TERRE

***T**rans **E**uropean **R**eplacement **R**eserves **E**xchange*

TERRE Stakeholder Workshop

16th March 2021

Agenda

TERRE Stakeholder Workshop

#	TOPICS	Timing (CET)
	Introduction	**13:30**
1	**Introduction from TSOs on TERRE project**	13:30
	Part 1	**13:40**
2	**RR process description**	13:40
3	**RR Implementation Framework**	13:55
4	**Questions & Answers**	14:15
	Break	**14:30**
	Part 2	**14:40**
5	**Activation Optimization Function description** 1. TERRE Market Principles 2. Market Products 3. Grid Modelling 4. Key principles of market design 5. IT platform - LIBRA Optimization Module (LOM)	14:40
6	**Activation Optimization Function updates**	15:30
7	**Questions & Answers**	16:10
	End of the meeting	**16:30**

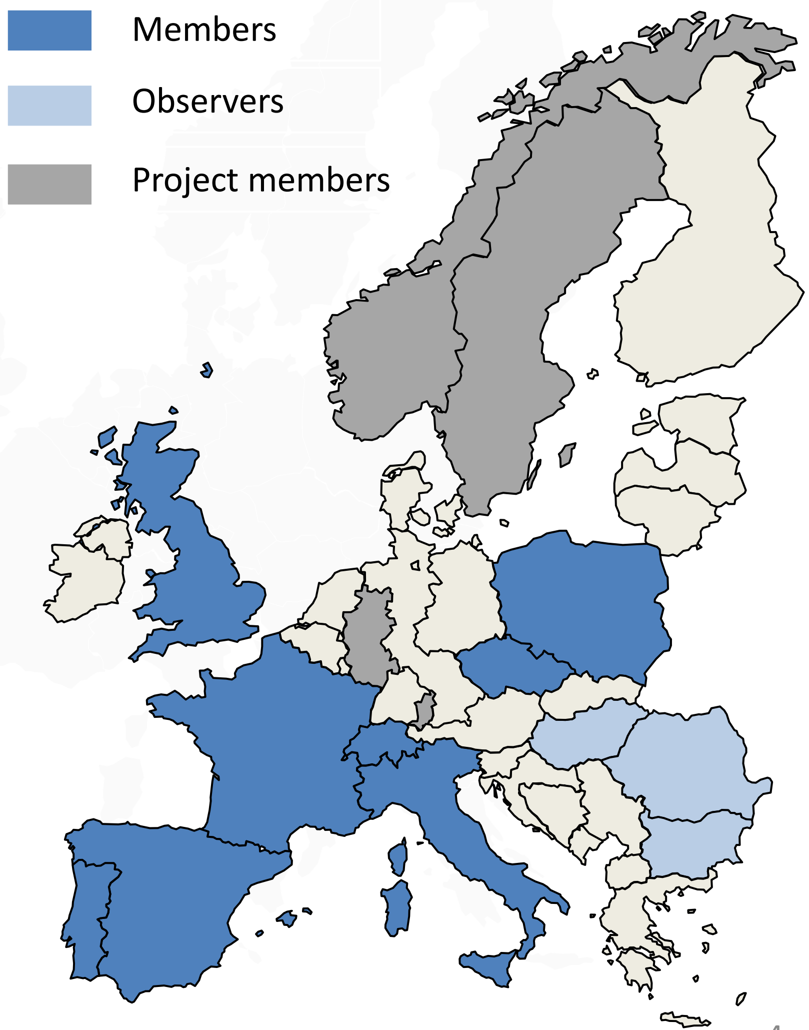
Topic 1: Introduction from TSOs

1. Introduction

TERRE project - Participating TSOs

TERRE Members

- **Region 1**
  - France (RTE)
  - Great Britain (NG ESO)
  - Italy (TERNA)
  - Portugal (REN)
  - Spain (REE)
  - Switzerland (SG)
- **Region 2**
  - Czech Republic (CEPS)
  - Poland (PSE)
- **Observers**
  - Bulgaria (ESO)
  - Hungary (MAVIR)
  - Romania (Transelectrica)



Project Members

- Germany (Amprion)
- Norway (Statnett) & Sweden (Svk)

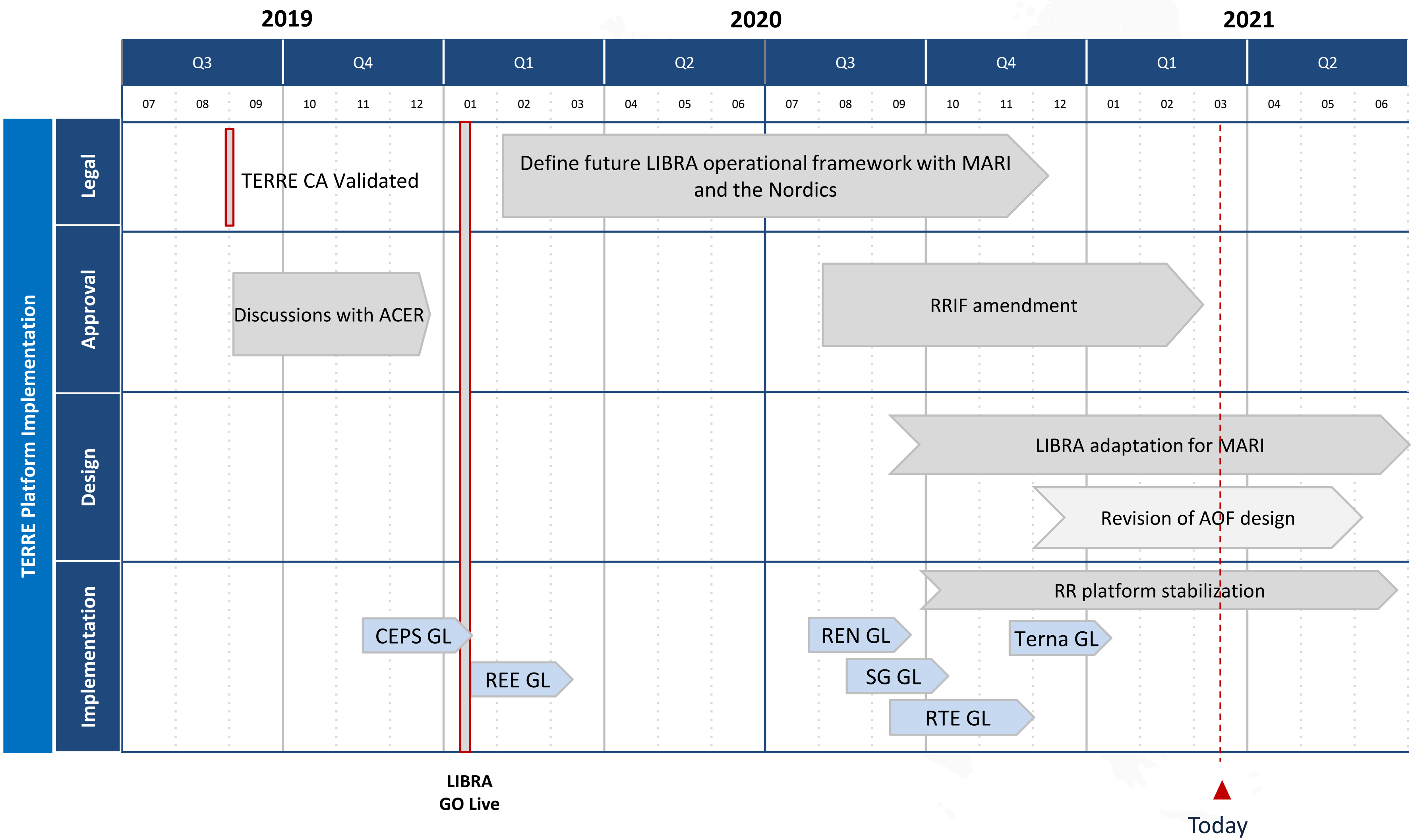
1. Introduction

Accession timeline – past and foreseen

Country	TSO	Date of accession
Czech Republic	ČEPS a.s.	6 January 2020
Spain	REE - Red Eléctrica de España S.A.U	3 March 2020
Portugal	REN – Rede Eléctrica Nacional, S.A	29 September 2020
Switzerland	Swissgrid AG	8 October 2020
France	RTE - Réseau de Transport d'Electricité	2 December 2020
Italy	Terna - Rete Elettrica Nazionale SpA	13 January 2021
Poland	PSE - Polskie Sieci Elektroenergetyczne S.A.	*Q1/Q2 2023*
Great Britain	National Grid Electricity System Operator Ltd	*On hold*

