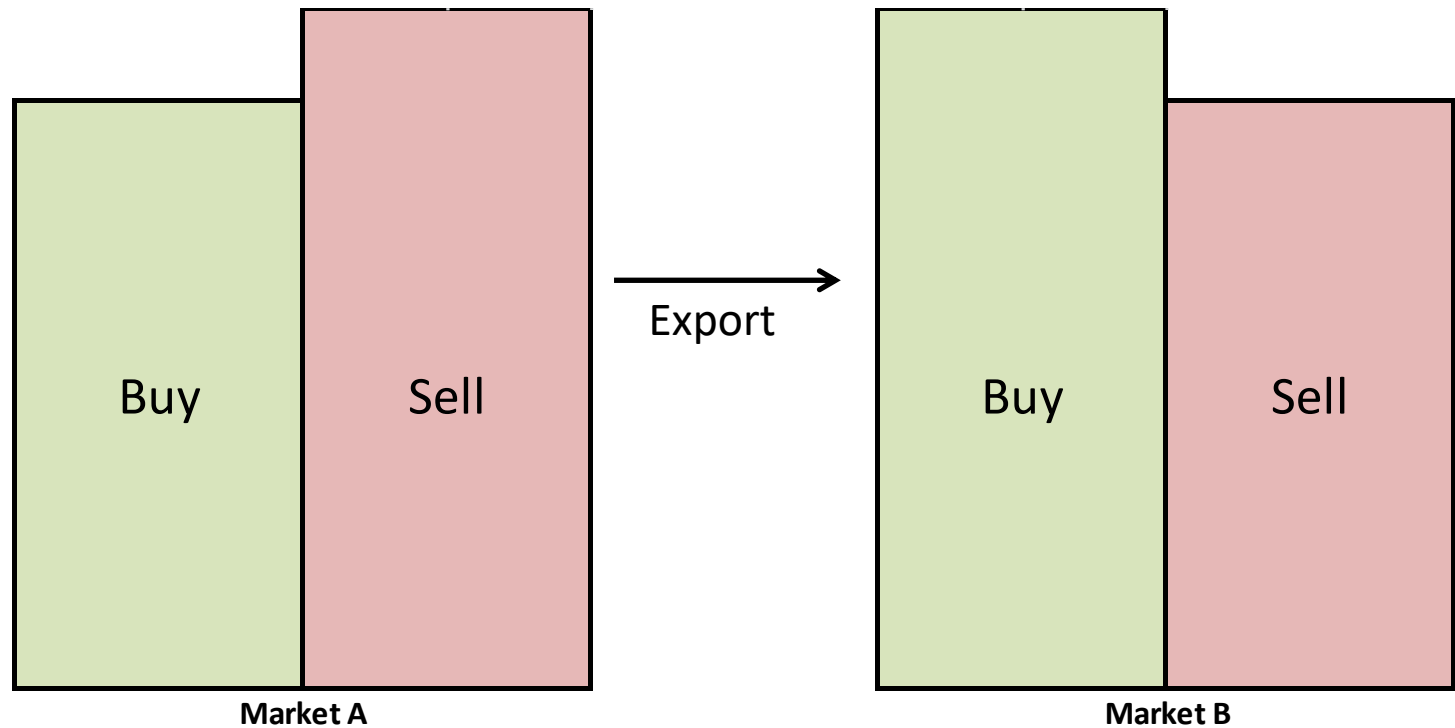
Market Coupling – No Coupling



Market Coupling - Coupling

- Energy is exported from A to B:
 - Generators in market A receive more revenue
 - Suppliers in market B can buy more energy
- Amount of energy sold affects the price:
 - Buyers in A are not willing to pay sellers
 - Buyers in B get access to cheaper energy
 - The overall solution improves both markets

Market Coupling - Coupling



Price Coupling of Regions (PCR)

- **WHAT is PCR?** Price Coupling of Regions (PCR) is a project of European Power Exchanges to harmonise the European electricity markets
- **HOW is this done?** By developing common assets, a single price coupling algorithm and PCR Matcher and Broker SW, to be used to calculate electricity prices across Europe

Price Coupling of Regions (PCR)

- Price Coupling of Regions (PCR) is a Market Coupling project focused on the delivery of a Market Coupling Operations Function (MCO Function) described by CACM Regulation 2015/1222
- An important part of all regional market coupling projects, linking them all together
- This is to accommodate the overall EU target of a harmonised European electricity market
- Based on three main principles:
 - One single algorithm
 - Robust operation
 - Individual accountability

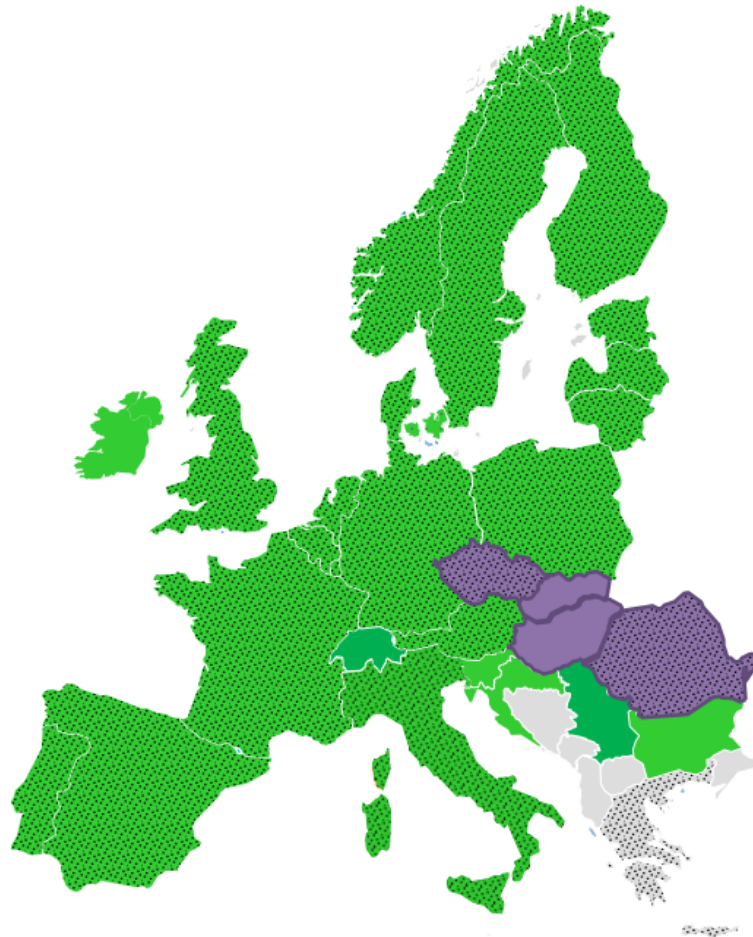
Price Coupling of Regions (PCR)

