Interconnector Trading in the SEM – Overview of Code Provisions and AP2

A presentation to the Interconnector Forum

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Agenda

1. Overview

2. Interactions

3. Quantities

4. Capacity Payment

5. SO Trades

6. Worked Example of SO Trades

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1. **Overview**

2. Interactions

3. Quantities

4. Capacity Payment

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6. Worked Example of SO Trades

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Overview – Terminology

- Interconnector
  - The physical entity which transmits power between SEM and another market (i.e. two jurisdictions)

- Interconnector User
  - The commercial entity which bids for capacity on a particular Interconnector

- Interconnector Unit
  - A Participant wishing to bid as an Interconnector Unit in SEM will register as an Interconnector User
  - Active Capacity Holdings will be generated by Interconnector Unit

Overview – Unit Types

Type	What is it for?	Registered to	Settlement class	Role
I/C Unit	Trading by Interconnector Users	I/C User	Predictable Price Maker Generator Unit	Allow I/C Users to trade between SEM and BETTA
I/C Residual Capacity Unit	Within-day trading (by the SO)	Relevant SO	Predictable Generator Unit (neither Price Taker or Price Maker)	Allow SO to utilise/trade spare I/C capacity
I/C Error Unit	Unexpected errors	I/C Administrator (for now)	Autonomous Generator Unit (Price Taker)	Allocate imbalance for settlement

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Overview – Rules

- **Interconnector Units are settled as 'Predictable Price Makers'…**
  - MSQ and SMP not known until after delivery

- **… with special rules for Offer Data**
  - includes Price and Quantity Pairs but no Start Up or No Load components
  - separate P/Q pairs for each Trading Period
  - no Technical Offer Data for individual Interconnector Units

- **SONI (as SO, as IA after first 12 months) declares ATC by 09.30 D-2**
  - definition precludes reducing ATC for local transmission constraints
  - transmission constraints (but not I/C trips) after that time are compensated

- **Dispatch Quantities are fixed D-1, shortly after Gate Closure**
  - two hour window of volume uncertainty in BETTA market
  - favourable compared with conventional generation

- **Capacity Payments are based on flows not on availability**

- **SO may trade using surplus capacity within-day (s.t. agreement)**
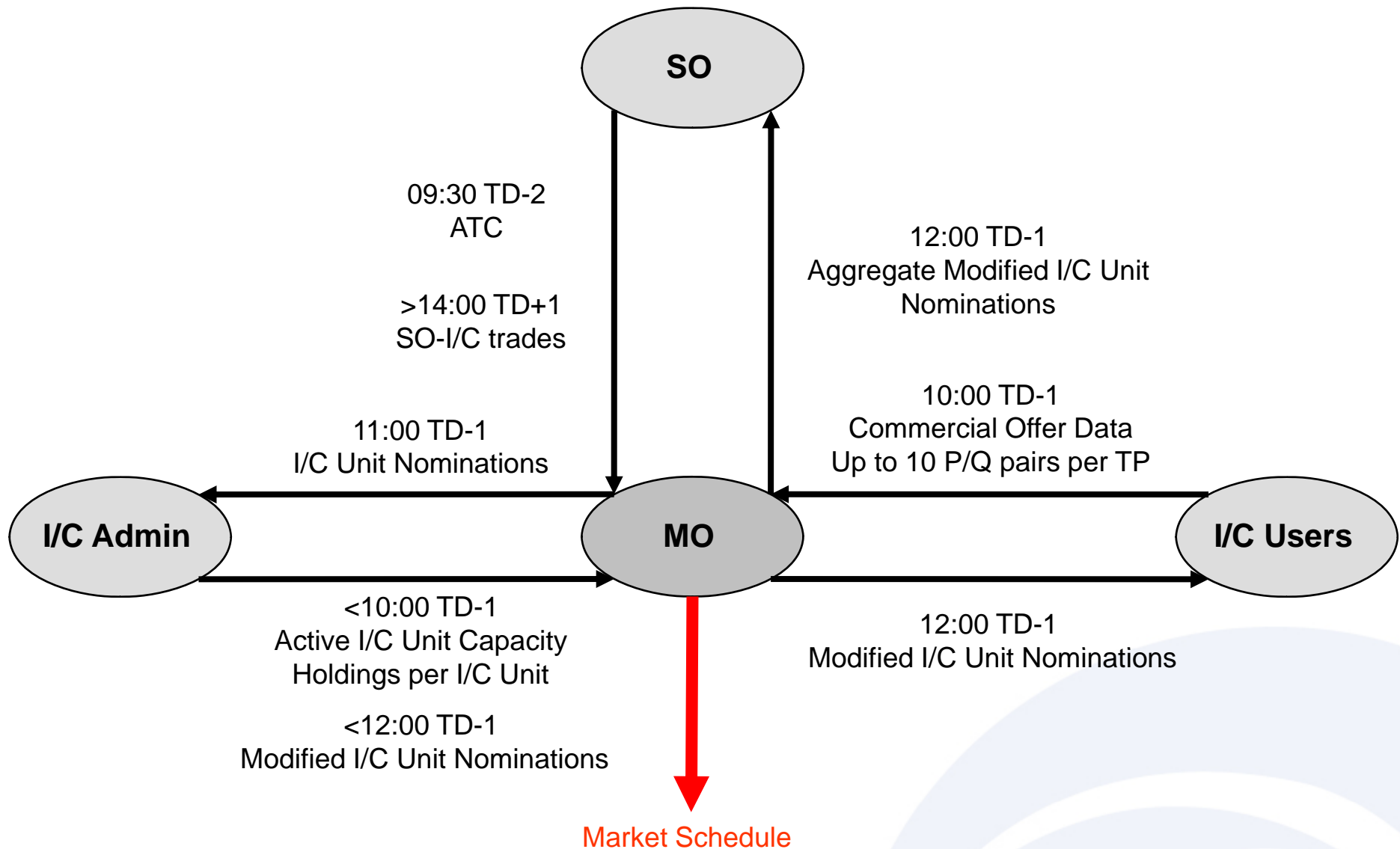
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Overview – Modelling of Interconnectors