1. Introduction

High level planning



1. Introduction

LIBRA platform overview

Main modules | Services

Lot B1: Artelys (FR)
Optimization/Clearing algorithm

Lot B2: Unicorn (CZ)
IT interface/data management

Lot C: : Unicorn (CZ)
Hosting

Lot D: EPEX SPOT (NL)
IT monitoring service

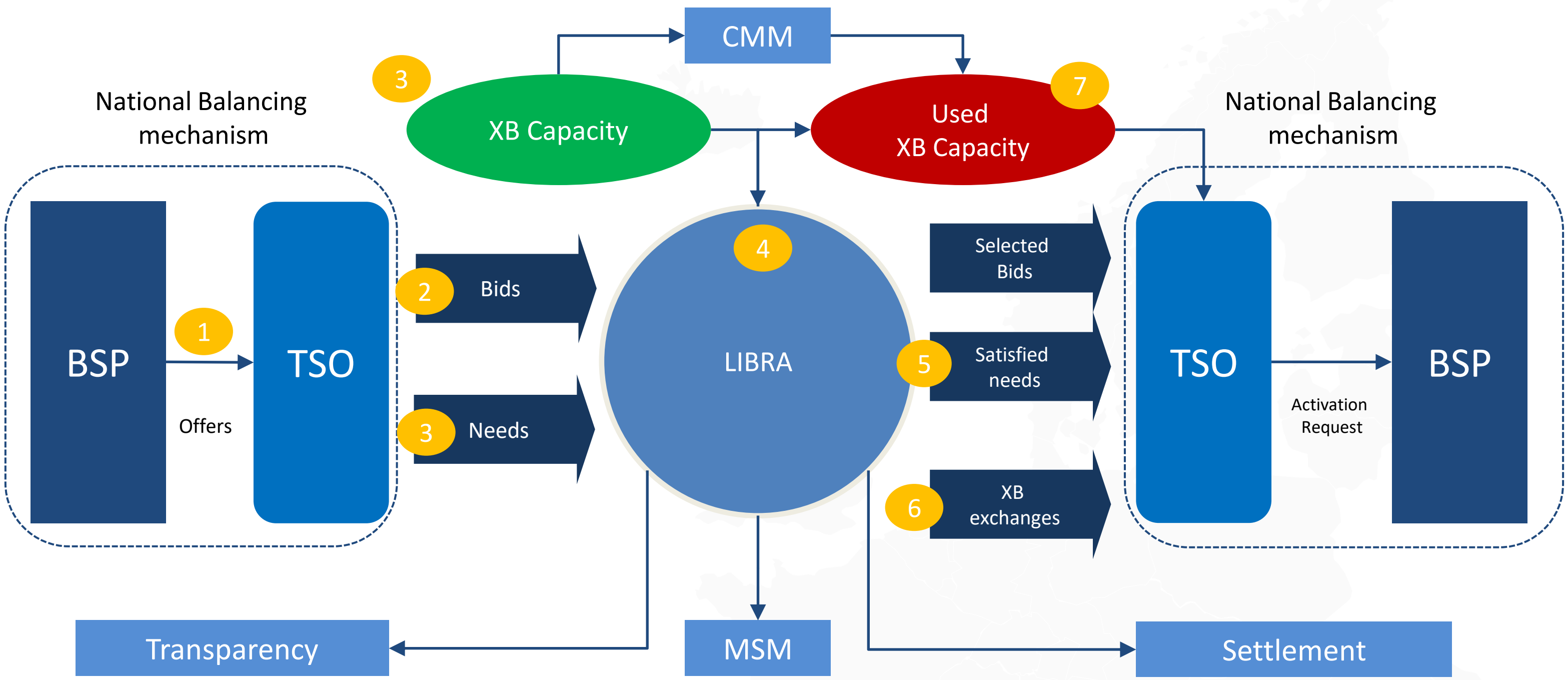
Lot E: JAO (LX)
Financial Settlement

Lot F: Testing

Topic 2: RR Process description

2. RR process description

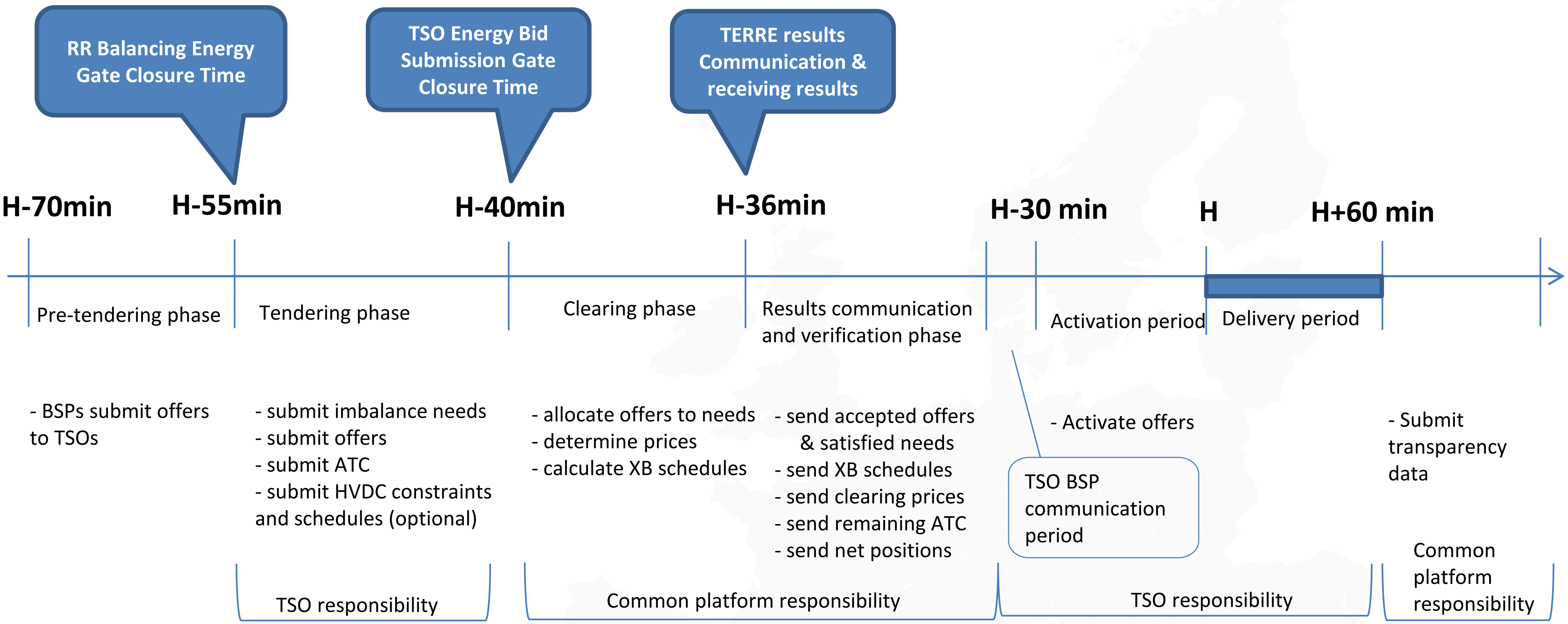
RR process overview



1. TSO receive bids from BSPs from their local balancing area/bidding zone.
2. TSOs put the valid RR bids on the LIBRA platform
3. TSOs send their needs and ATC values to the platform.
4. Platform runs the algorithm with offers and needs.
5. Communication of accepted offers, satisfied needs and marginal prices
6. Calculation of the bilateral exchanges between balancing areas and TSO-TSO settlement.
7. Residual ATC and net positions are communicated to TSOs

2. RR process description

Timeline



RR process consists of the following phases:

- pre-tendering phase
- tendering phase
- clearing phase
- results communication and verification phase
- activation phase
- delivery phase

Topic 3: RR Implementation Framework

3. RR Implementation Framework

Highlights

The RRIF was validated by the NRAs on 14 January 2019 – link

After the approval of the TSO-TSO settlement proposal and the pricing proposal, the TSOs representatives of the TERRE project have carried out an amendment of the RRIF to reflect the following:

Changes submitted to Public Consultation in October 2020

- **Designation entity - Art. 10:** Amendment to enable all TSOs to be regarded as operators of the platform
- **Interconnection Controllability – Art 3(b) & 11(3):** The activation and settlement of bids for satisfying the controllability of interconnection will be compliant with the latest versions of the Pricing Proposal and the TSO-TSO Settlement Proposal validated by ACER, as of their entry into force in mid-2022.
- **Daily clearings – Article 11(5a):** added mention that the reduction of cross-border scheduling steps to less than 60 minute it is still subject for possible derogation
- **Counter activations - Art 13(5):** Postponement of the date set for the minimisation of the counter activations

Additional changes were included based on the feedback received during Public Consultation and by NRAs

Changes proposed by NRAs

- **List of participating TSOs - Article 1:** TSOs no longer explicitly mentioned
- **Rules for governance and operation of the RR Platform and designation of the entity - Art.10 and Annex:** clarifications and content moved to Annex

Changes following feedback received during Public Consultation

- **High level design of the RR platform (DFR) - Art.3(b):** wording made clearer

Artelys SOLUTIONS EN OPTIMISATION

entsoe

TERRE Workshop

TERRE Public Workshop

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10/03/2021

www.artelys.com

Table of content

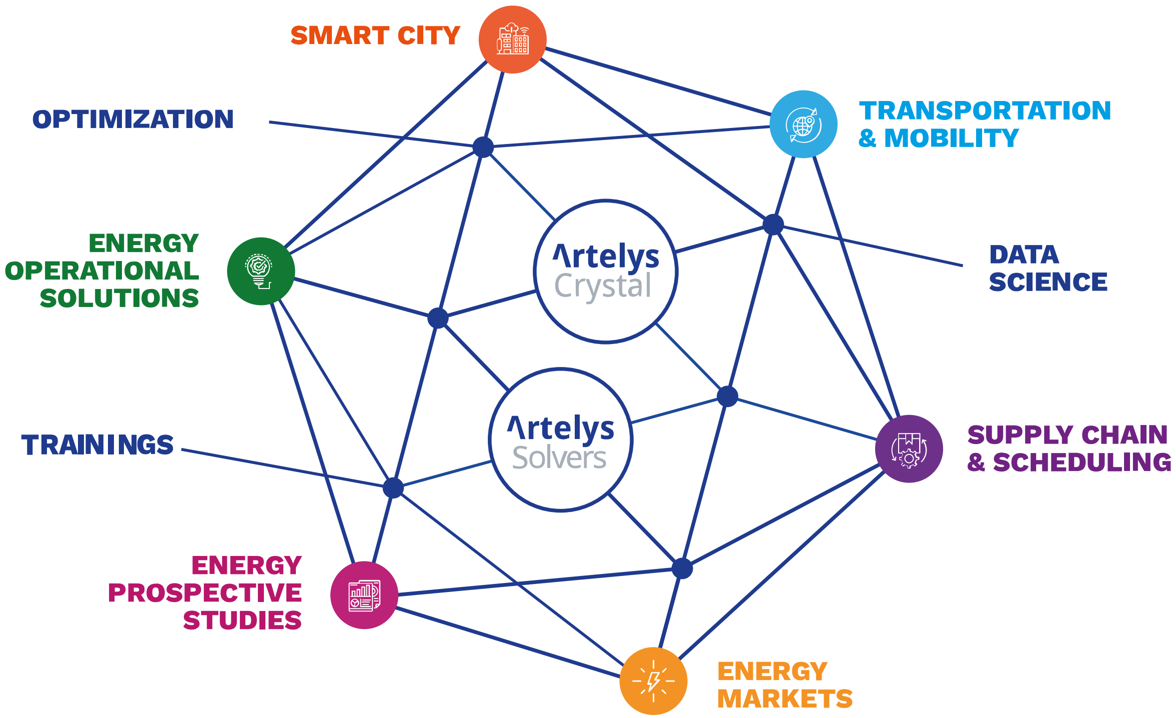
Artelys

Artelys is an **independent** company, founded in 2000, specialized in **decision** engineering, **modelling and optimization**

A mastery of tools and methods of system modelling, numerical optimization and statistical analysis