- PCR is a project currently being operated by eight Power Exchanges: EPEX SPOT, GME, HEnEx, Nord Pool, OMIE, OPCOM, OTE and TGE, open to other European Power Exchanges wishing to join. PCR is creating a governance structure based on a Co-Ownership Agreement and a Co-Operation Agreement among exchanges
- PCR is used to couple the following countries: Austria, Belgium, Czech Republic, Croatia, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, Ireland, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and UK
- Development of a single price coupling algorithm, Euphemia. It is used to calculate electricity prices across Europe. It also optimises the overall welfare and increases transparency of prices and flows

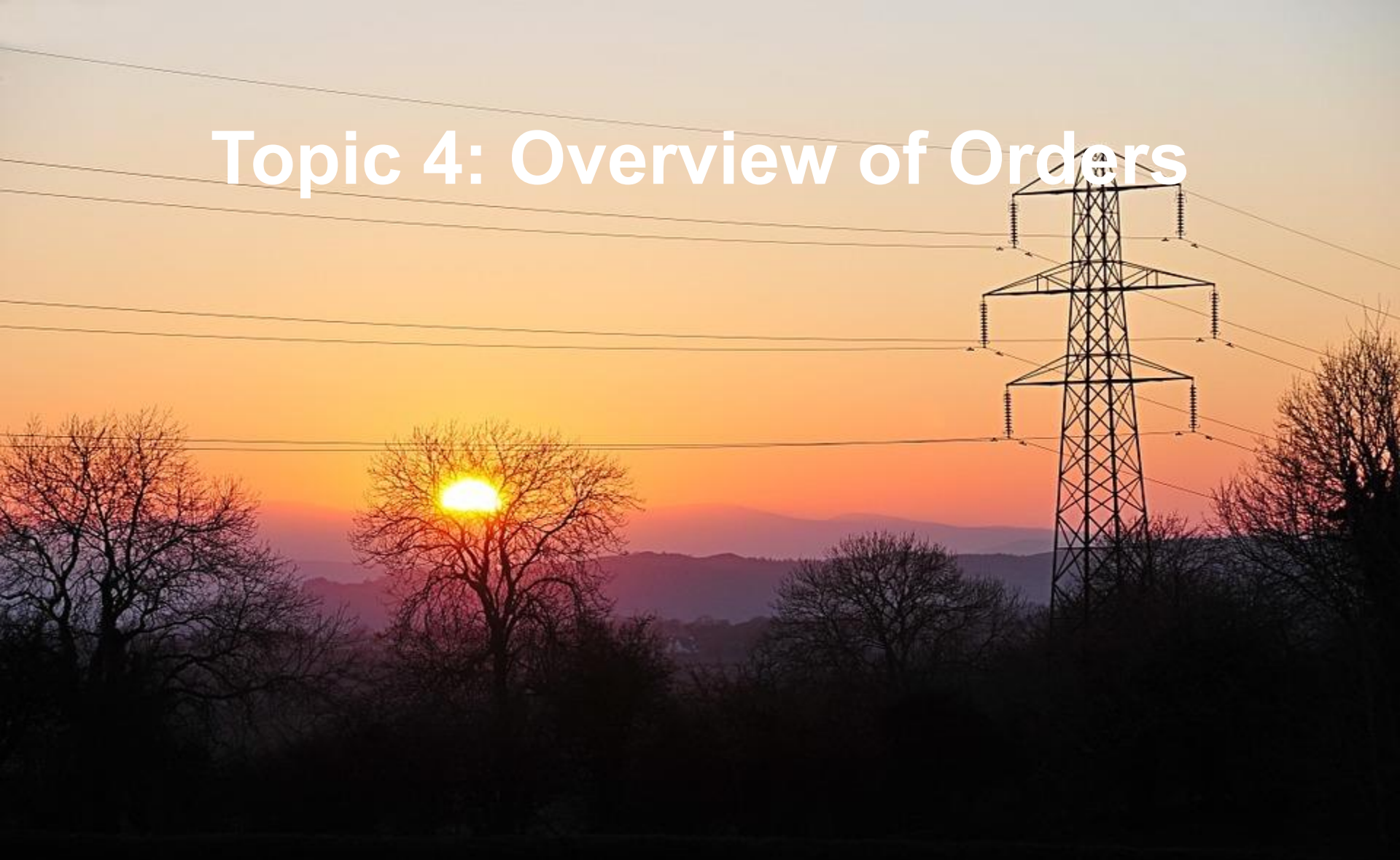
Price Coupling of Regions (PCR)

PCR users and members

- Markets using PCR: MRC
- Markets using PCR: 4MMC
- Markets PCR members
- Independent users of PCR
- Markets associate members of PCR



Topic 4: Overview of Orders



Differences between the SEM and I-SEM – Ex-ante Design

SEM

Single ex-post price for settlement

Mandatory

Auctions only

Market positions updated by later auctions

I-SEM

Range of prices for settlement

Non-mandatory (exclusive)

Auction and continuous

Firm positions for each trade and balance responsibility

Differences between the SEM and I-SEM – Generators

SEM

Sell energy only

Market position updated by later runs

Schedule optimised by the market solver algorithm

Wide range of TOD and COD

I-SEM

Buy or sell energy

Market position from DAM is firm

Trade to reflect preferred scheduling

Limited number of set products

Differences between the SEM and I-SEM – Suppliers

SEM

Price taking

No bids

Settled based on ex-post
consumption

Pay at a single price ex-post

I-SEM

Can be price making

Bids as required

Balance responsibility for ex-
ante trades

Can secure prices and volumes
ex-ante

Auction Order Type Overview

- The products available in EUPHEMIA, i.e. the algorithm to be used for the DAM and IDAs for SEMOpx are shown below.