- Interconnectors are different ...

1. *Interactions between two separate markets*
2. *Interconnector Units are virtual, not physical*
3. *Capacity Bidding by Interconnector Users*
4. *Bidding for each Trading Period for each Trading Day*
5. *Schedule affected by bought capacity*
6. *Ex-Post Schedule affected by Ex-Ante Schedule*
7. *Interconnector Units have no Technical Offer Data*
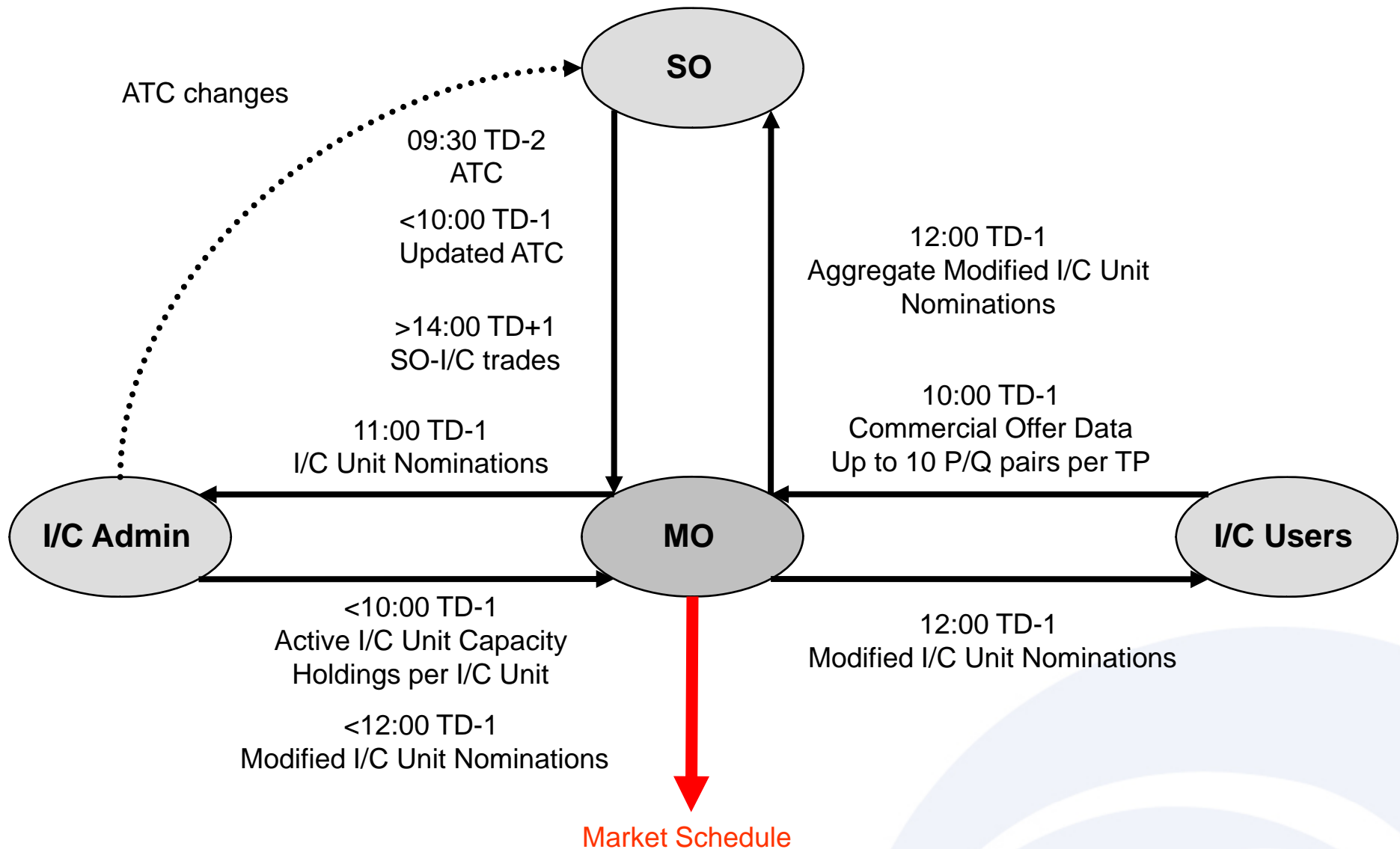8. *Interconnector Units are affected by aggregate interconnector restrictions*