A unmatched know-how in scientific consulting and project management

A strong business expertise in **energy**

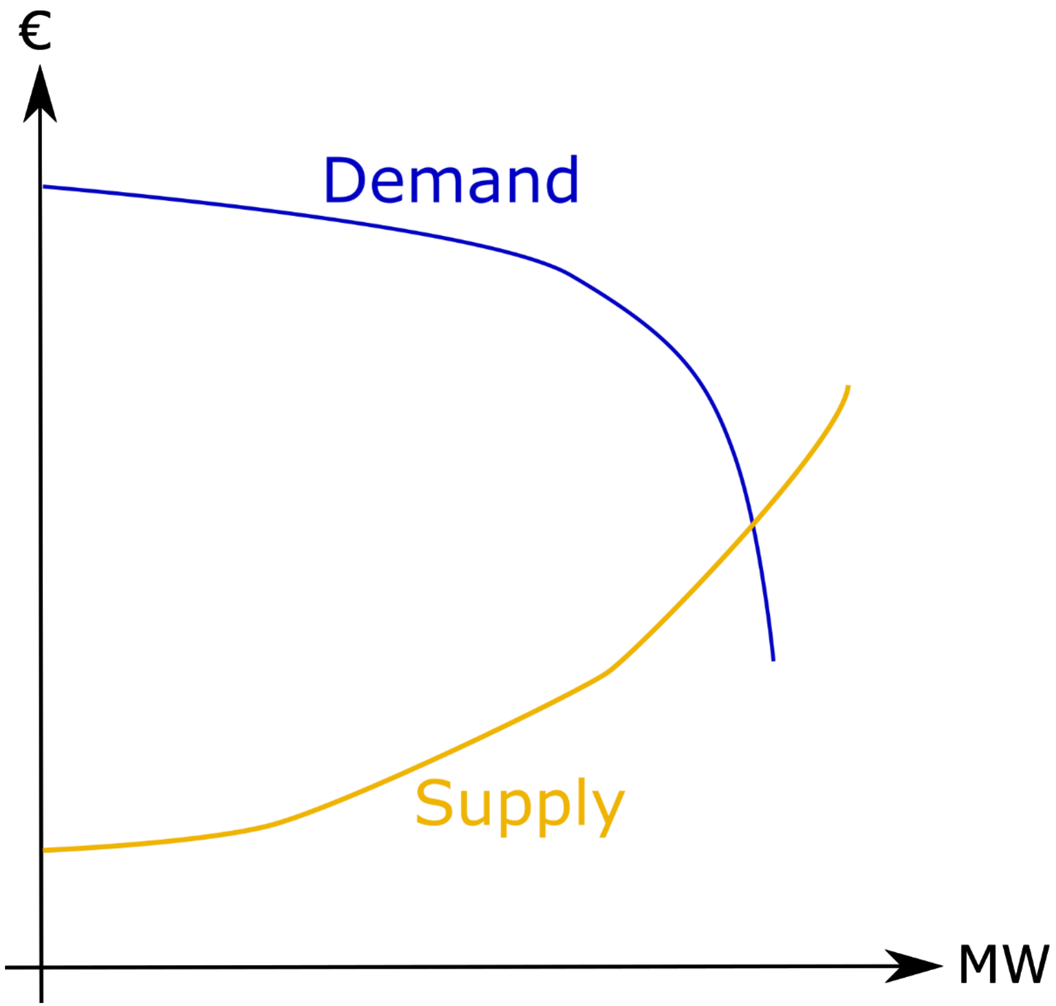


CONSULTANCY

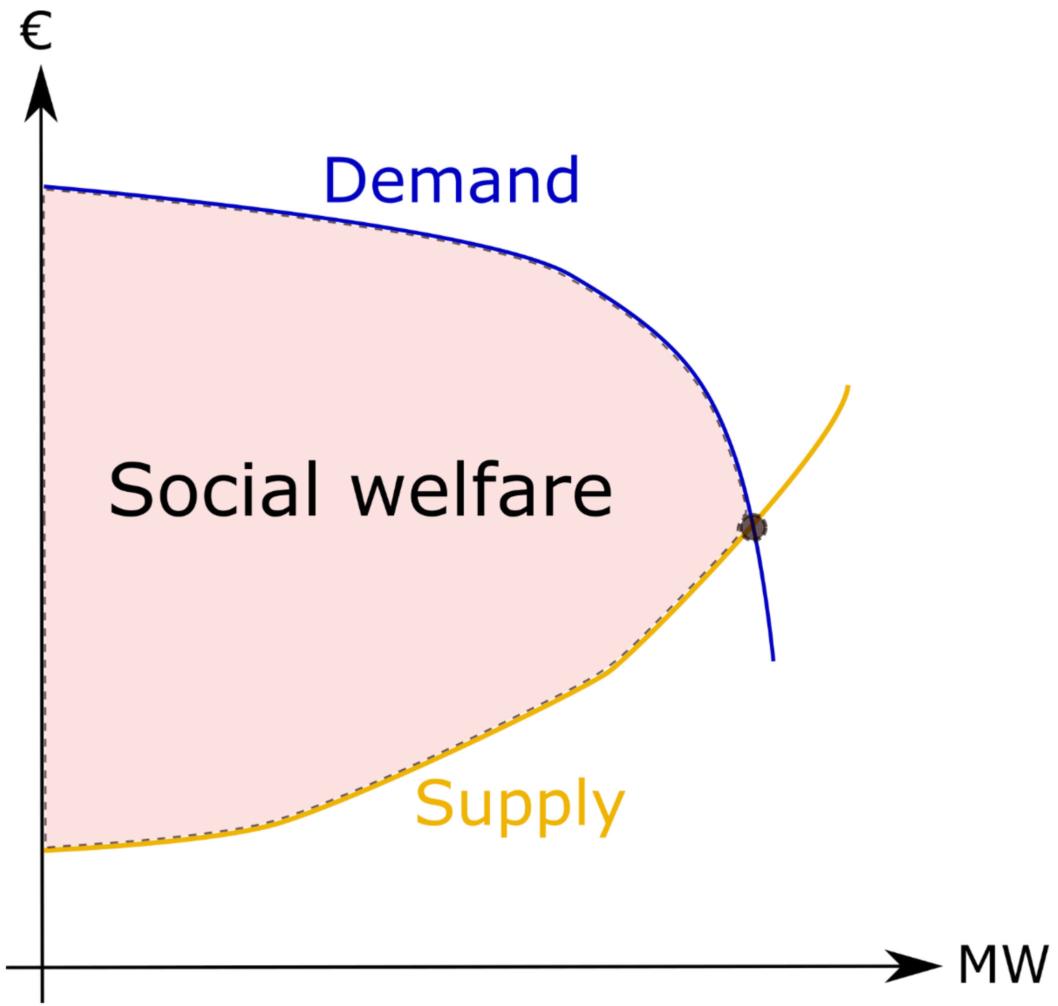
SOFTWARE

TERRE Market Principles

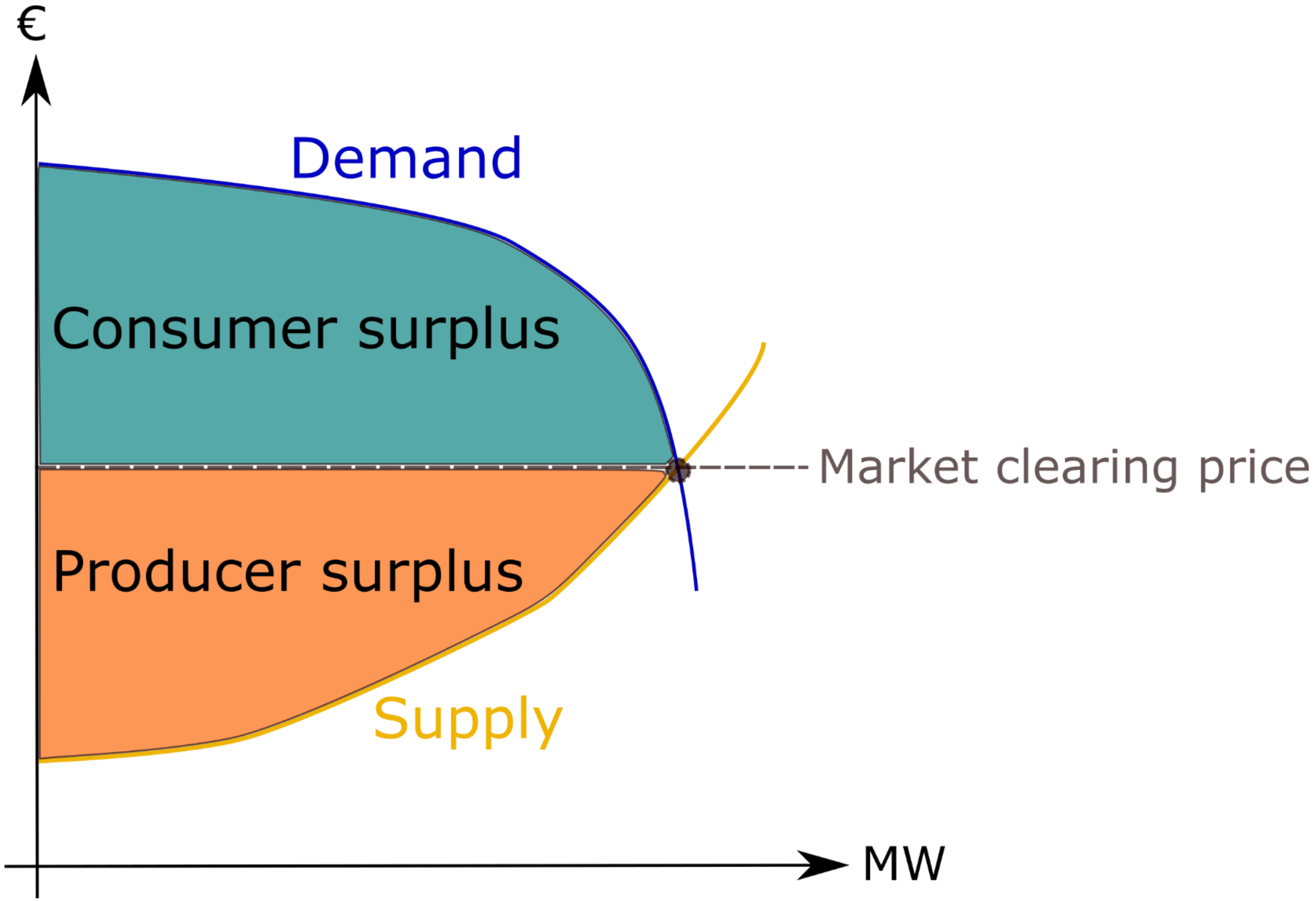
Market principles

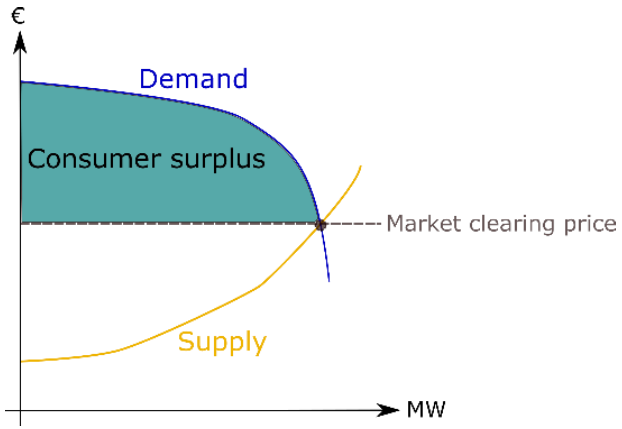


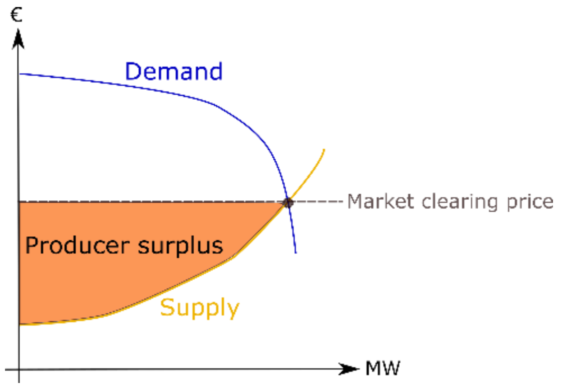
Market principles



Market principles







Market principles

- The Market Clearing Price (MCP) is defined by the intersection between the demand and supply curves

- Social welfare as the sum of all surplus:
  - Consumer surplus
  - Producer surplus
  - Congestion rent

- Surplus values depend on Market Clearing Price

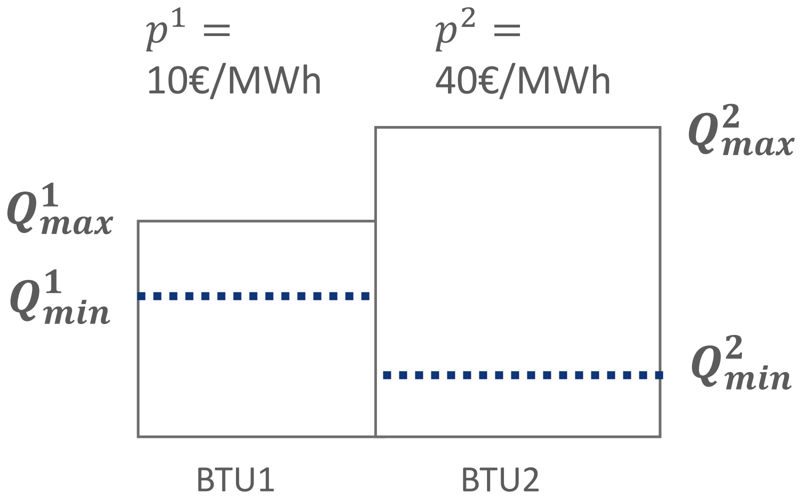
- Social welfare does not depend on Market Clearing Price

Market Products

Balancing Bids

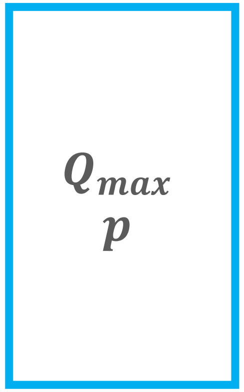
- A balancing offers is characterized by
  - A scheduling area (**schA**)
  - One or several **time steps** (BTU). The clearing is performed on 4 BTUs.
  - A product:
    - One common direction for all BTUs (**Upward** or **Downward**)
    - **Maximum quantity** which can vary across BTUs t (Q_{max}^t)
    - **Minimum quantity** which can vary across BTUs t (Q_{min}^t)
    - **Price** which can vary across BTUs t (p^t)
    - The bid may belong to a family group (optional)

Divisible upward bid on 2-BTU



Fully Divisible Bids

- Fully Divisible Bid (FDB)
  - **single-BTU**
  - Maximum quantity Q_{max} positive
  - Price p

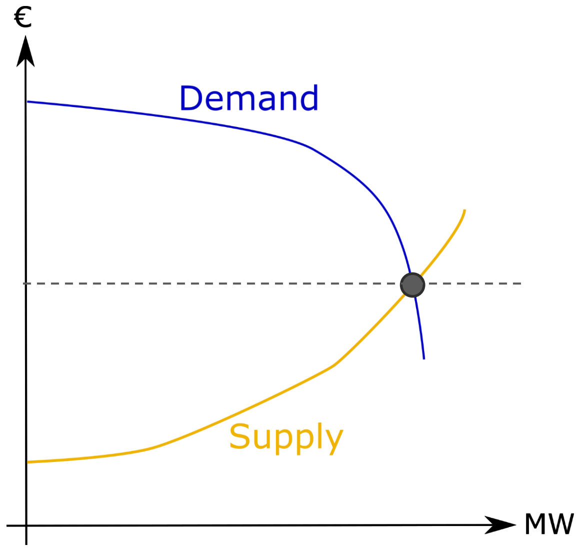


Fully divisible bid

- Accepted quantity lower or equal to Q_{max}

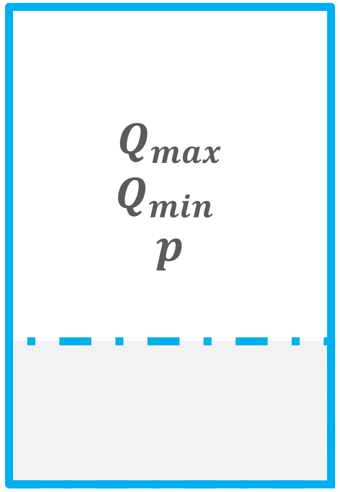
- Bid is rejected if its accepted quantity is 0

- If all bids are FDB, acceptance only depends on if the bid is **in the price or not**



Divisible Bids

- Divisible Bid
  - **single-BTU**
  - Maximum quantity Q_{max} positive
  - Minimum quantity Q_{min} strictly greater than 0
  - Price p



Divisible bid

- If the bid is accepted, the accepted quantity is between Q_{min} and Q_{max}

- If the bid is rejected, the accepted quantity is 0

Block Bids

- Block Bid
  - **single-BTU**
  - Maximum quantity Q_{max} equals to minimum quantity Q_{min}
  - Price p

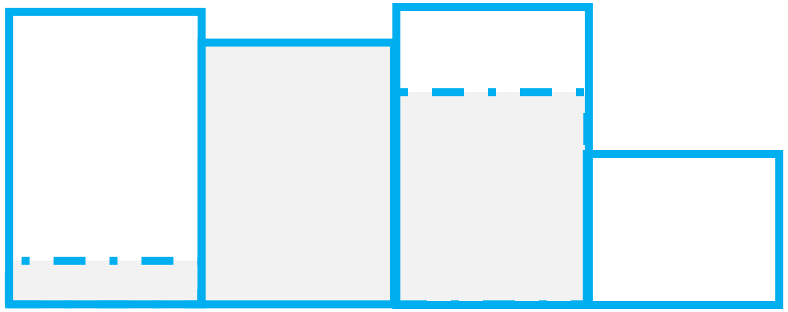
- The block bid can be either
  - Rejected
  - Fully accepted

$$\boldsymbol{Q_{max} = Q_{min}}$$
$$\boldsymbol{p}$$

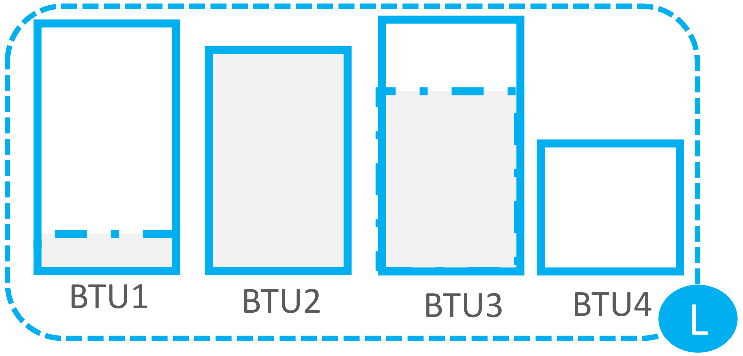
Block bid

Linked Bids

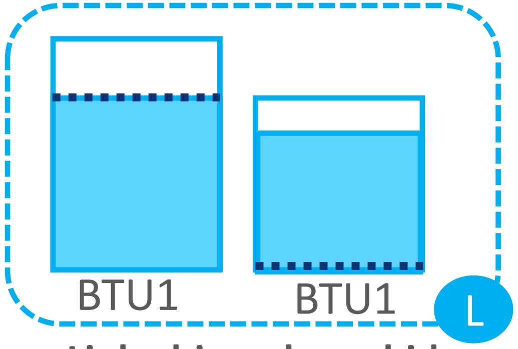
- Linked bid
  - Family of bids belonging to same schA
  - Maximum/Minimum quantity can vary
  - Price can vary as well
- All bid of the family have the same direction
- Coupling constraint: **same ratio** for all bids of the family
- **2 types of linkage:**
  - **linked-in-time** (all bids on different BTU)
  - **linked-in-volume** (all bids on same BTU)
- 2 ways in which BSPs (Balancing Service Providers) can submit link-in-time bids:
  - 1 bid defined on multiple BTUs
  - Several bids on different BTU with link indicator