Simple Orders

- Price-quantity pairs with no conditions

Scalable Complex Orders

- Price-quantity pairs with conditions
- Cost and technical data

Topic 5: Simple Order Examples



Simple Orders

- Simple orders are price quantity pair(s) (PQ pair(s)) orders for supply or demand (buy or sell). The rules that apply for the acceptance of simple orders are the following:
 - Any order in-the-money (in merit) must be fully accepted.
 - Any order out-of-the money (out of merit) must be rejected.
 - Orders at-the-money (marginal) can be either accepted (fully or partially) or rejected.
- Simple orders can be used for a range of buy and sell prices in the same order
- Simple orders primarily used where fixed costs and technical constraints are not binding:
 - Supplier units
 - Price taking units
 - Wind and other renewable units
- Can be used where technical constraints exist but have low impact over the trading period:
 - Peaker units
 - Energy limited hydro units

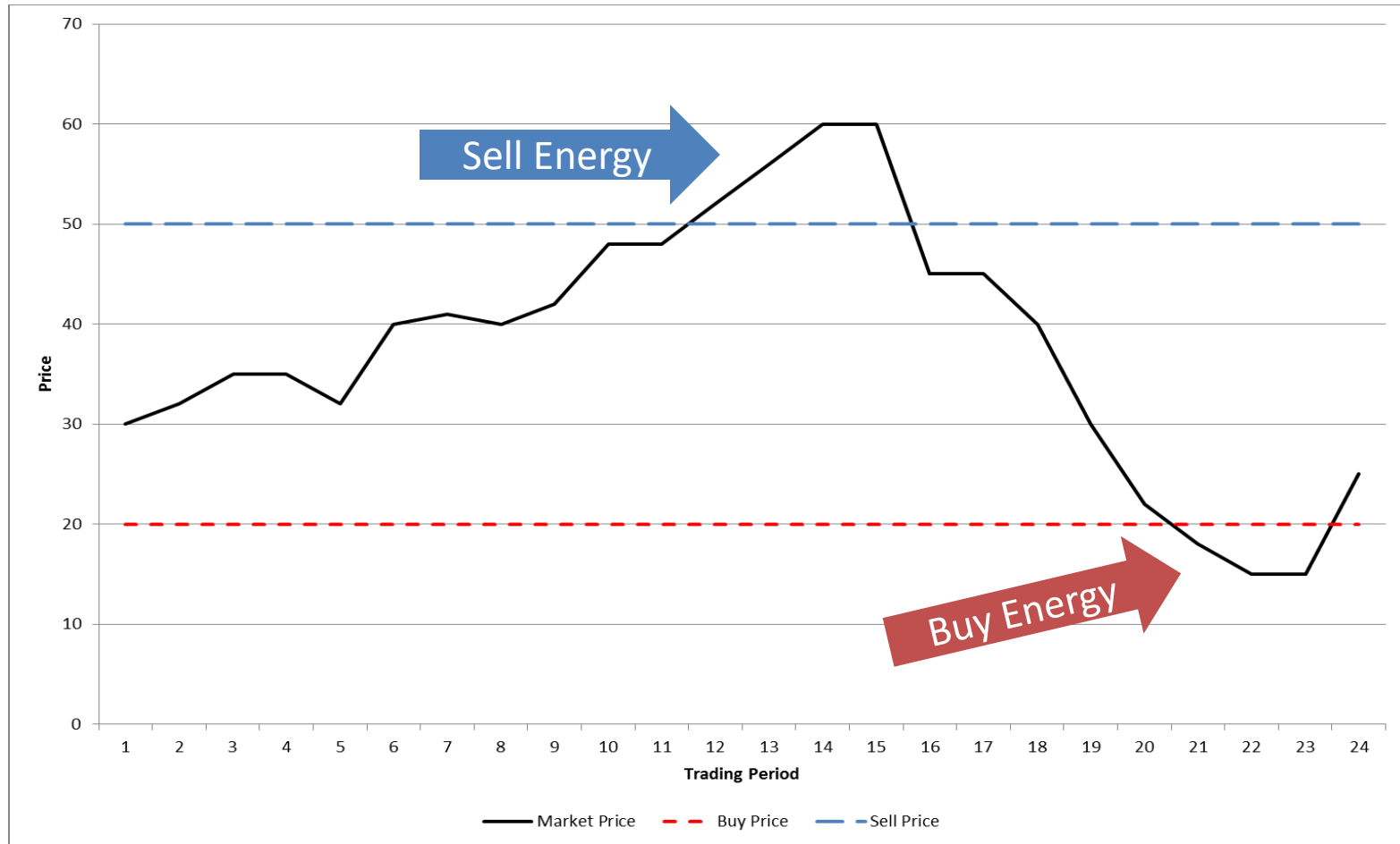
Simple Order Examples – No Constraint

- Supplier unit has no fixed cost base but is only willing to pay €200 in DAM for energy and believes forecast is correct:
 - Quantity in each trading period is equal to their forecast
 - Quantities are buy quantities
 - Price in each trading period is equal to €200 (max price for buy)
- Wind unit is a price taker and believes their forecast is correct:
 - Quantity in each trading period is equal to their forecast
 - Quantities are sell quantities
 - Price is set to the price floor (i.e. will accept any sale price)
 - Price in each period is equal to -€500 (min price for sell)