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Interaction & Data Transactions (interim)

SO

09:30 TD-2
ATC

>14:00 TD+1
SO-I/C trades

11:00 TD-1
I/C Unit Nominations

12:00 TD-1
Aggregate Modified I/C Unit
Nominations

10:00 TD-1
Commercial Offer Data
Up to 10 P/Q pairs per TP

I/C Admin

MO

I/C Users

<10:00 TD-1
Active I/C Unit Capacity
Holdings per I/C Unit

<12:00 TD-1
Modified I/C Unit Nominations

12:00 TD-1
Modified I/C Unit Nominations

Market Schedule

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Change to ATC before Gate Closure (spot the difference)

ATC changes

SO

09:30 TD-2
ATC

<10:00 TD-1
Updated ATC

>14:00 TD+1
SO-I/C trades

11:00 TD-1
I/C Unit Nominations

12:00 TD-1
Aggregate Modified I/C Unit
Nominations

10:00 TD-1
Commercial Offer Data
Up to 10 P/Q pairs per TP

I/C Admin

MO

I/C Users

<10:00 TD-1
Active I/C Unit Capacity
Holdings per I/C Unit

<12:00 TD-1
Modified I/C Unit Nominations

12:00 TD-1
Modified I/C Unit Nominations

Market Schedule

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Change to ATC after Gate Closure (after calculation of MIUNs)

ATC changes

SO

09:30 TD-2
ATC

12:00 TD-1
Aggregate Modified I/C Unit
Nominations

>14:00 TD+1
SO-I/C trades

10:00 TD-1
Commercial Offer Data
Up to 10 P/Q pairs per TP

11:00 TD-1
I/C Unit Nominations

I/C Admin

MO

I/C Users

<10:00 TD-1
Active I/C Unit Capacity
Holdings per I/C Unit

12:00 TD-1
Modified I/C Unit Nominations

<12:00 TD-1
Modified I/C Unit Nominations

Revised Modified I/C Unit
Nominations

Market Schedule

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# Bids submitted by Interconnector Units

- Offers can be submitted on any of the 29 days leading up to TD-1 at 10:00

- Submissions are in the form of Price Quantity Pairs
- 10 Price Quantity Pairs per Trading Period per Trading Day

Pi, Qi	Price	Quantity
1	15 Euro	10MW
2	20 Euro	20MW
3	25 Euro	30MW

Unit has 3 PQ pairs:
- *P1 applies from Maximum Export to Q1*
- *P2 applies from Q1 to Q2 (excluding Q1)*
- *P3 applies from Q2 to Q3 (excluding Q2)*
- *P3 also applies up to Maximum Import*

Interconnector Unit Bid Format – Ex Ante

Price (£ or €/MWh)