Linked-in-time bid



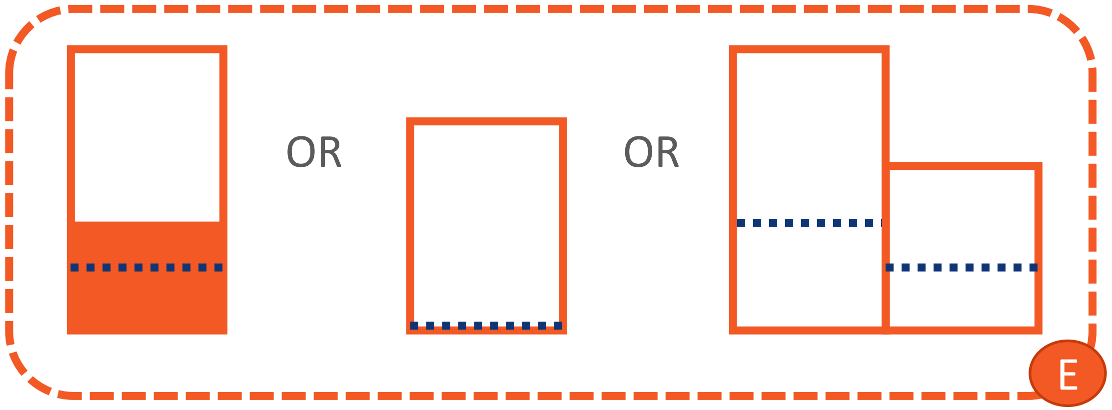
Linked-in-time bid



Linked-in-volume bid

Exclusive Bids

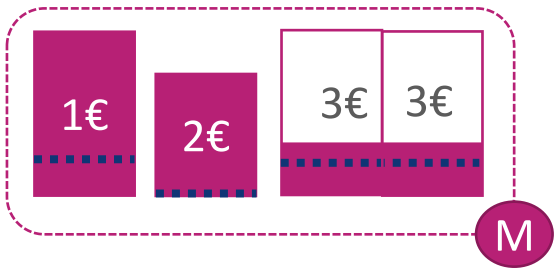
- Exclusive bid
  - Family of bids belonging to same schA
  - Coupling constraint: **Only one bid of the family** can be accepted (even partially)
  - Bids part of the family can be either **fully divisible**, **divisible** or **block**
  - Bids part of the family can be **Upward** and/or **Downward**
  - Bids part of the family can be **single BTU** and/or **multi-BTU**



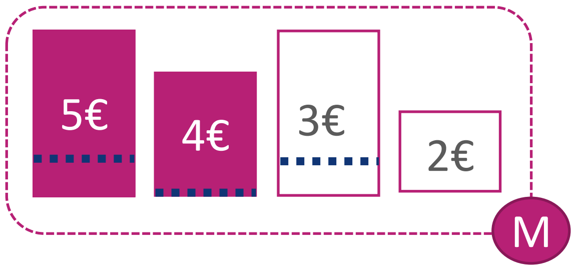
Multi-part Bids

Multi-part bid

- Family of bids belonging to same schA
- Bids are ordered according to their price
- Coupling constraint: If on bid is accepted, **All bids in earlier position shall be fully accepted**
  - ↳ Multi-part **Upward**: If a bid is accepted, all bids of the family with lower prices must be fully accepted
  - ↳ Multi-part **Downward**: If a bid is accepted, all bids of the family with higher prices must be fully accepted
- Bids of the family can be multi-BTU, but must have constant price, maximum and minimum quantities across BTUs



Multi-part Up



Multi-part Dn

Balancing Needs Products

- 3 types of Needs

Inelastic **Elastic** **Tolerance Band**

- Common characteristics
  - **Maximum quantity**
  - **Zero minimum quantity** (fully divisible)
  - **One direction:** Upward or Downward
- Specificities for each need type

Inelastic	**Elastic**	**Tolerance Band**
No price	Price in €/MWh	No price
Can be multi-BTU	Can be multi-BTU	Used only if it improves social welfare
Only one per SchA and BTU	FDB Up ⇔ Elastic Need Dn single BTU	Single-BTU only
Can come with a tolerance band		Always associated with an inelastic need

Grid Modelling

Geographic and temporal aspects

Market period = 60min (PT60M)

15 min	15 min	15 min	15 min

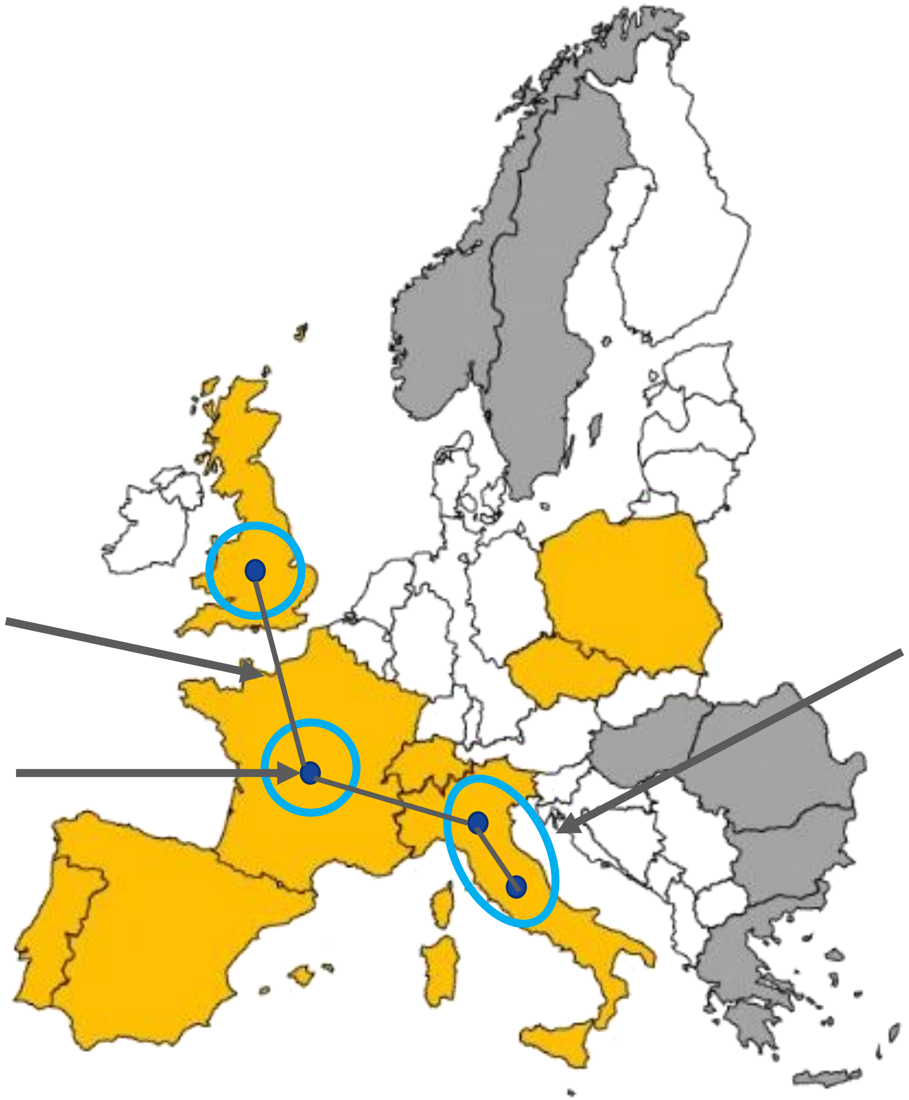
Market resolution = 15min (PT15M)

30min	30 min

Interconnector scheduling step

Interconnectors
2 directions

SchA = Scheduling Area
Bids and Needs are submitted at the SchA level



CtrlA = Control Area
Contains one or more SchA

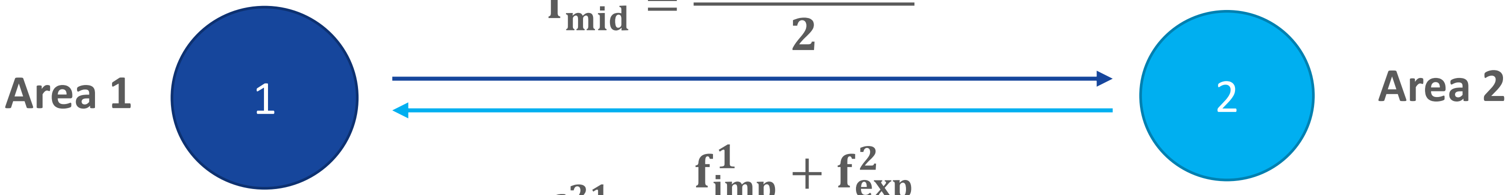
Interconnectors

- An interconnector links two scheduling areas
- Interconnectors characteristics
  - Losses (i.e. 0.1 = 10%)
  - **Scheduling step** (2 BTUs = 30 min)
  - Scheduling area ID for each side (i.e. Area 1 & 2)
  - Two directions specifying for all BTUs:
    - Available Transfer Capacity (ATC)
    - Desired Flow Range

$$\mathrm{f}^{1}_{\mathrm{exp}}$$

$$\mathrm{f}^{2}_{\mathrm{imp}} = \mathrm{f}^{1}_{\mathrm{exp}} \cdot (1 - \mathrm{l})$$

$$\mathbf{f}^{12}_{\mathbf{mid}} = \frac{\mathbf{f}^{1}_{\mathbf{exp}} + \mathbf{f}^{2}_{\mathbf{imp}}}{2}$$



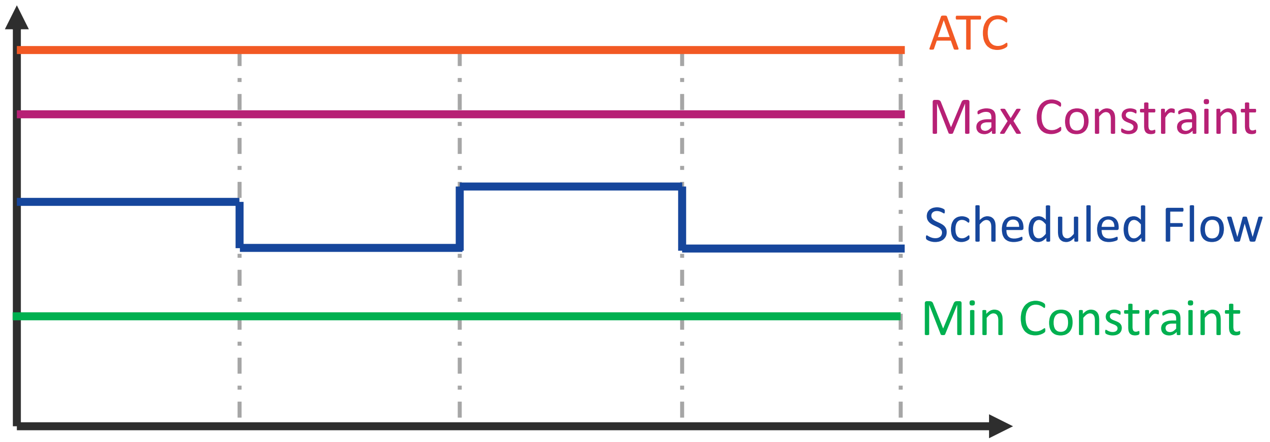
$$\mathbf{f}^{21}_{\mathbf{mid}} = \frac{\mathbf{f}^{1}_{\mathbf{imp}} + \mathbf{f}^{2}_{\mathbf{exp}}}{2}$$

$$\mathrm{f}^{1}_{\mathrm{imp}} = \mathrm{f}^{2}_{\mathrm{exp}} \cdot (1 - \mathrm{l})$$

$$\mathrm{f}^{2}_{\mathrm{exp}}$$

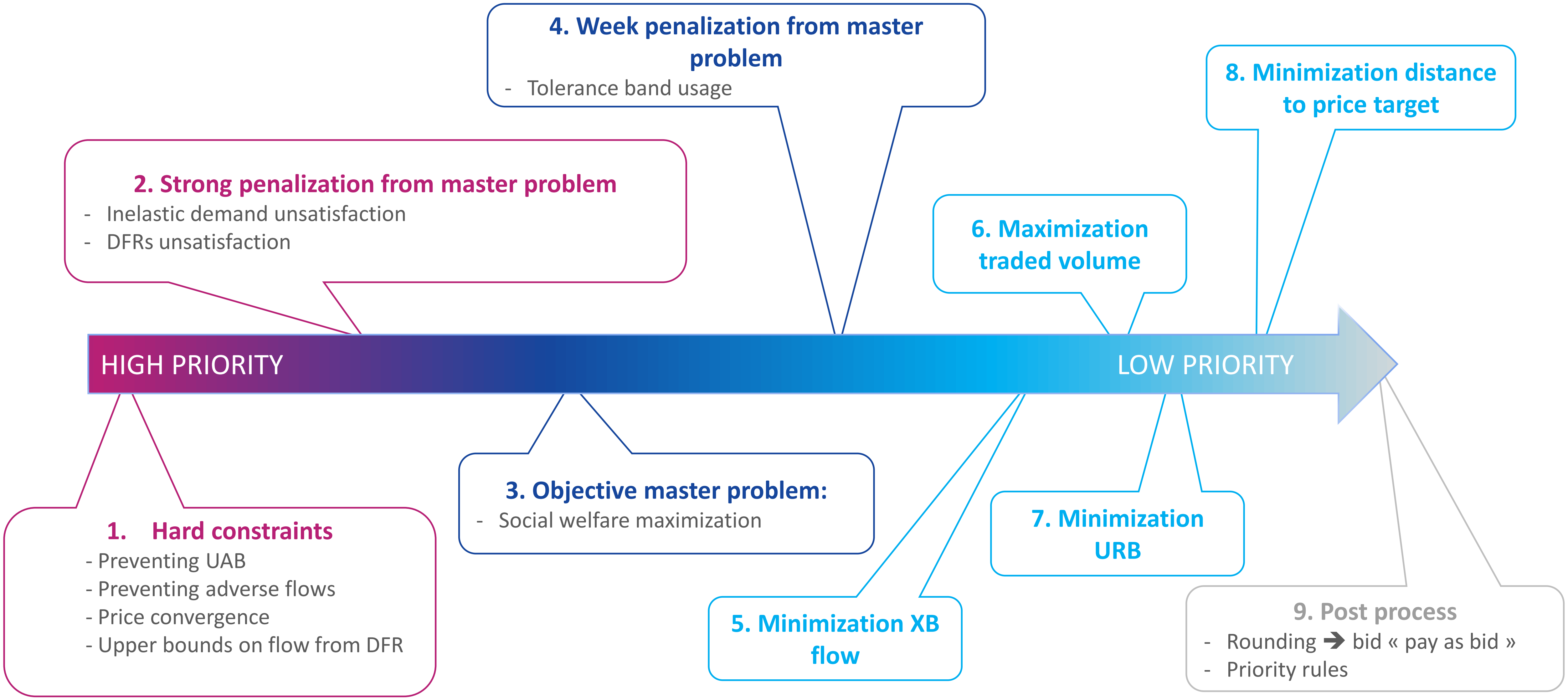
Desired Flow Range

- Desired Flow Range (DFR) indicates a continuous interval for the flow on one or both interconnector directions
  - It relates to mid-channel flow
  - It takes into account
    - already scheduled exchanges (Scheduled flow)
    - A maximum overall flow (Max constraint)
    - A minimum overall flow (Min constraint)