Simple Order Example – Hydro Unit

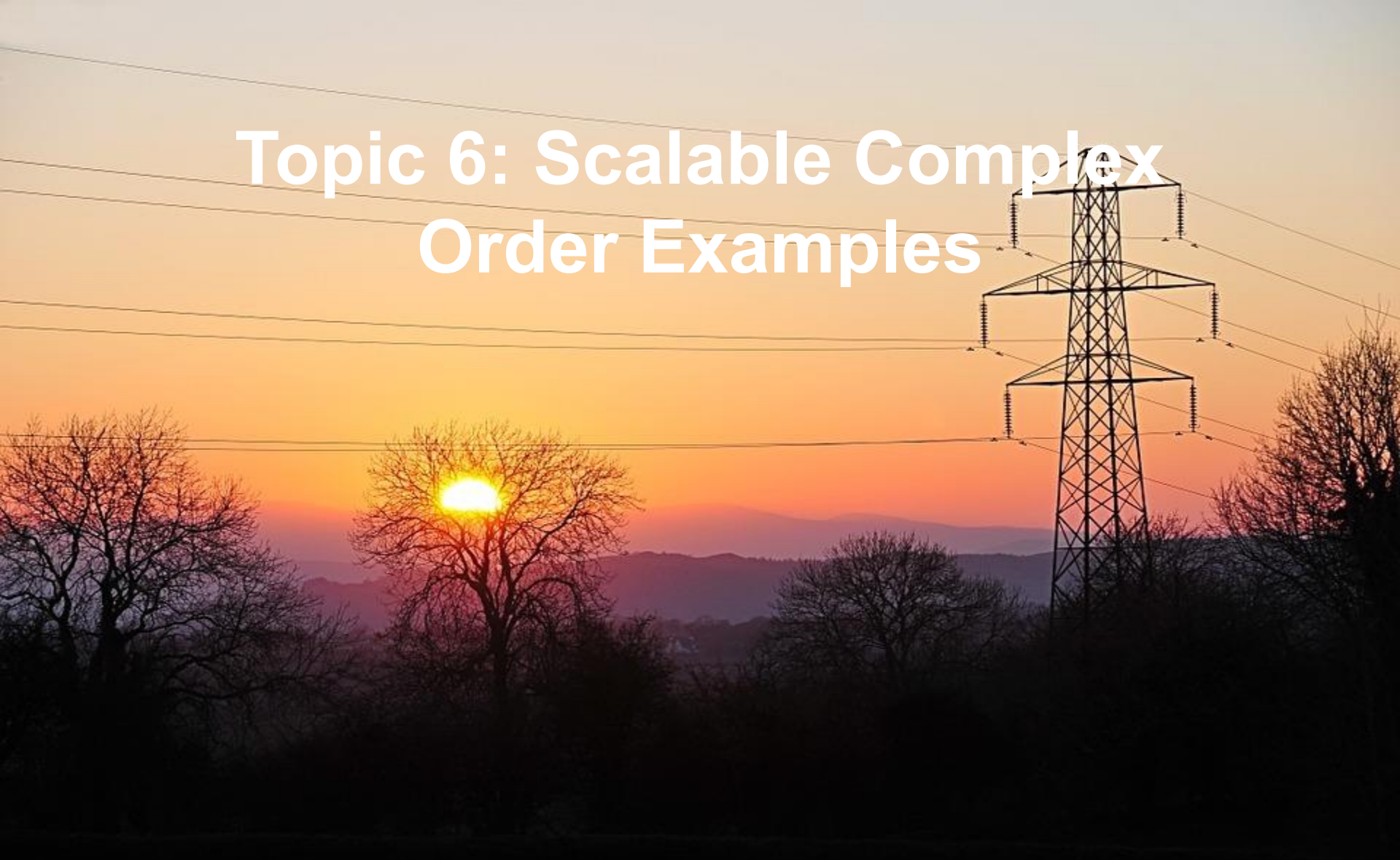
- Hydro unit is subject to an energy constraint:
 - Max capacity is 10 MW
 - Energy limit for the day is 50 MW
 - Can only produce at max output for 5 hours
 - Must decide how to offer to the market
- Hydro unit chooses to sell energy in 5 hours only:
 - Uses wind and load forecast to find highest demand hours
 - Highest demand should lead to highest price for energy
 - Unit offers into the 5 highest demand hours
 - These hours do not need to be consecutive
 - Units offers a volume of zero into all other hours

Simple Order Example – Buy and Sell



- Buy and sell prices put in the same simple order
- Unit buys energy in hours when it is cheap
- Unit sells energy in hours when it is expensive