Max Export

Max Import

0
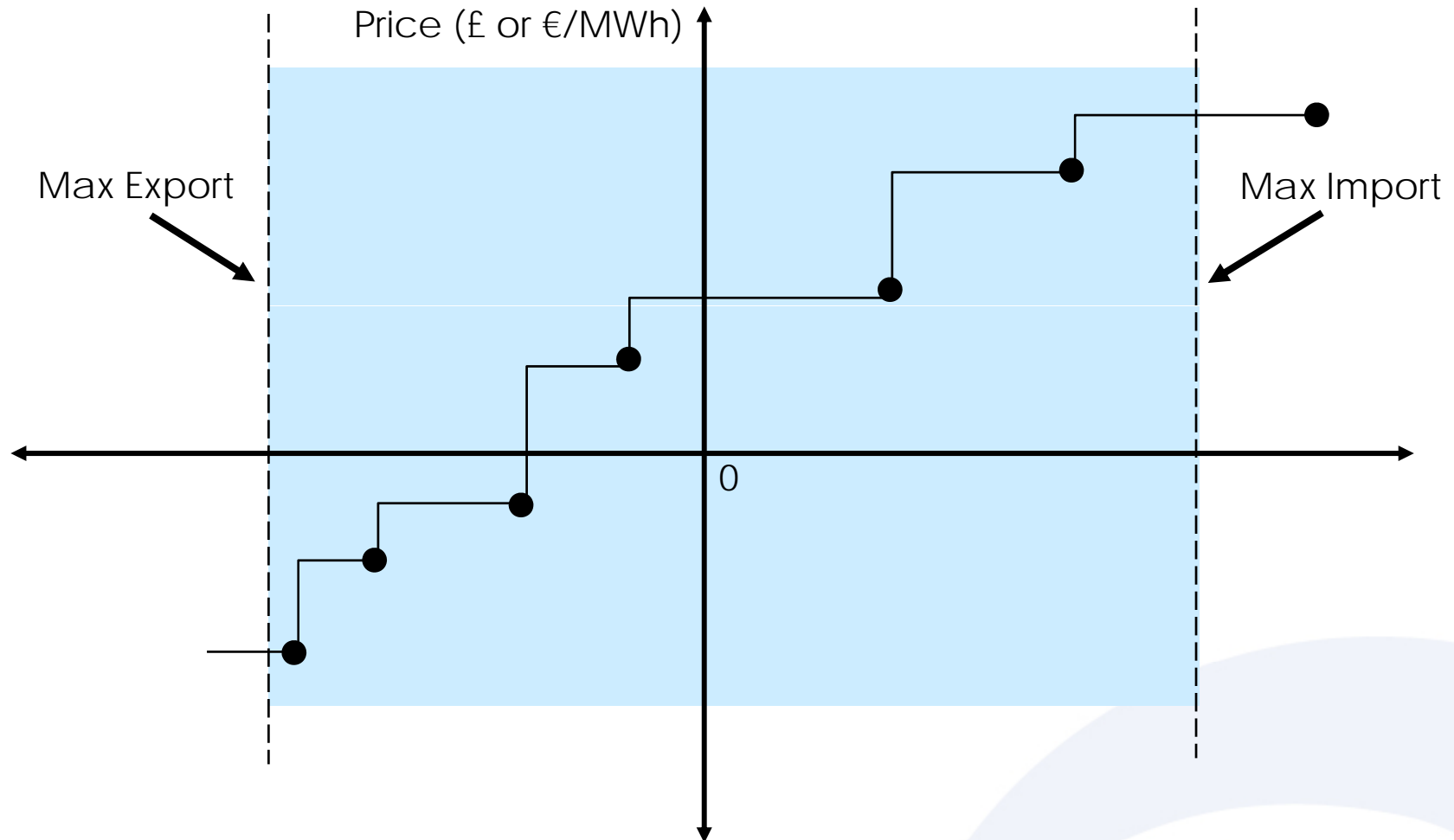
● These are the price, quantity points specified in the participant's bid

Interconnector Unit Bid Format – Ex Post Limits
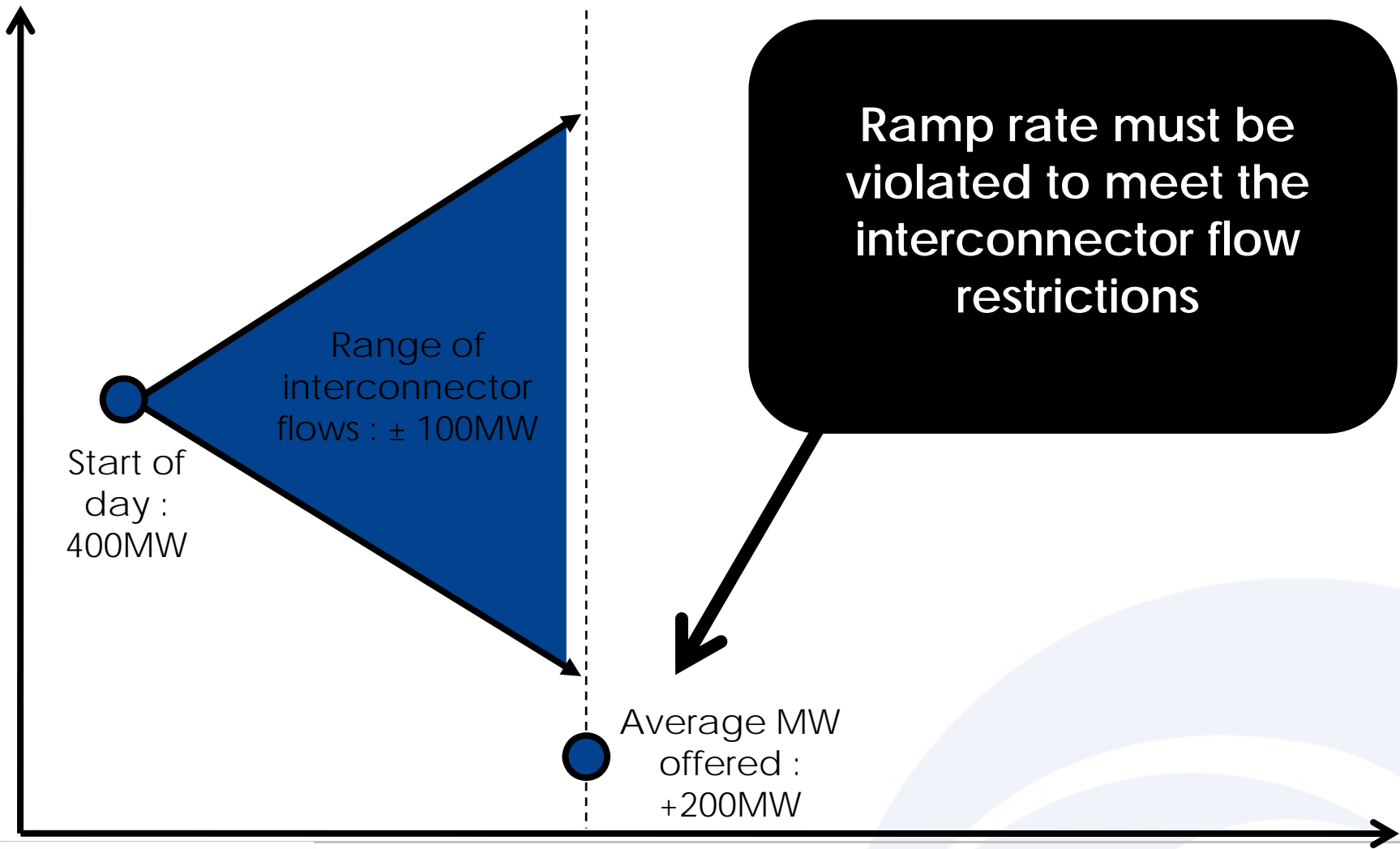
SCENARIO 1:

If latest MIUN >=0 then …

SCENARIO 2:

If latest MIUN < 0 then …

MIUN

Range in which the IU can be scheduled by the MSP Software in Ex Post Runs

0

Range in which the IU can be scheduled by the MSP Software in Ex Post Runs

MIUN

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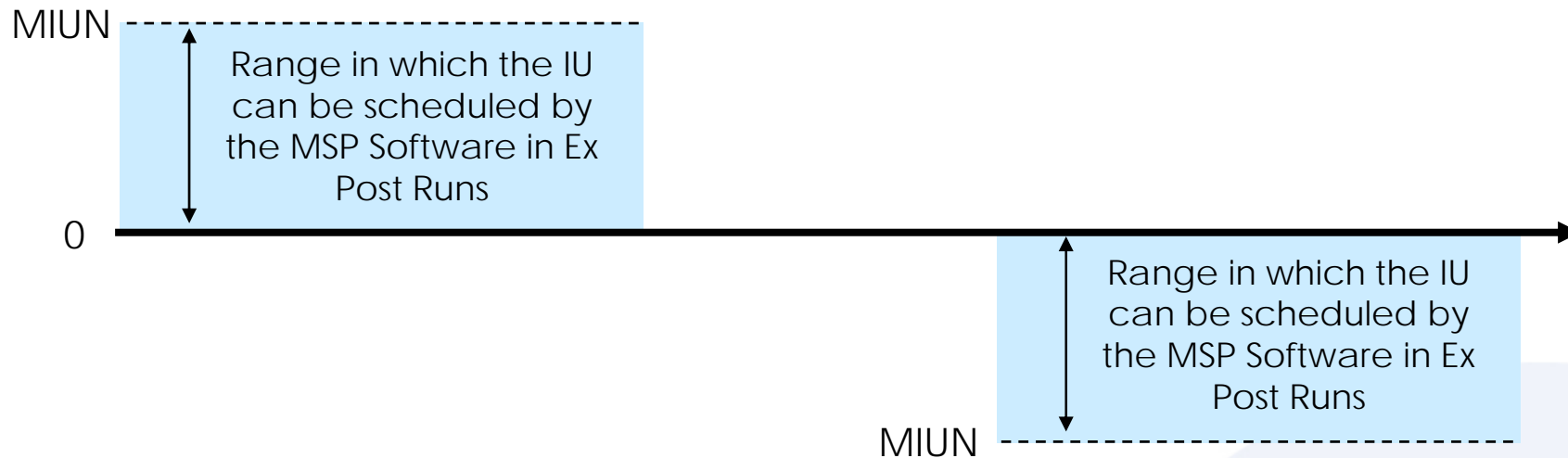
Aggregate Interconnector Scheduling

- Basic of Interconnector flows
  - Imports to SEM are positive, exports are negative
  - The flow on an interconnector can be positive or negative by Trading Period
  - Changes in interconnector flows between periods are constrained by the Aggregate Interconnector Ramp Rate
  - There can be positive and negative flows for different Interconnector Units in the same Trading Period (superpositioning)