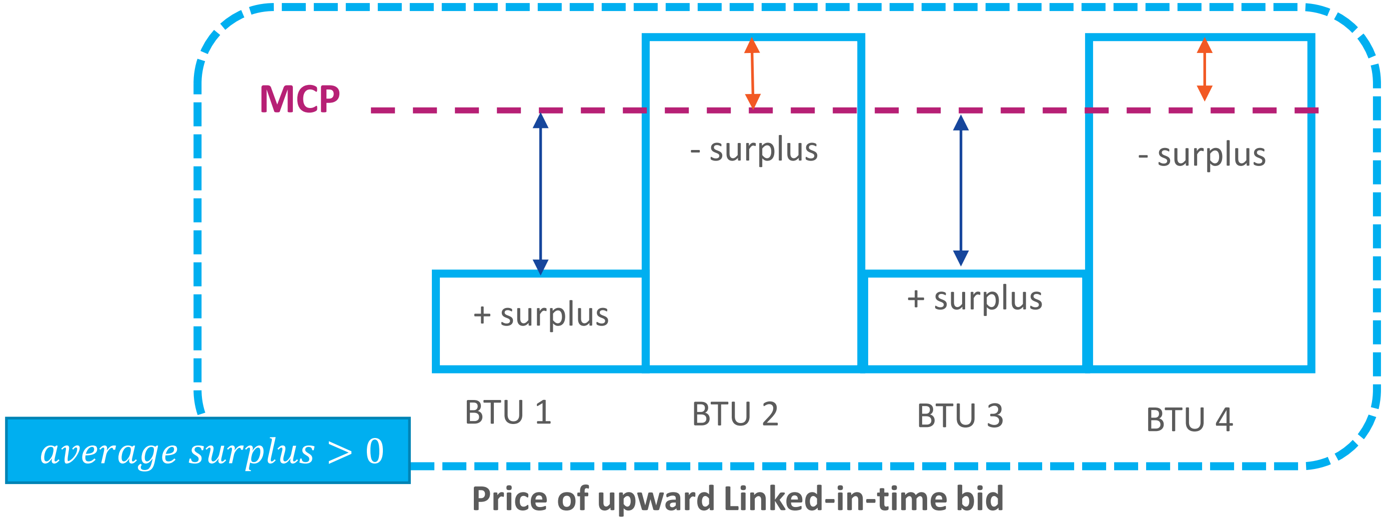
Keys Market Design Concepts

Market Rules Overview



Average surplus

- Average surplus of a bid or an elastic need per unit volume (MWh) of energy that was submitted is the results of the comparison between:
  - The average price of the bids
  - The average market clearing prices



- Average surplus can either be
  - Positive: bid is **in the money**
  - Negative: bid is **out of the money**
  - Equal to 0: bid is **at the money**

- Average surplus is calculated in the same way for linked-in-time and linked-in-volume bids.

Unforeseeably Accepted Bids (UAB)

- A bid or need is an **Unforeseeably Accepted Bid** (UAB) if:
  - The offer is accepted
  - The offer is **out of the money** (average surplus negative)

- UABs are strictly forbidden so that
  - Upward bids or downward needs cannot be paid less than their submitted prices
  - Downward bids or upward needs cannot be asked to pay more than their submitted prices

- UABs rules are implemented as **hard** constraint in the model
  - For **single-BTU** offers (not part of complex family), UAB rule is straightforward:
    - MCP shall be **greater or equal** than **bid** price
    - MCP shall be **lower or equal** than **need** price
  - For **multi-BTU** offers, UAB constraints are expressed using the average surplus:
    - average surplus shall be **greater or equal** to 0

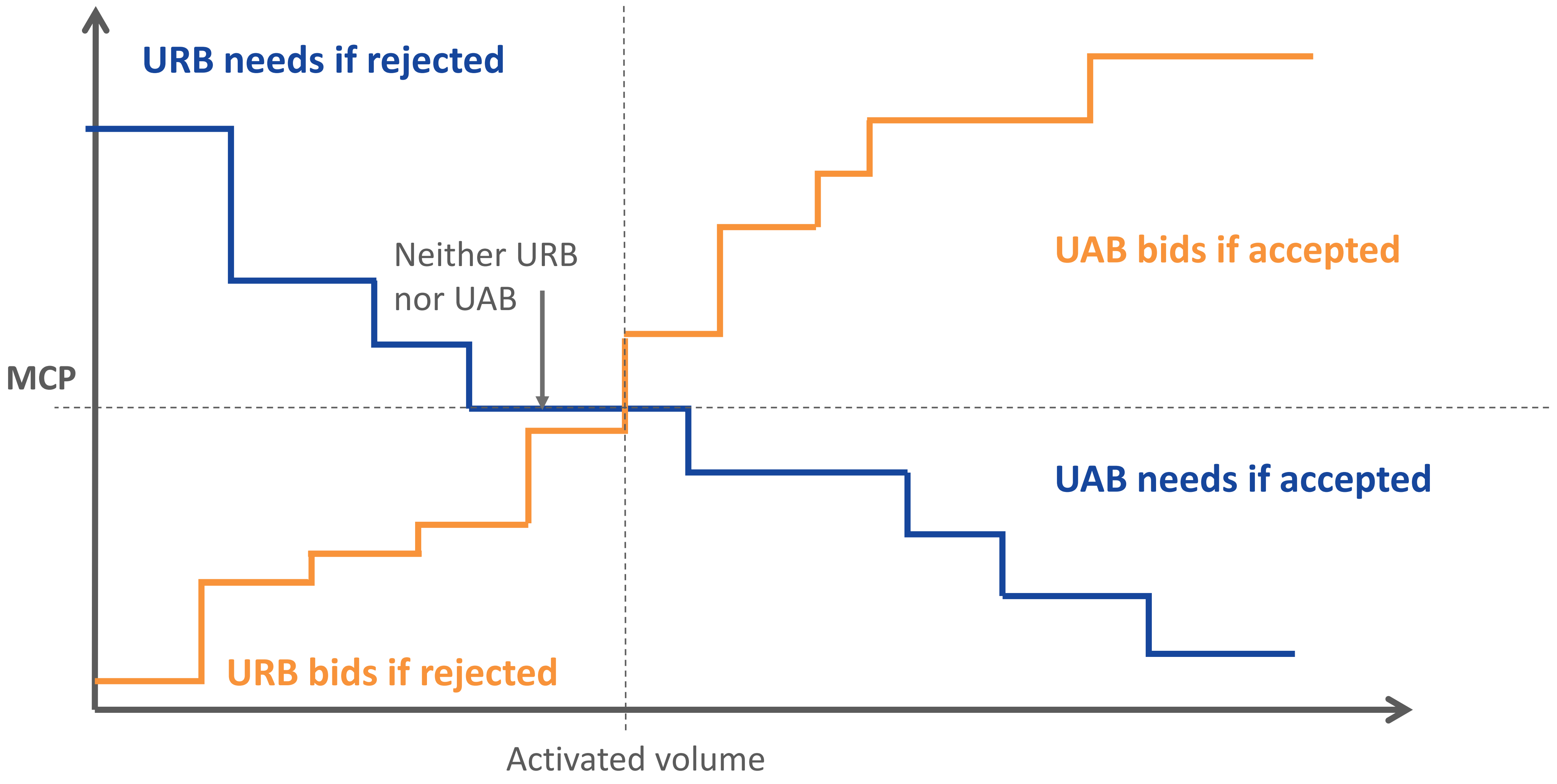
Unforeseeably Rejected Offers (URB)

- A bid or need is an **Unforeseeably Rejected Bid** (URB) if:
  - It is fully or partially **rejected**
  - The offer is **in the money** $(\text{average surplus} > 0)$
    - ↳ A bid/need rejected and at the money $(\text{average surplys} = 0)$ is not URB

- URBs are not forbidden
  - Any bid or need can be URB

- TERRE algorithm seeks to minimize URBs
  - Single-BTU URB minimization
  - Multi-BTU URB minimization
  - Price target determination

UAB/URBs Examples



Considerations on Bids

- Fully divisible bids are **key products in TERRE market**
  - They guarantee more **liquidity** on the market
    - With FDB, accepting a bit more or a bit less of need is just a matter of a small variation of acceptance of the last bid
  - Price indetermination is less likely to happen
  - No combinatorial aspects (good for performances)

- Complex and multi-BTU bids comes with coupling constraints
  - Problem becomes much more complex
  - Results are harder to interpret and can be counter intuitive

Price convergence and adverse flow

- Interconnectors between areas also energy exchanges between these areas, but also coupled the market clearing prices of the areas.

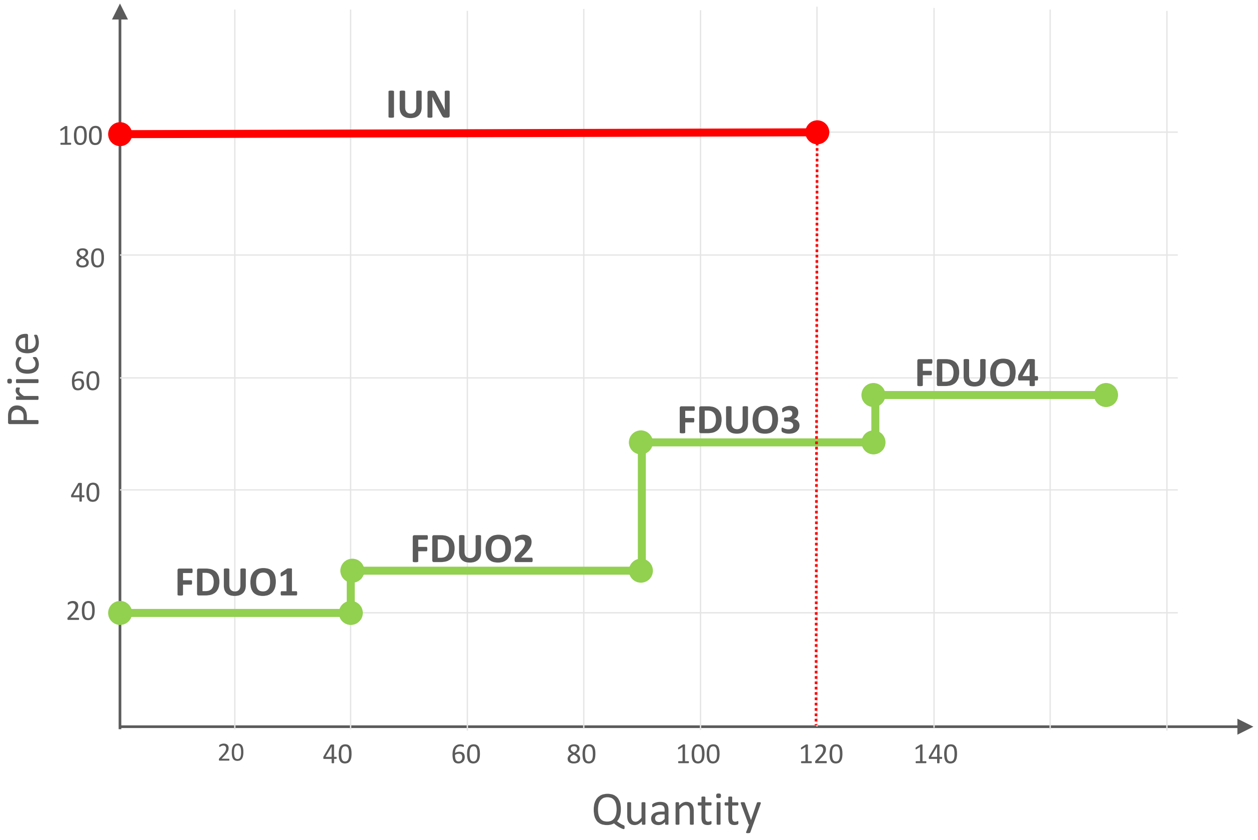
No saturation of the interconnector:
→ *Apply price convergence*
→ $MCP_A = MCP_b$