Topic 6: Scalable Complex Order Examples

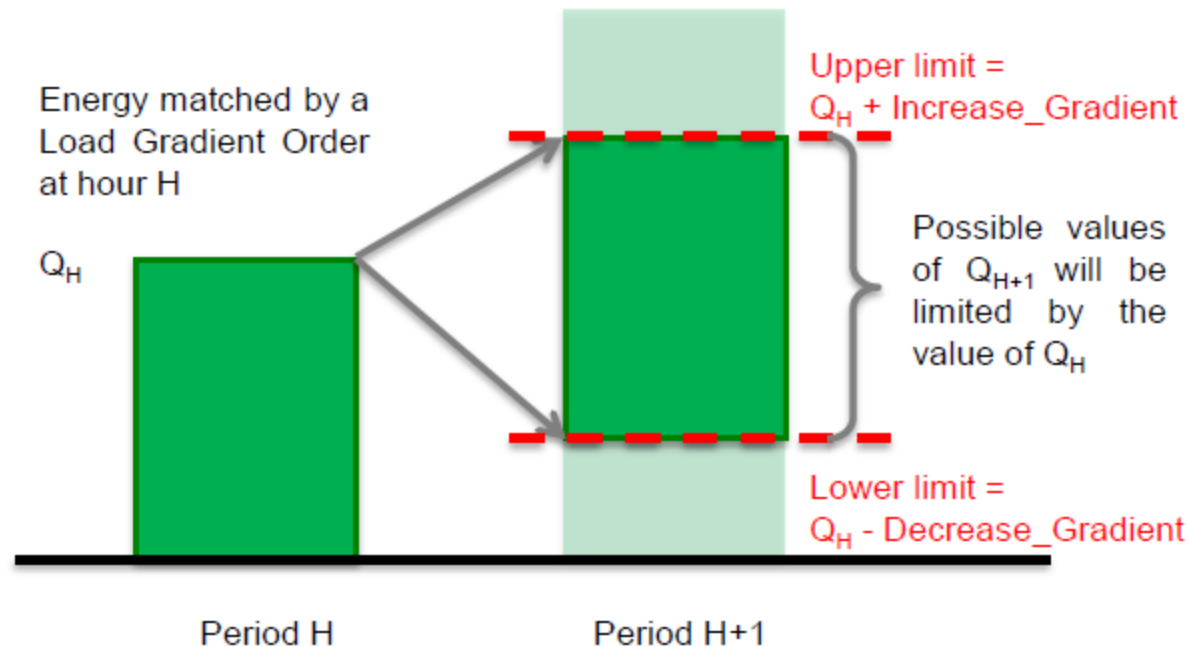


Scalable Complex Order Overview

- Combines simple PQ pairs with complex conditions:
 - Load gradient
 - Minimum Income Condition
 - Minimum Acceptance Volume
 - Scheduled Stop Condition
- Useful for a range of units:
 - High fixed costs
 - Slow ramping
 - Not currently on (e.g. need to recover start costs)

Scalable Complex Orders – Load Gradient Condition

- Load gradient limits movement in volume between hours:
 - Single load gradient (ramp rate) applied to all hours
 - Load gradient defined separately in up and down direction
 - Change between hours cannot exceed the load gradient



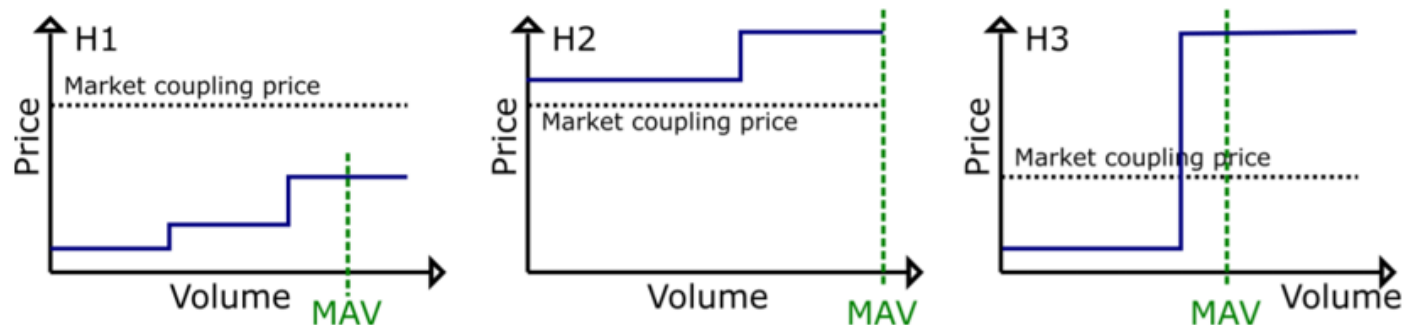
Scalable Complex Order – Minimum Income Condition (MIC)

- Minimum Income Condition defines the minimum revenue required for the order
- Single MIC variable can be defined:
 - Fixed term (FT) MIC
- FT provides a fixed bundle of cost to recover
- Order can only be accepted if total MIC (FT) is met

Scalable Complex Order – Minimum Acceptance Volume (MAV)

MAV effect on SCO acceptance

- Minimum acceptance volumes per hour (MAV) for Scalable Complex Order (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.



Scalable Complex Order – Scheduled Stop Condition

- Used where a unit was on in the previous day
- Defines a number of periods where the MIC may be ignored as a backup
- Follows a series of steps to activate and use:
 - Order is rejected due to the MIC not being met
 - Scheduled stop condition is used
 - For a set number of trading periods (1 – 3)
 - First PQ pair is treated as a simple order ignoring the MIC