- Ramp Rates
  - A single ramp rate, used for ramping up and down (set by Interconnector Administrator) applies to the aggregate rate of change for Interconnector Units
  - Interconnector Units are assumed to have infinite (99999.9) ramp rates

- Ramp slack variables exist to resolve any inconsistency between initial flows, ramp limits and the bids

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Aggregate Interconnector Scheduling

Range of interconnector flows : ± 100MW

Start of day : 400MW

Ramp rate must be violated to meet the interconnector flow restrictions

Average MW offered : +200MW

Interconnector Example

- Two Interconnector Users on a single Interconnector
  - Each will bid on the Interconnector by Gate Closure (10:00 on the day prior to the Trading Day)

- Interconnector - registered capacity of 400MW in each direction
  - ATC can change by Trading Period
  - Aggregate Interconnector Ramp Rate of 1MW/minute (30MW per Trading Period)

- The following is a simple example of how the interconnector processes will work

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Interconnector Unit Bids by GC 10:00 TD-1

- ATC is calculated to be 65MW in Trading Period 1 and 125MW in Trading Period 2

Pi, Qi	Price	Quantity
1	15 Euro	10MW
2	20 Euro	20MW

Interconnector Unit 1:
- Trading Period 1 - Maximum Import Capacity 15MW
- Trading Period 2 - Maximum Import Capacity 20MW

Pi, Qi	Price	Quantity
1	5 Euro	30MW
2	10 Euro	50MW
3	35 Euro	100MW

Interconnector Unit 2:
- Trading Period 1 - Maximum Import Capacity 40MW
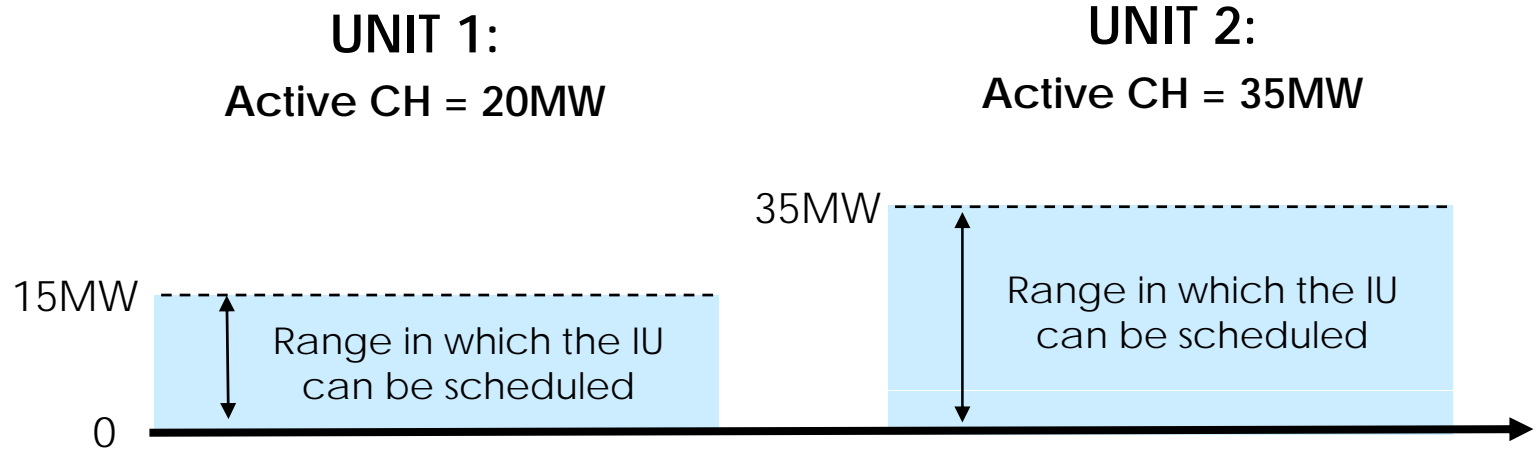- Trading Period 2 - Maximum Import Capacity 100MW

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Ex Ante Scheduling Limits, at GC 10:00 TD-1 (ignoring export)