Saturation of the interconnector from A to B:
→ *Prevent adverse flow*
→ $MCP_A \leq MCP_b$

- Market coupling rules
  - **Preventing adverse flow**: if flow is in direction A → B on one scheduling step, the flow weighted average price in B shall be greater than the flow weighted average price in A (positive congestion rent)
  - **Ensure price convergence**: In case of non-saturation of the interconnector between areas A and B, the market clearing prices in areas A and B should converge

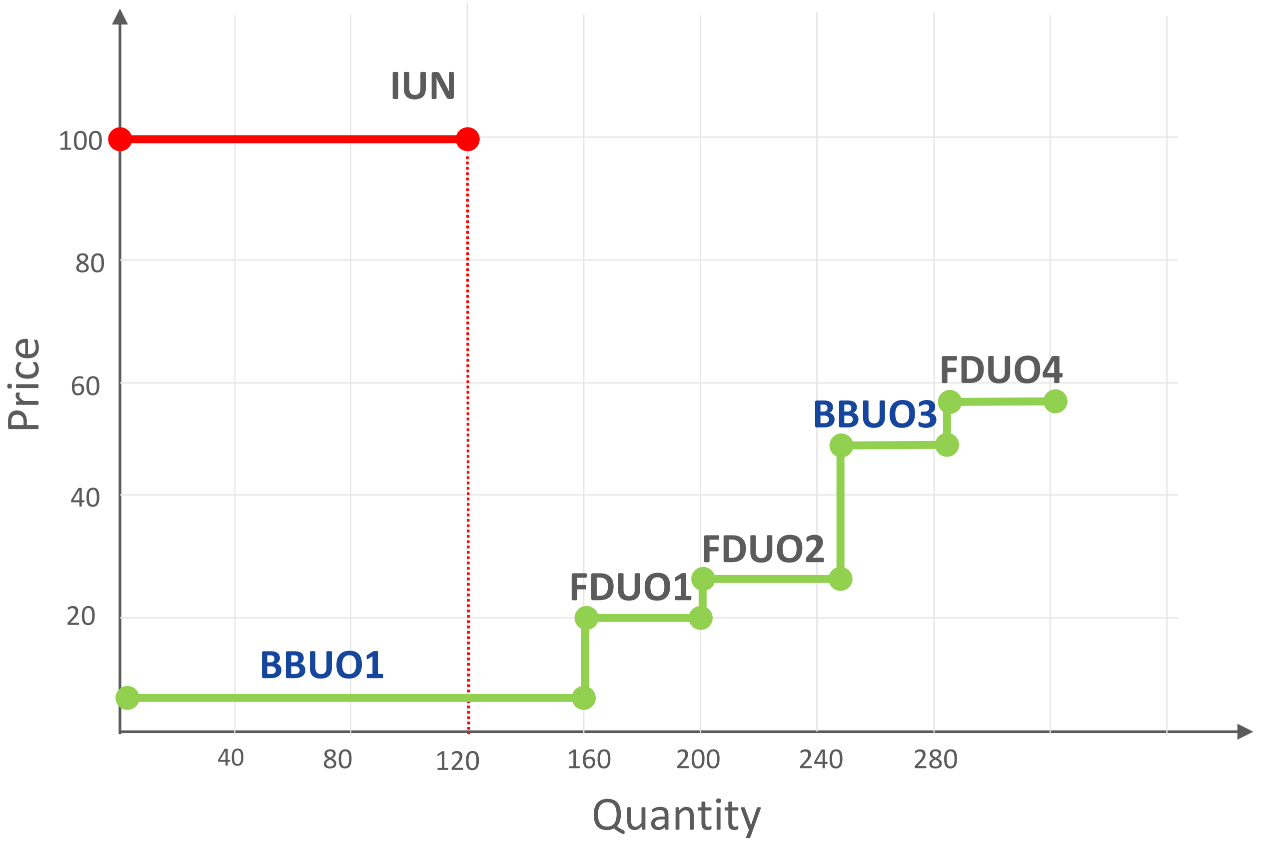
- Note: these rules integrate the eventual losses on the interconnectors

Example 1



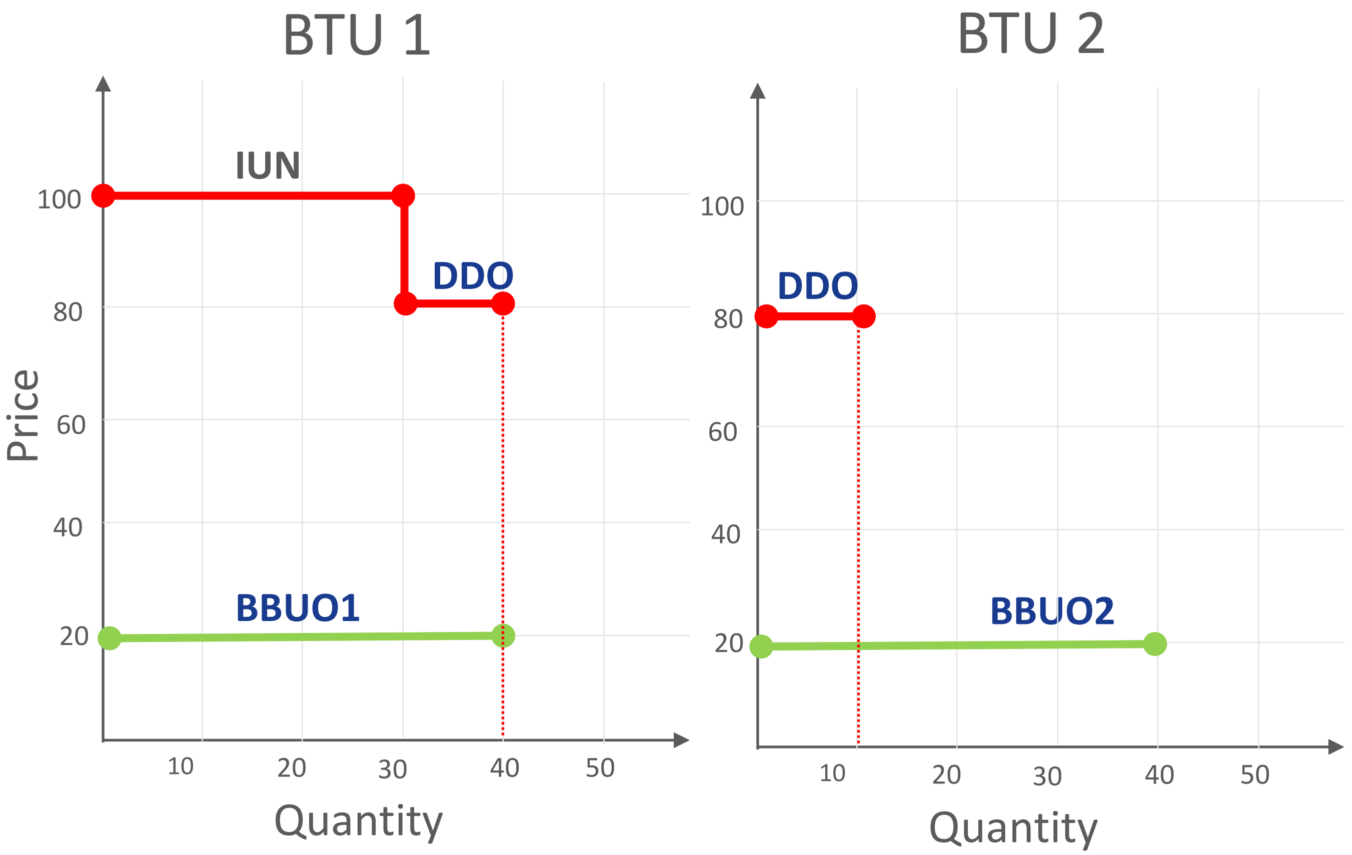
- Bids/Needs (Upward)
  - IUN : inelastic need 120 MW
  - FDUO1 : FDB bid 40 MW @ 20 €/MWh
  - FDUO2 : FDB bid 50 MW @ 25 €/MWh
  - FDUO3 : FDB bid 40 MW @ 50 €/MWh
  - FDUO4 : FDB bid 40 MW @ 55 €/MWh
- Solution
  - IUN fully accepted
  - FDUO1, FDUO2 fully accepted
  - FDUO3 partially accepted (30 MW)
  - FDUO4 rejected
  - Prix : 50 €/MWh
  - Social welfare: 8450 € (= 120*100 – 40*20 – 50*25 – 30*50)

Example 2



- Bids/Needs (Upward)
  - IUN : inelastic need 120 MW
  - BBUO1 **block** bid 160 MW @ 5 €/MWh
  - FDUO1 : FDB bid 40 MW @ 20 €/MWh
  - FDUO2 : FDB bid 50 MW @ 25 €/MWh
  - BBUO3 : **block** bid 40 MW @ 50 €/MWh
  - FDUO4 : FDB bid 40 MW @ 55 €/MWh
- Possible solutions
  - Solution 1
    - IUN fully accepted
    - FDUO1, FDUO2 fully accepted
    - FDUO4 partially accepted (30 MW)
    - BBUO1, BBUO3 rejected
    - Prix : 55 €/MWh
    - Social welfare: **8300** € (= 120*100 – 40*20 – 50*25 – 30*55)
  - Solution 2
    - IUN fully accepted
    - FDUO1, BBUO3 fully accepted
    - FDUO2 partially accepted (40 MW)
    - BBUO1, FDUO4 rejected
    - Prix : 50 €/MWh
    - Social welfare: 8200 € (= 120*100 – 40*20 – 40*25 – 40*50)

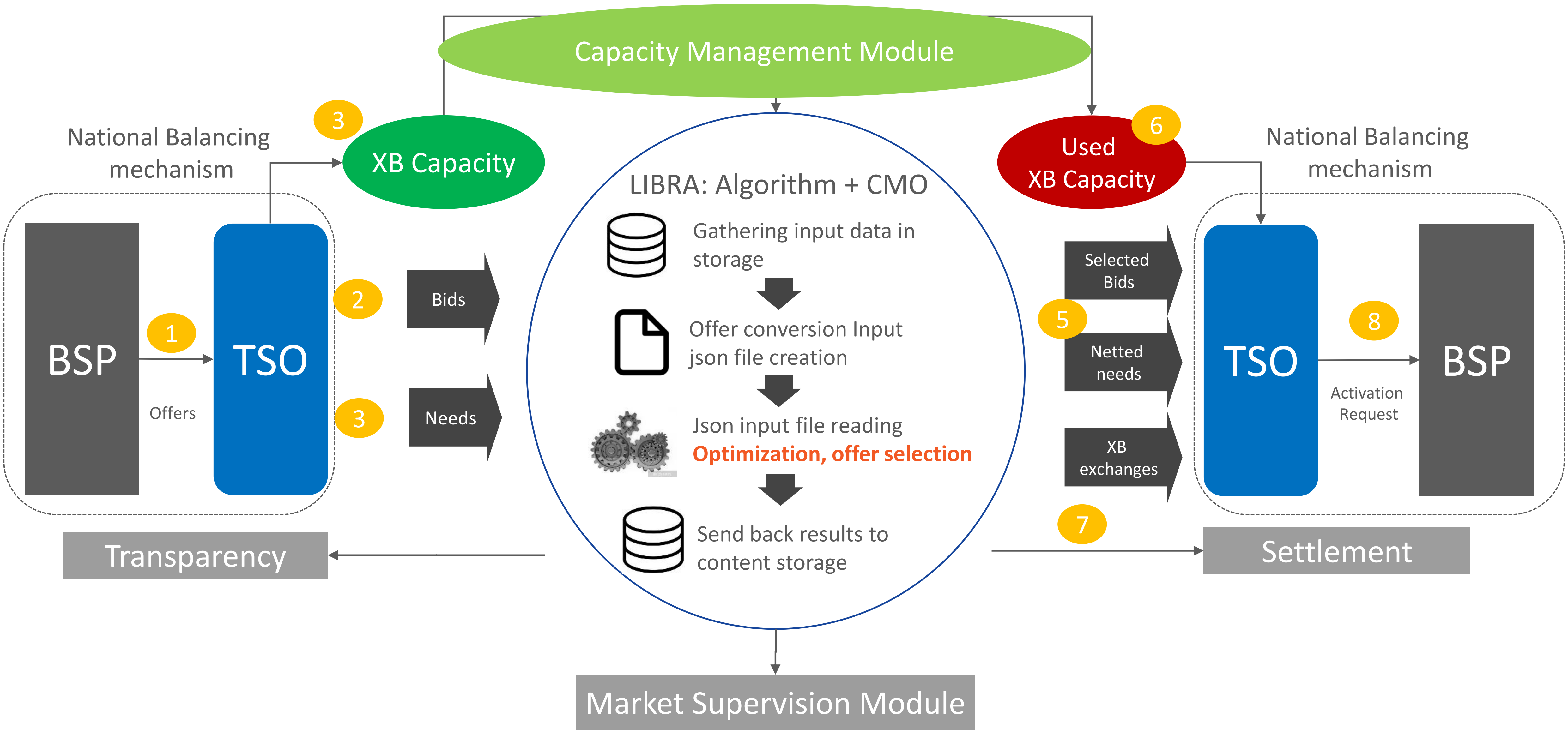
Example 3



- Bids/Needs
  - IUN : inelastic need Up 30 MW
  - BBUO1 : **block** bid Up 40 MW @ 20 €/MWh sur BTU 1
  - BBUO2 : **block** bid Up 40 MW @ 20 €/MWh sur BTU 2
  - DDO : divisible bid **2-BTU** Dn [10,10] MW @ 80 €/MWh
- Solution
  - All offers are rejected
  - Social welfare: 0 €
- If multi-BTU need DDO is replace by two equivalent single-BTU needs (DDO2, DDO2):
  - IUN fully accepted
  - DDO1, BBUO1 fully accepted
  - DDO2, BBUO2 rejected
  - Price [50, 80] €/MWh
  - Social welfare: 1500 € (=(30*100 + 10*80 – 40*20)*0.5)