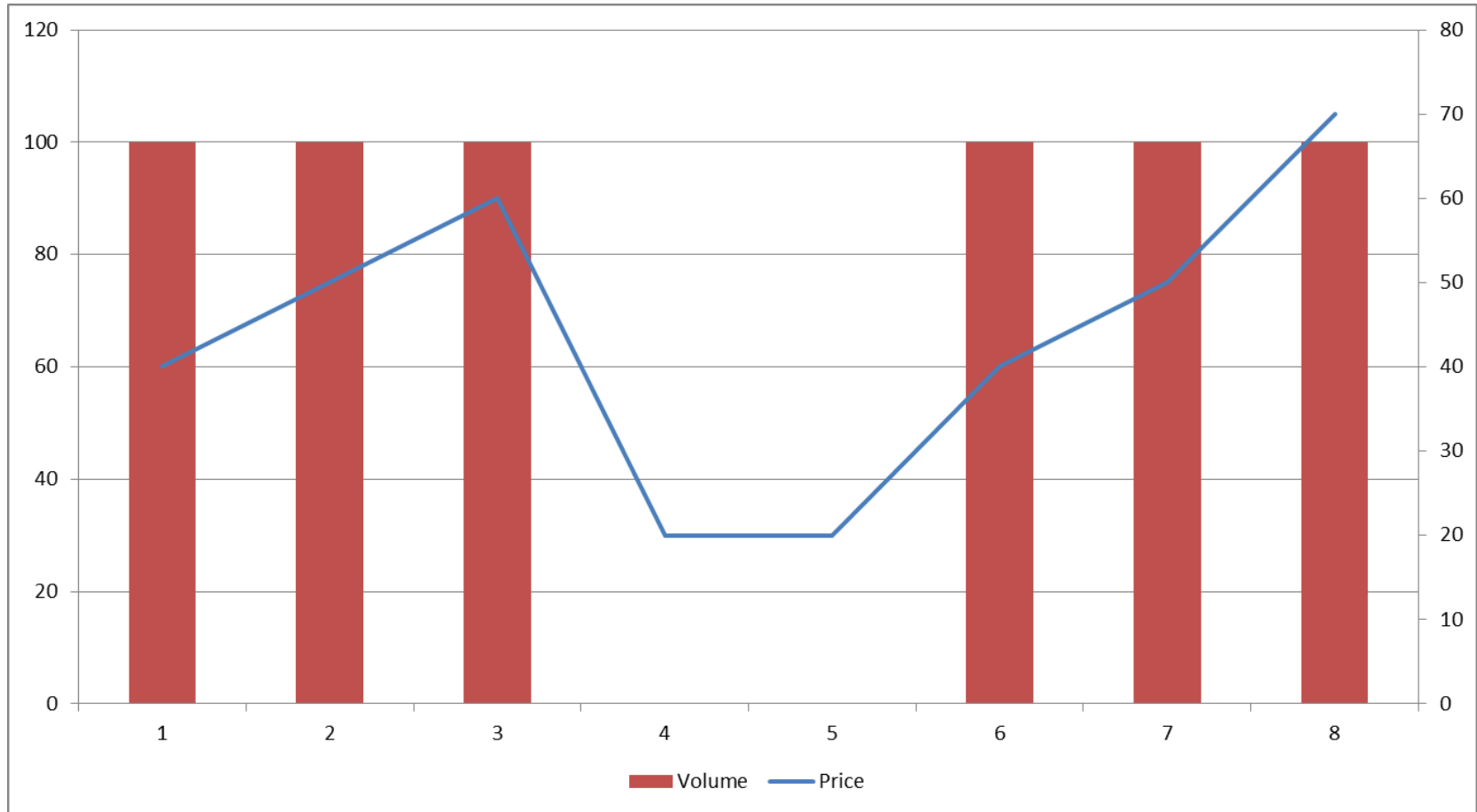
Scalable Complex Order - Example

- Generator X is a mid-merit unit:
 - Start-up cost of 100,000 and no-load cost of 1,000
 - Ramp up and down rate of 600
 - Capacity of 300 MW
 - Fuel cost of €30/MWh
- Scalable Complex Order is entered as follows:
 - Load gradient not used (not a binding constraint)
 - Fixed MIC of 124,000 ($100,000 + 1000 \times 24$)
- If scheduled to max output in all 24 hours total MIC is:
 - $124,000 \text{ (fixed MIC)} + 24 \times 300 \text{ (hours} \times \text{output)} = €131,200$

Scalable Complex Order – Volume Risk

- Auction schedules are firm:
 - Must be submitted to SEMO for imbalance settlement
 - Must be factored into a generators PN
- Risk that volumes are not feasible:
 - Not technically feasible
 - Incur unexpected start or shutdowns
- Unexpected starts/shutdowns may not be included in fixed costs:
 - Leads to a risk that costs are not recovered by the order