TRADING PERIOD 1

UNIT 1:
Active CH = 20MW

15MW

Range in which the IU can be scheduled

0

UNIT 2:
Active CH = 35MW

35MW

Range in which the IU can be scheduled

TRADING PERIOD 2

UNIT 1:
Active CH = 45MW

20MW

Range in which the IU can be scheduled

0

UNIT 2:
Active CH = 90MW

90MW

Range in which the IU can be scheduled
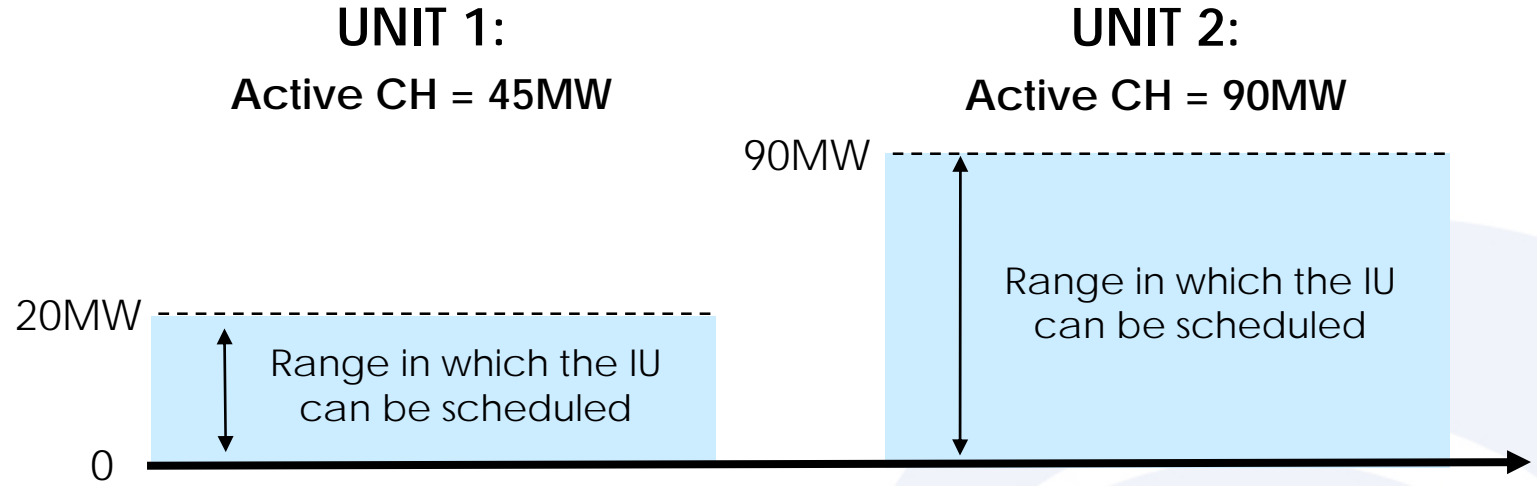
Ex Ante MSP Run, by 11:00 on TD-1

- MSP Software will schedule all Generating Units (including Interconnector Units) to meet Schedule Demand
  - Interconnector Units can be scheduled to import (positive values) or export (negative values)

- Interconnector Unit 1 – Interconnector Unit Nominations:
  - Trading Period 1 – 15MW
  - Trading Period 2 – 30MW

- Interconnector Unit 2 – Interconnector Unit Nominations:
  - Trading Period 1 – 20MW
  - Trading Period 2 – 60MW

MIUNs, by 12:00 on TD-1

- Interconnector Unit Nominations (IUNs) are amended to take account of:
  - Restricted ranges of physical output (e.g. ±15MW)
  - Consequential impacts of amendments on the Aggregate Interconnector Ramp Rate

- Interconnector Unit 1 – Modified Interconnector Unit Nominations:
  - Trading Period 1 – 15MW (no change)
  - Trading Period 2 – 30MW (no change)

- Interconnector Unit 2 – Interconnector Unit Nominations:
  - Trading Period 1 – 20MW (no change)
  - Trading Period 2 – 50MW (-10MW)

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MSP Software and exporting Interconnector Units

- The MSP Software schedules exporting for Interconnector Units only if it reduces the overall production cost by doing so.

- For example:
  – Schedule Demand =100MW, met by Generator Units each at cost < €30/MWh
  – Two additional unscheduled Units offer to the market as follows:

    - Interconnector Unit offers to export 100MW at a price of €35/MWh (Maximum Export Capacity=-100, P=35 and Q=0)
    - Conventional Generator Unit offers to generate 100MW at a price of €32/MWh (P=32 and Q=100)

- MSP Software will schedule both of these units, with MSQs of -100 and 100 respectively.

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Quantities – Determining Interconnector Quantities (interim)

- Available Transfer Capacity (ATC):
  - Provided by SO to MO by 09:30 TD-2
  - Published by MO by TD10:00 D-2
  - Any updates are published by MO TD+1

- Active Interconnector Capacity Holding (export and import):
  - Provided by IA to MO by 10:00 TD-1 (Gate Closure)
  - Made available by MO to I/C Users by 10:30 TD-1

- Maximum Interconnector Unit Import/Export Capacity
  - Submitted by Users as part of Commercial Offer Data at 10:00 TD-1

- Interconnector Unit Nominations
  - Determined by the MO via MSP Software by 11:00 TD-1
  - Respects Aggregate Interconnector Ramp Rate

- Modified Interconnector Unit Nominations
  - Determined by the IA (using MITS, using dead-bands and ramp rates)
  - Provided to I/C Users by the MO by 12:00 TD-1

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Quantities – Dispatched, Scheduled & Metered

- Interconnector units are Predictable Price Makers (represented in MSP)