Libra Optimization Module (LOM)

Data flow LOM

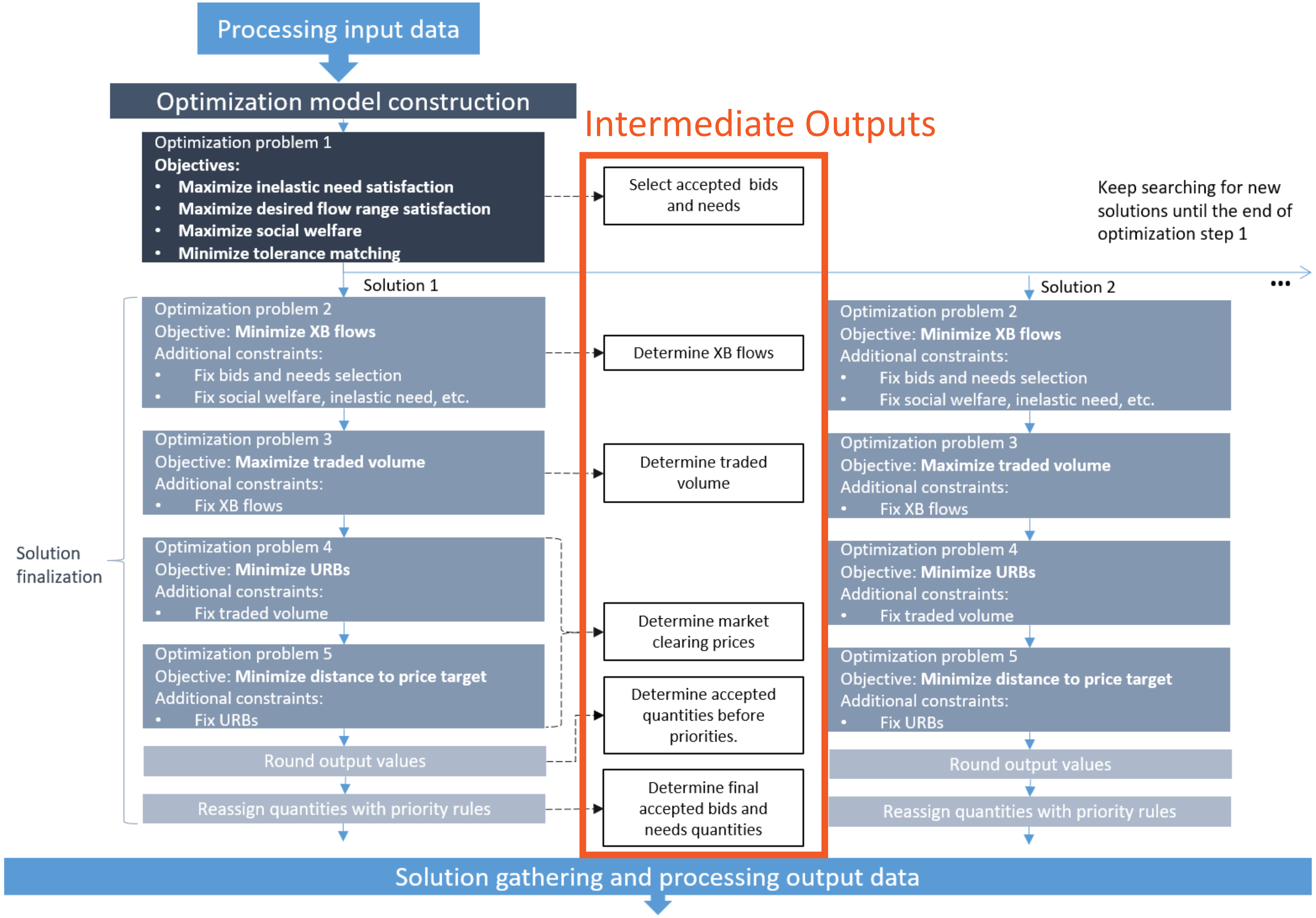


LIBRA resolution modes

- **Unconstrained Coupled (UC)**
  - All bids and Needs
  - All interconnectors
  - **Desired Flow Ranges NOT considered**
- **C Mode**
  - **When Desired Flow Ranges are submitted**
  - Additionally compute **Constrained Coupled (CC)** optimization results:
    - CC model is same as UC but DFR are taken into account
  - CC and UC results are **merged** keeping:
    - **Quantity of CC mode**
    - **Prices of UC mode**
  - This merge process can create **pay-as-bid**
- **Decoupled mode (DC)**
  - All bids and Needs
  - **Cross border flow between control areas NOT considered**
  - **Desired Flow Ranges NOT considered**

Algorithm steps

Libra Platform sends the JSON files



Market clearing price determination

- Price determination is done through multiple steps
  1. Main problem
     - UAB constraints enforce Lower/Upper Bounds on market clearing prices
     - Price rules for interconnectors shall be consistent with price rule between areas
  2. XB flow minimization
     - No direct impact on prices
  3. Traded volume maximization
     - No direct impact on prices
  4. URBs minimization
     - Bounds on market clearing prices are updated
  5. Distance to price target minimization
     - Target prices defined as middle point between bounds from accepted offers prices and rejected marginals offer prices
     - This steps defines the final market prices still respecting bounds defined in previous steps.

Activation Optimization Function updates

Analysis of the current situation

- Libra clearing design « philosophy »
  - **Fully divisible bids (FDB) are key market product**
    - They guarantee **liquidity** of the market
    - They make it much less unlikely to have price indetermination
    - They have no combinatorial aspect (good for performances)

- Analysis of the current situation
  - Current market situation
    - FDB bids are not yet used in every market area
    - Many multi-BTUs bids
    - Many block bids
  - Satisfaction of inelastic need to be reinforced
  - The C mode market outcomes may not be straightforward
    - (C mode = UC prices and the CC quantities)

Recent LOM Updates

- Initially
  - **Only single-BTU bids** where considered for URB minimization
  - Only bounds from UAB/URB rules on single-BTU bids where used to define price targets
  - **Many URB multi-BTU** bids experienced
  - In particular, in some scheduling area only multi-BTU bids are submitted

- The update implemented considers also multi-BTU bids in the definition of price targets
  - Dedicated optimization step **to minimize URBs on multi-BTU bids**
  - Both **bounds from UAB/URB rules on single-BTU AND multi-BTU bids** are considered in the definition of the price target and therefore with an impact on the market clearing price

Discussed LOM Updates

Reinforcement of inelastic need satisfaction

1. **Inelastic need check**
   - Ensure that all TSOs benefit from the coupled optimization (UC/CC solution)
   - If for at least one TSO, the inelastic need satisfaction is better in the decoupled optimization (DC solution), then the solution produced by decoupled optimization shall be used

Market clearing price determination

1. **Ongoing discussions to further adapt the algorithm to the current market**
   - In some complex situations, even though the market clearing prices returned were compliant with the market rules, better prices could have been determined
   - Ongoing discussions to improve the market clearing price determination process

Discussed LOM Updates : C mode

C mode / Single clearing

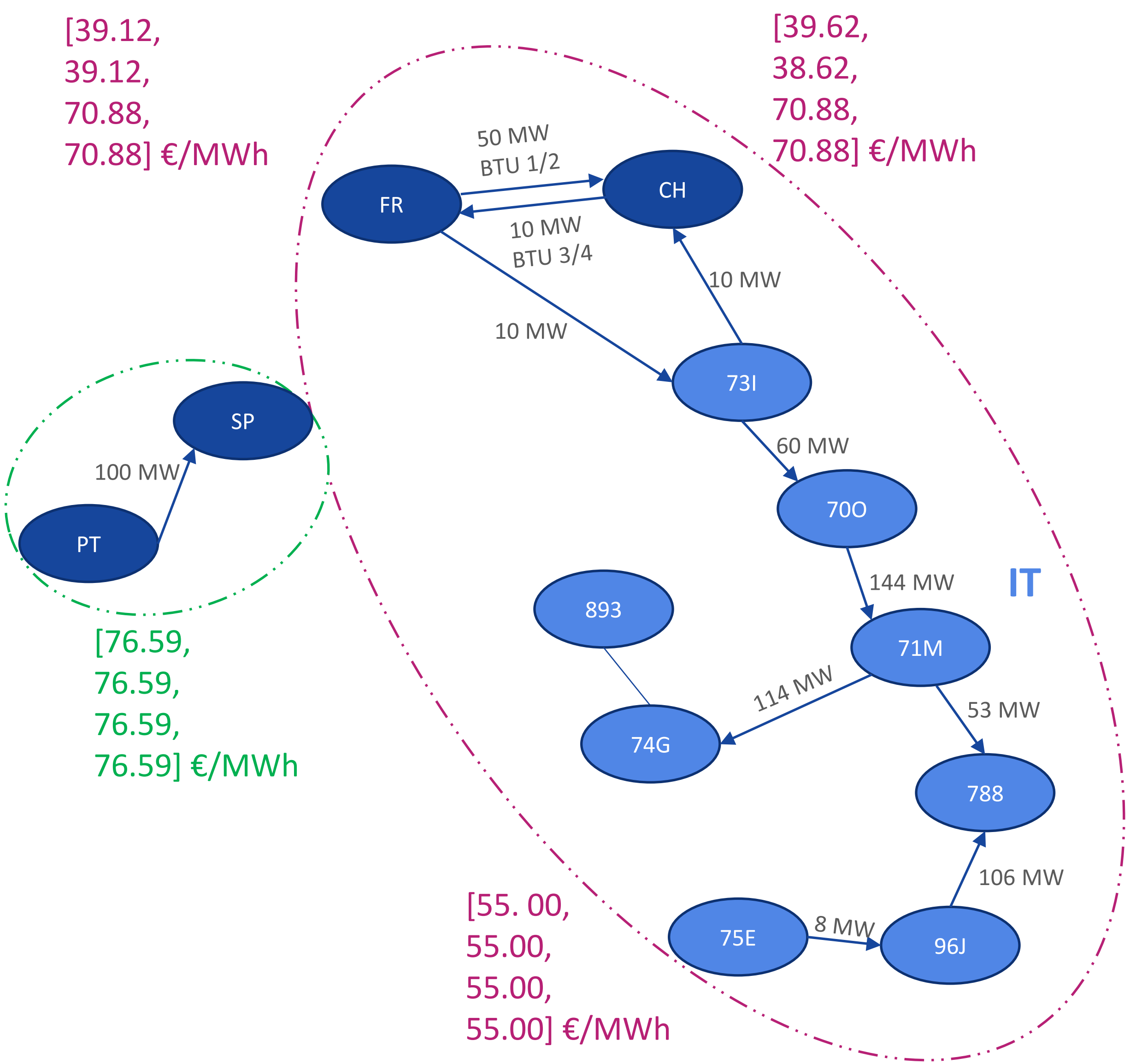
1. The C mode is the merge of the UC solution (prices) and the CC solution (quantities)
   - Bids may be activated be **pay-as-bid**
   - Potential high level of **uplift costs**
   - Complex understanding of the market outcomes

2. Ongoing discussions in order to avoid such a level of uplift costs

Questions

Examples

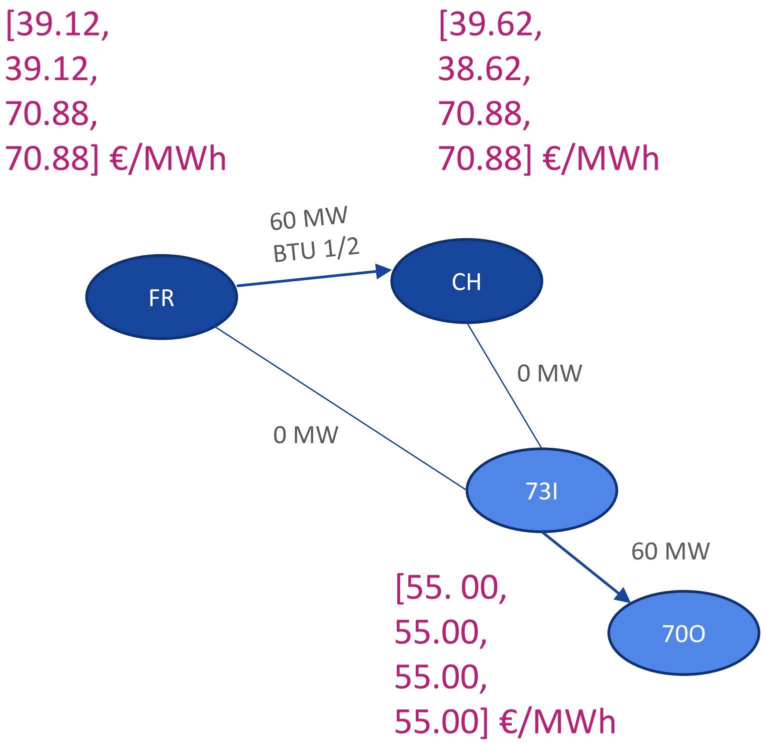
Example 1 – 18/01/2021 gate of 12h delivery period: 13h-14h (1)



Area	Needs	Bids
FR	Dn : [100,100,0,0] TB Dn : [100,100,0,0]	Dn : 8 exclusiv families block (except 1 div bid) [1036,1036,841,841] MW @ ≤ 46.17 €/MWh
CH		Up : several block bids Dn: several 4-BTUs block bids 9 block bids on 1 or 2 BTU @ ≤ 58.50 €/MWh
IT_73I	Dn : [217,217,217,217] @ 0 €/MWh	Up : several bids block/div Dn : several bids block/div, 22 bids part of 11 exclusive families @ ≤ 67.50 €/MWh

- How to cover needs with many block bids (and exclusive families) while minimizing cross border flow?