Volume Risk – Default PQ Pairs

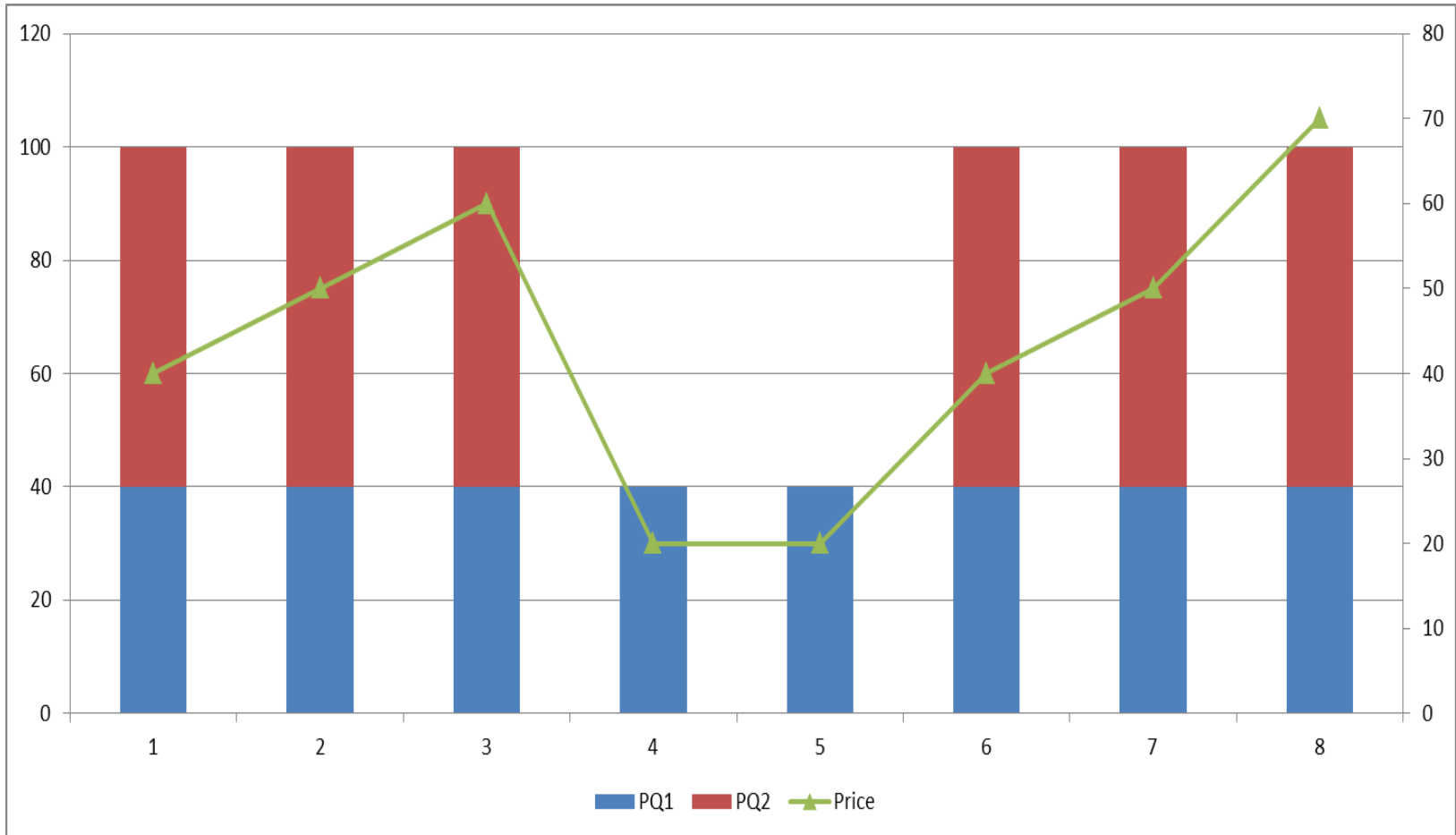


- Example PQ (€30,100MW)
- As price drops unit shuts off - Participant exposed

Scalable Complex Order – Adjusted PQ Pairs

- Possible strategy to mitigate this risk involves PQ pairs:
 - Adjust PQ pairs to avoid a shutdown where price is low
 - Take account of the actual cost of not running
- Enter new PQ pair at a low volume and low price:
 - E.g. minimum stable generation
 - E.g. €0
 - When price drops, volume will be for this low volume and not 0 MW
- Avoids a unit being shut down for a one time dip to price:
 - MIC values would still ensure a level of minimum revenue
 - Lost revenue at low volume made up by profit in other hours

Volume Risk – Adjusted PQ Pairs



- PQ1 is now below lower than price in period 4 and 5
- Participant avoids additional start cost

Topic 7: Course Summary



Review of Learning Objectives

After reviewing this training material you should understand:

The clearing process for SEMOpx trades



How each order clears in the auctions



Overall process from bidding to nomination



Part 2: SEMOpx Intraday Continuous



SEMOpX Intraday Continuous

Training Topic

Learning Outcomes

Topic 1: Introduction to SEMOpX clearing of trades

Topic 2: Recap of M7 overview

Topic 3: Clearing of Trades

Topic 4: Trade Recalls

Topic 5: Overview of order types for intraday continuous

Topic 6: Course Summary

Learning Outcomes

- This document will provide an understanding of:
 - The process for trading in SEMOpx continuous market
 - How each order clears in the continuous market
 - Overall process from bidding to nomination

A night-time aerial view of a city, likely San Francisco, with a lightning storm in the sky. The city lights are visible in the foreground and middle ground, while the sky is dark with several bright lightning bolts. The title text is overlaid on the upper half of the image.

Topic 1: Introduction to SEMOpx Clearing of Trades

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Trading Steps – Basic Steps

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 - Different process for auction and continuous trading
- SEMOpx determines the set of cleared orders
- SEMOpx sends cleared orders to ECC for settlement:
 - On sending to ECC, the cleared trades become contracts

Flow of a trade - Diagram

Order (Participant)

Bid to buy or offer to sell

Submitted by the participant SEMOpx



Trade (SEMOpX)

Order which has been accepted by SEMOpX (i.e. will form a contract)

Has not yet been notified to ECC, not a binding contract



Contract (ECC)

Trade which has been notified to ECC

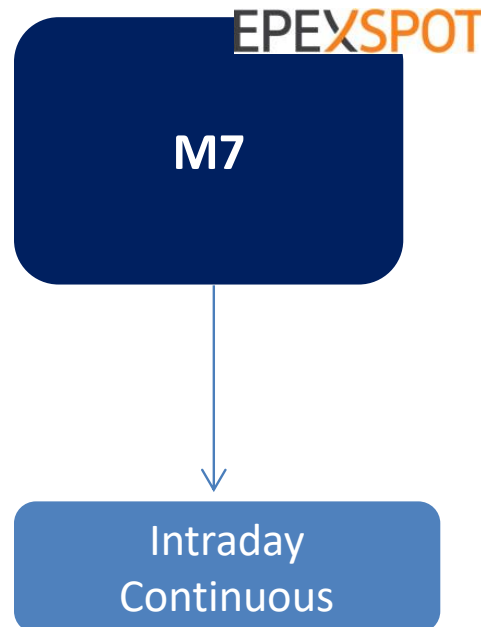
Forms a binding contract for payment and delivery

Topic 2: Recap of M7 Orders Overview



M7 Orders

- M7 is the trading system used by SEMOpx for the continuous market
- All continuous market orders are submitted through M7



Topic 3: Clearing of trades



SEMOpX Intraday Continuous Trading

- The SEMOpX Intraday Continuous Market trading day is divided into 48 (30 minute) trading periods, compared with 1-hour periods in the Day Ahead Market. D-1 and D are the day D and the day before D. Both days start at 23:00. The market opens after the Day Ahead Auction Closure, D-1, runs continuously and closes 60 minutes ahead of every 30 minute trading period. The trading day starts at 23:00 D-1 and lasts until 23:00 D.
- The SEMOpX Intraday Continuous Market allows market Participants to adjust their physical positions closer to real time. The need to do so can arise for a number of reasons, including orders failing to clear in the Day Ahead Market, new information becoming available (for example plant failures and forecast changes), and congestion on interconnectors driving price differentials between zones, and assetless traders wishing to exit their positions. This market offers a huge amount of flexibility as Participants can trade themselves out of their contracted positions 24/7.
- Trading in the SEMOpX continuous market is local only (i.e. trades in the SEM only with no cross border trades).

Continuous Clearing of Trades

- Within-zone bids and offers for each 30-minute trading period (t to $t+0.5$) are matched continuously and paid-as-bid.
- Orders are stored in order books, which are visible to all traders. Orders are matched on a first-come-first-served basis (no social welfare optimisation is performed) using the time stamp of the order when entered into the order book.
- For example, if the order book contains two offers:
Order 1 – 16:00:00 Sell 10 MWh @ €50
Order 2 – 16:00:01 Sell 30 MWh @ €40
And a bid is received:
Order 3 – 16:01:00 Buy 20 MWh @ €80
Order 3 is executed in the following order:
 1. 10 MWh @ €50 from order 1
 2. 10 MWh @ €40 from order 2 (if not restricted from partial execution)
- As indicated in this example, offer and bid quantities may be partially executed and, depending on the restrictions attached to the order, any residual quantity is either retained in the order book for further matching or cancelled. Any bids and offers, whole or partial, that cannot be matched when the submission gate closes at $t-1$ are cancelled

Continuous Clearing of Trades

To be immediately executable in the Price-time matcher, an order must be:

- An order, where opposite side already exists in the Order book;
- An order to buy at a price at or above the lowest offer in the Order book;
- An order to sell at a price at or below the highest bid in the book

If however that fails and the order is not matched immediately upon instruction, it is entered into an order book then following matching rules will apply:

- order with the best price will be selected for execution.
- If there is more than one order with the best available price then the order with the older time stamp will be executed first.