- Dispatch Quantity (DQuh):
  - **IU = Modified Interconnector Unit Nomination**
  - **IRCU = Net of SO import and SO export quantities (SIIQ + SIEQ)**
  - **IEU = zero**

- Market Schedule Quantity (MSQuh):
  - **IU = as determined by MSP Software**
  - **IRCU = zero (i.e. all SO trades are treated as constraints)**
  - **IEU = zero**

- Metered Generation (MGuh):
  - **IU = Dispatch Quantity x Trading Period Duration (i.e. no uninstructed imbalance)**
  - **IRCU = Dispatch Quantity x Trading Period Duration (i.e. constraint payments)**
  - **IEU = difference total I/C import & sum of Dispatch Quantities (i.e. for UI payments)**

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Capacity Payment – Treatment of I/C

- All types of I/C Unit are treated as Generator Units for the purpose of Capacity Payments and Energy Payments (whether import or export)

- Capacity Payments are based on flow not capacity:

- Eligible Availability (EAuh):
  - **IU = Dispatch Quantity (used to determine Metered Generation)**
  - **IRCU = Dispatch Quantity (used to determine Metered Generation)**
  - **IEU = Metered Generation / Trading Period Duration**

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SO Trades - Treatment

- Settled as Constraint Payments to IRCU:
  - Submission of SIIP, SIEP, SIIQ, SIEQ values by the SO at D+1
  - Quantities will net against constraint quantities at other Units

- If within-day constraints cause flow to be changed, the IRCU picks up the cost (or revenue)

- No impact on MSQ or SMP
  - (since quantities will be balanced by constraints at other Units)

- This is the closest the SEM has to use-it-or-lose-it

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Worked Example – Case A

Case A ▼	SO buys from BETTA at high price (		
	€/MWh	MW	€
	Price	Quantity	Cashflow
Market	100	5000	€250,000
Constrained unit	100	-100	-€5,000
	€/MWh	MW	€
	SIIP	SIIQ	Cost to SO
Imports	150	100	€7,500
	SIEP	SIEQ	
Exports	0	0	€0
	€/MWh	MW	
Net purchases	150	100	€7,500
IGNORES LOSSES			€
Settlement for market			€250,000
Constrained Unit			-€5,000
SO imports			*€ 7,500*
SO exports			*€ 0*
SO costs			€7,500
Total constraint costs			€2,500
All			€252,500
Difference in cost			€2,500

- Impact of constraining down a generator and increasing imports

- Net cost (constraint)

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Worked Example – Case B

Case B ▾	SO buys from BETTA at low price (a		
	€/MWh	MW	€
	Price	Quantity	Cashflow
Market	100	5000	€250,000
Constrained unit	100	-100	-€5,000
	€/MWh	MW	€
	SIIP	SIIQ	Cost to SO
Imports	50	100	€2,500
	SIEP	SIEQ	
Exports	0	0	€0
	€/MWh	MW	
Net purchases	50	100	€2,500
IGNORES LOSSES			€
Settlement for market			€250,000
Constrained Unit			-€5,000
SO imports			€2,500
SO exports			€0
SO costs			€2,500
Total constraint costs			-€2,500
All			€247,500
Difference in cost			-€2,500

- Impact of constraining down a generator and increasing imports

- Net saving (arbitrage)

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Worked Example – Case C

Case C ▼	SO sells to BETTA at low price (cons		
	€/MWh	MW	€
	Price	Quantity	Cashflow
Market	100	5000	€250,000
Constrained unit	100	100	€5,000
	€/MWh	MW	€
	SIIP	SIIQ	Cost to SO
Imports	0	0	€0
	SIEP	SIEQ	
Exports	50	-100	-€2,500
	€/MWh	MW	
Net purchases	50	-100	-€2,500
IGNORES LOSSES			€
Settlement for market			€250,000
Constrained Unit			€5,000
SO imports			*€ 0*
SO exports			*-€ 2,500*
SO costs			-€2,500
Total constraint costs			€2,500
All			€252,500
Difference in cost			€2,500

- Impact of constraining up a generator and decreasing imports

- Net cost (constraint)

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Worked Example – Case D

	SO sells to BETTA at high price (arbi		
Case D ▼	€MWh	MW	€
	Price	Quantity	Cashflow
Market	100	5000	€250,000
Constrained unit	100	100	€5,000
	€MWh	MW	€
	SIIP	SIIQ	Cost to SO
Imports	0	0	€0
	SIEP	SIEQ	
Exports	150	-100	-€7,500
	€MWh	MW	
Net purchases	150	-100	-€7,500
IGNORES LOSSES			€
Settlement for market			€250,000
Constrained Unit			€5,000
SO imports			*€ 0*
SO exports			*-€ 7,500*
SO costs			-€7,500
Total constraint costs			-€2,500
All			€247,500
Difference in cost			-€2,500

- Impact of constraining up a generator and decreasing imports

- Net saving (arbitrage)

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