Example 1 – 18/01/2021 gate of 12h delivery period: 13h-14h (1)

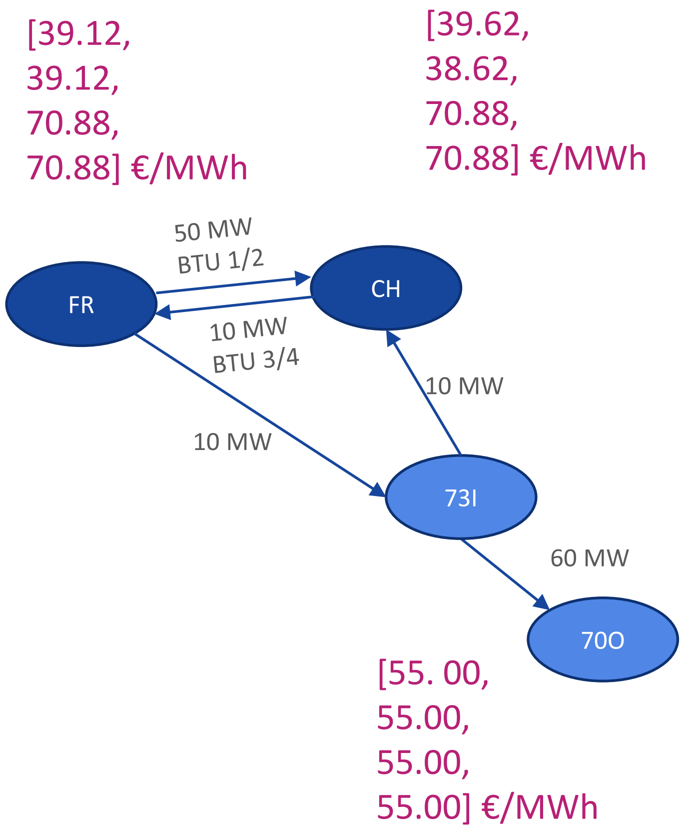


Resolution process (Main problem)

Area	Accepted needs	Accepted bids
FR	Dn : [100,100,0,0] TB Up : [14,14,0,0]	Dn : [54,54,0,0] @ 39,12 €/MWh
CH		Dn: [60,60,0,0] in total [20,0,0,0] @ 58.50 €/MWh [0,20,0,0] @ 57.50 €/MWh [20,20,0,0] @ 57.00 €/MWh [20,20,0,0] @ 41.10 €/MWh
IT_73I	Dn : [217,217,217,217] @ 0 €/MWh	Dn: [151,151,151,151] @ 67.50 €/MWh (fully accepted) [6,6,6,6] @ 55.00 €/MWh (partially accepted)

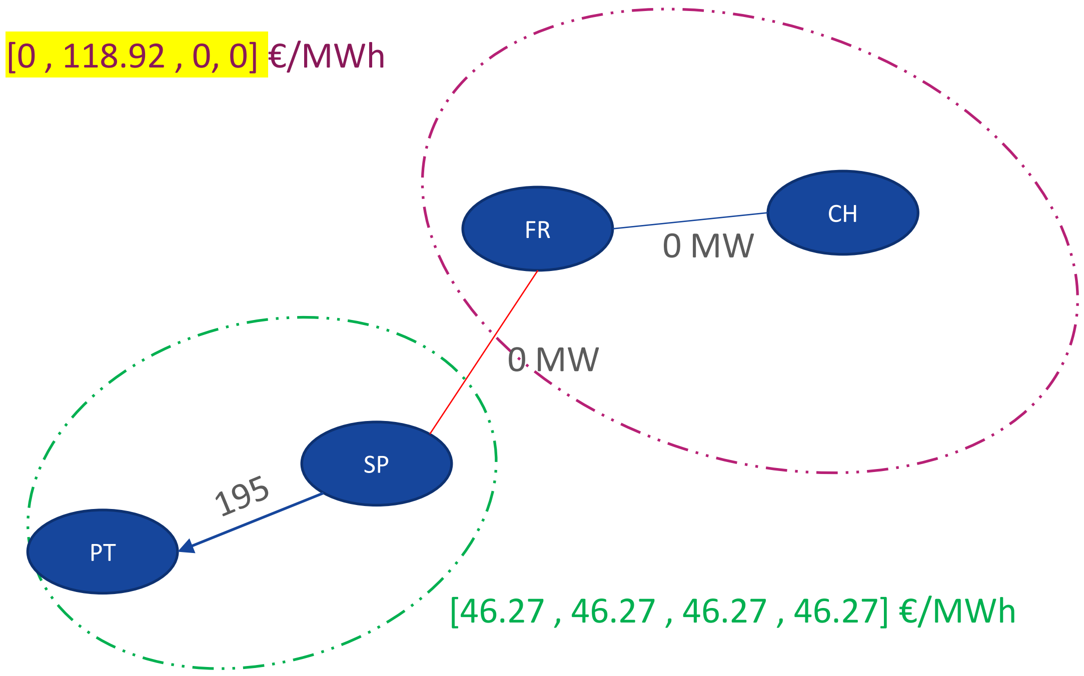
- Social welfare maximization
  - FR exports towards CH since CH only has Dn bids more expensive than bids in FR (BTU 1-2)

Example 1 – 18/01/2021 gate of 12h delivery period: 13h-14h (1)



- Resolution process (finalization)
  - XB flow minimization:
    - Impact solution since flow from FR to CH shall be minimized
    - in CH on BTU 1-2. due to schdStep FR→IT_73I of 60min, FR is forced to export same quantities over all BTUs
    - Loop flow IT_73I → CH → FR → IT_73I on BTU 3-4
    - $2 * 60^2 + 0 = 7200$ VS $2 * 50^2 + (4 + 4 + 2) * 10^2 = 6000$
  - Traded volume maximization: No impact
  - single-BTU URBs minimization: No impact
  - multi-BTU URBs minimization :
    - Partially accepted bids at 55.00 €/MWh fixes the price in IT_73I
  - Distance to price target minimization
    - Price target determination
      - Bounds UAB single-BTU : CH, BTU 1 = [-inf, 58.50] et BTU 2 = [-inf, 57.50]
      - Bounds URB single-BTU : No impact
      - Bounds UAB and URB multi-BTU (where still undefined bounds):
        - FR, BTU 1 and 2 = [-inf, 39.12]
        - IT_73I, all BTUs = [55, 55]
      - Target prices:
        - FR = [39.12, 39.12, …, …]
        - CH = [58.50, 57.50, …, …]
        - IT_73I = [55, 55, 55, 55]

Example 2 - 22/12/2020 gate of 12h delivery period: 13h-14h (1)



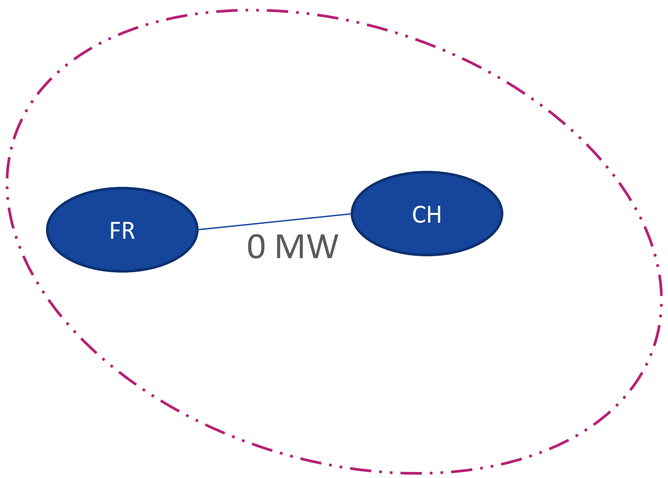
Context for FR – CH area

Area	Needs	Bids
FR	**Dn :** [500,500,500,500] @ 0 €/MWh	**Dn:** 4-BTU Block bids ϵ 6 exclusive families price < 37€/MWh 1 div bid Dn [195,195,195,195] @ 38.4€/MWh **Up:** 4-BTU Block bids ϵ 10 exclusive families price > 42€/MWh
CH		**Dn :** Block bids @ < 44€/MWh **Up:** Block bids @ > 65€/MWh

Why do we get these prices in FR ?

Example 2 - 22/12/2020 gate of 12h delivery period: 13h-14h (1)

[0 , 118.92 , 0, 0] €/MWh



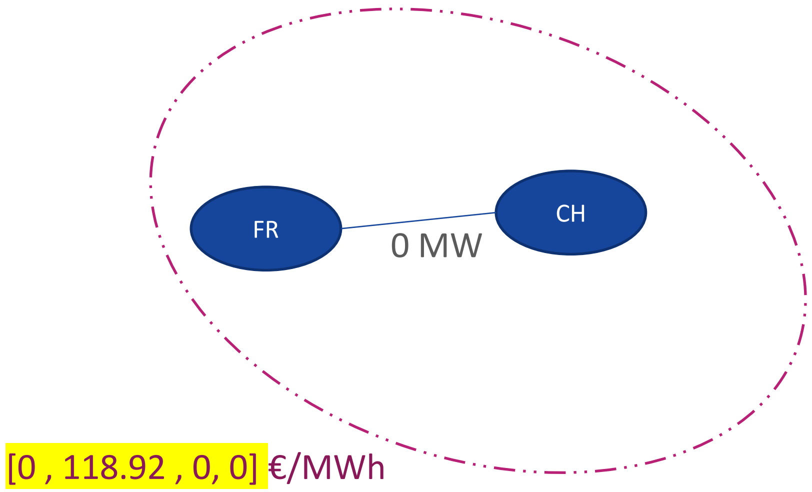
- Resolution process

Area	Accepted needs	Accepted bids
FR	**Dn:** [403, 500 , 403, 414] @ 0 €/MWh	**Dn:** Bid1 block : [127,127,73,73] @ 37.76 €/MWh Bid2 div : [179,179,179,179] @ 38.4€/MWh partially accepted Bid3 block : [97,194,194,162] @ 36.03 €/MWh

- Constant need cannot be covered by multi-BTU block bids with different volume across BTU

- Social welfare maximization
  - Price convergence in FR-CH
  - Multi-BTU block bids constraints

Example 2 - 22/12/2020 gate of 12h delivery period: 13h-14h (1)

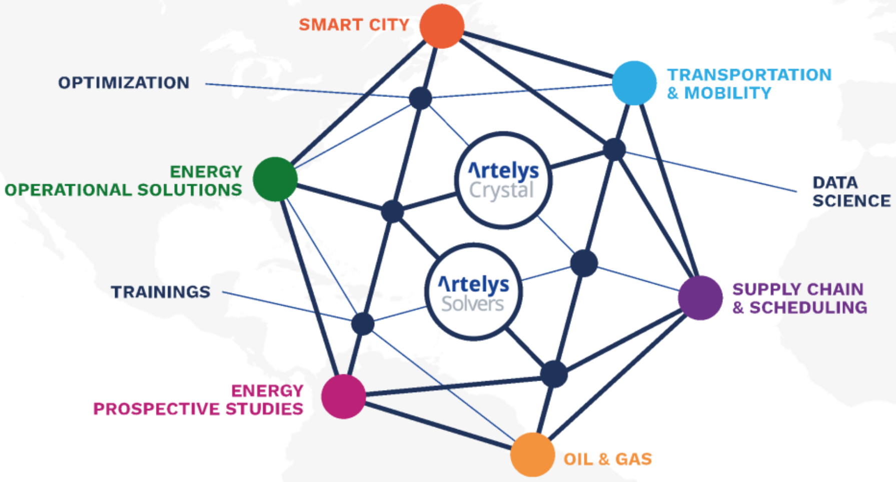


UAB bounds offer	URB bounds offers
Dn: Bid1: [127,127,73,73] @ 37.76 €/MWh Bid2 : [179,179,179,179] @ 38.4 €/MWh Bid3: [97,194,194,162] @ 36.03 €/MWh Dem :[403, 500 , 403, 414] @ 0€/MWh	**Dn:** Bid2 : [179,179,179,179] @ 38.4€/MWh Dem :[403, 500 , 403, 414] @ 0€/MWh

- Resolution process(finalization)
  - XB flow minimization: No impact
  - Traded volume maximization : No impact
  - single-BTU URBs minimization :
    - Need partially accepted on BTU 1,3,4:
      - MCP BTU 1,3,4 = 0 €/MWh
  - multi-BTU URBs minimization
    - Bid2 @ 38.4 €/MWh partially accepted:
      - Objective: sum MCP >= 38.4*4 to avoid URB

      => MCP BTU2 >= 153.6 €/MWh (since MCP BTU 1,3,4 = 0€/MWh)
    - UAB constraints for Bid1 :
      - MCP BTU 2 <= 118.92 €/MWh (since MCP BTU 1,3,4 = 0€/MWh)
      - Note: tighter constraint than Bid3 while less expansive
    - MCP BTU 2 = 118.92€/MWh
  - Distance to price target minimization: No impact

Contact



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