In the example above, order 2 is the best price order on sell side and stays in the order book on the top (before order 1) as best ask order. Order 3 which has been entered as aggressor order later on will match against the best sell order 2 and thus:

- Trade will be between order 2 and order 3 (20 MWh @ €40) and the price of order 2 will be taken into account.
- Order 2 with 10 MWh @40 will remain completely in the order book.

In case order 3 would have 35 MWh @ €80 then the execution plan would be the following:

- 1. Execution of 30 MWh @ €40 from order 2
- 2. Execution of 5 MWh @ €50 from order 1
- 3. In that case 5 MWh @ €50 from order 1 remain in the order book.

Topic 4: Trade Recall



Trade Recall Process

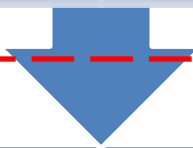
- Process to cancel trades before they become binding
- Used to cover cases of manifest error:
 - Error in submission of order
- Participant initiates recall via M7:
 - Click on recall button within 5 minutes of matching trade
 - Strict timeline – must be before trade is notified to ECC
- Details of the costs involved for a trade recall can be found within the fee section of our website.

Flow of a trade - Diagram

Order (Participant)

Bid to buy or offer to sell

Submitted by the participant SEMOpx



Trade (SEMOpx)

Order which has been accepted by SEMOpx (i.e. will form a contract)

Has not yet been notified to ECC, not a binding contract

- Process must take place after acceptance but before contract formation
- Only applies on an exceptional basis

Topic 5: Overview of order types for intraday continuous



Intraday Continuous Trading

- Allows for trading continuously:
 - Participants enter orders to buy or sell energy
 - SEMOpx displays the order book of active orders anonymously
 - Participants can match their order with ones they see in the order book on a continuous basis
 - Once an order is matched to another, a trade is created
- Trading is open up to one hour ahead:
 - Trading can take place at any time up to the close of trading
 - Trading available overnight
- Runs in parallel to the auctions:
 - Continuous trading is not suspended when auctions are occurring

Continuous Market Orders

Simple Orders

- PQ pairs with execution conditions attached
- Orders aggregated into hourly curve

Block Orders

- Block of energy covering multiple trading periods
- Only pre-defined blocks allowed

Continuous Market Orders – Simple Orders

Simple orders:

- Price quantity pair(s)
- Allow partial acceptance of the order by default

Immediate or cancel:

- Order should be accepted immediately or cancelled
- Allows for partial acceptance of the order



Continuous Market Orders

All or none:

Order must be matched for full amount, no time limit

Fill-or-kill:

- Order should be fully accepted or fully rejected immediately
- Does not allow for partial acceptance
- Combination of All-or-None and Immediate-or-Cancel

Continuous Market Orders – Simple Orders

Good for session:

- Order is valid until trading is closed for the product
- I.e. order is valid until 1 hour before delivery

Good till Date:

- Order is valid until a particular time
- Time is set by the user when entering the order
- Most common to be good until a given timestamp
- E.g. order is available until IDA1 order book closure



Continuous Market Orders

Iceberg order:

- A larger order is displayed as a series of smaller orders
- When one part of the order is accepted, the next becomes available
- Allows users to hide the full extent of their buy/sell

Iceberg Order - Example

- Generator X has 200 MWh to sell in hour 4
- Generator X feels that they can sell for the following prices:
 - 200 MWh @ €40; or
 - 50 MWh @ €50
 - Based on idea that if energy is more scarce, price will be higher
- Generator X uses an iceberg order to split generation:
 - Split 200 MWh into four parts of 50 MWh
 - Able to sell each 50 MWh piece at a higher price
 - As each 50 MWh piece sells the next one becomes available
 - No need to manually post each 50 MWh piece of the order

Iceberg Order - Example

Original

200 MWh @ €40

Iceberg

50 MWh
@ €50

50 MWh
@ €50

50 MWh
@ €50

50 MWh @
€50

Visible

Not Visible

- The original order if accepted at the bid price will net €8,000
- By splitting the order, the bid price can be increased to €50
- The iceberg order, if accepted at the bid price, will net €10,000

Continuous Market Orders – Block Orders

- Block order:
 - Block of energy with a single price
 - Price reflects per unit cost of the block
 - Block may span multiple trading periods
 - Entire block will be considered as one (unit price x volume)
- Pre-defined block:
 - Block for pre-defined time periods set by SEMOpX
 - Allows for ease of access to commonly traded periods
- **Only pre-defined blocks will be allowed for go-live**
- Note block orders matched separately to simple orders:
 - Block cannot be matched to multiple simple orders

Pre-defined block orders

- Pre-defined blocks covering multiple trading period:
 - Range of blocks available
 - Attempt to cover most popular times (e.g. peak, baseload etc.)
 - List aligns with the pre-defined blocks of the auctions
 - List can be updated over time based on participant feedback
- Can be of use for generators:
 - Ensures a number of consecutive periods are offered
 - Can sell consecutive hours if not committed and need a long schedule
 - Can buy a number of hours to cover an outage
 - Allows more extensive volumes than small adjustments

Block order - example

- Generator X trips after the IDA1:
 - Needs to buy back 8 hours of production
 - First half of day will be unavailable in IDA2
- May not clear all simple orders:
 - Reliant on each buy going through individually
 - Reliant on finding 16 different sellers
- Block allows whole outage to be bought at once
 - May allow for other sellers (e.g. non-committed unit)
 - Note that pre-defined blocks may not cover time of outage perfectly

Topic 6: Course Summary



Review of Learning Objectives

After reviewing this training material you should understand:

The clearing process for SEMOpx trades



How each order clears in the auctions



Overall process from bidding to nomination

