2nd PUBLIC **WORKSHOP**

on the Long Term Flow-Based Allocation

Tuesday, 24.05.2022
10:00 - 13:00 CET

Please keep your microphone muted when not speaking

Raise your hand when you want to provide a comment or question: your mic will be activated

The slides will be shared

The meeting has been recorded

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	AGENDA	
10:00-10:10	Introduction	ACER & ENTSO-E
	SESSION 1: CORE AND NORDIC LONG TERM FLOW-BASED: CAPACITY CALCULATION	
10:10-10:20	Nordic TSOs planning on the implementation of LT CCM	Nordic TSOs
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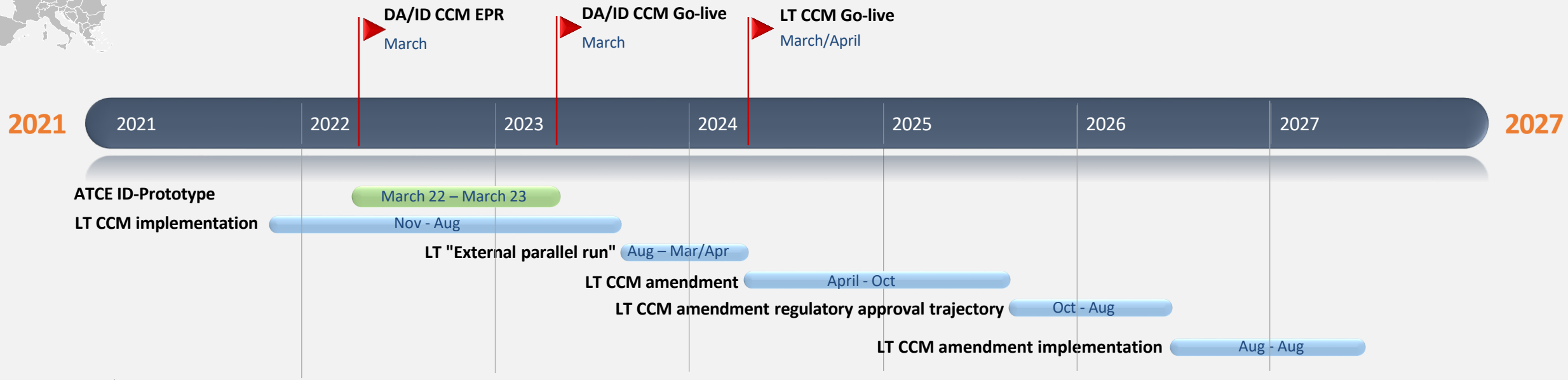
12:55-13:00	Wrap-up	ACER

Nordic CCM HL timeline



- Capacity calculation is for forecasting-purposes only
  - FTRs currently only on DK1-DK2
  - ACER decision on LTTR:s or other measures for FI-SE borders expected in September 2022
- The target model for the Nordic LT CC is an FB approach
- The intermediate Nordic LT CC is ATCExtraction (until FB in SAP)
  - LT CGM ⇒ LT FB-domains ⇒ Extracted LT ATC-domains
  - Both the FB and ATC-domain will be published
- Frequent Stake Holder meetings to discuss the approach and progress

ENERGINET SVENSKA KRAFTNÄT FINGRID Statnett

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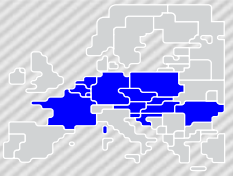
Core Long Term CC

Status update

J. FERNANDEZ



Core TSOs are currently implementing the Core LT CCM

- Core TSOs are drafting the HLBP and Requirements and have started prototype development.
- Core TSOs have requested market participants feedback on KPIs and EXT // run organization starting in the last CCG meeting in March → *See next slides as a reminder*

Roadmap, status and main milestones

	Key project milestones	Target due date
1	Prototype LTCC tool ready for testing and experimentation	Q2 2022
2	Offers for IT development approved	Q3 2022
3	Tooling ready for Int // Run	Q1 2024
4	Ext. // Run Start (6 months before Go-Live)	01/05/24
5	FB LTCC Go-Live	01/11/24

Next meetings with market participants:

- Core CCG meetings
- MESC meetings

Core Long Term CC

EXT // run organization and KPIs

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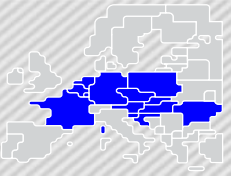

Reminder:

- **27/01:** Core TSOs informed market participants on a proposal to cooperate on the organization of the EXT // run during the last workshop.
- **29/03**: Core TSOs requested market participants to provide input for EXT // run organization and KPIs during the last CCG meeting.

Today Core TSOs would like to request market participants to provide input for the EXT // run organization and KPIs:

- Input is requested on EXT // run organization:
  - How can market participants provide the data for EXT // run?
  - When should the data be provided for EXT // run?
  - Which kind of data should be provided (Union of domain, or market simulations) for EXT // run?
- Market participants are also requested to indicate whether any other KPI than the KPIs already defined in DA would be necessary for the LT EXT // run.

→ *See next slides*

Core Long Term CC

EXT // run organization and KPIs

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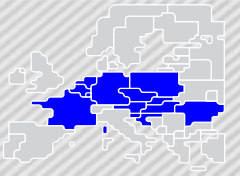

Currently existing KPIs in Core DA project, market participants to indicate if any new KPIs should be introduced for LT:

KPI Category	KPI	Description
CNEC Selection Impact	Maximum AMR per CNE per TS (MW)	Maximum across all Contingencies per CNE
	Maximum AMR per CNE per TS (% of Fmax)	Maximum across all Contingencies per CNE
	Average maximum AMR per CNE per BD (MW)	For each CNE, average of KPI_1.1a across all 24 TS per BD
	Average maximum AMR per CNE per BD (% of Fmax)	For each CNE, average of KPI_1.1b across all 24 TS per BD
	Maximum AMR per TSO per TS	Maximum AMR across all CNECs of the respective TSOs
	Average maximum AMR per TSO per BD	For each TSO, average of KPI_1.3 across all 24 TS per BD
	Share of TSs with intervention per TSO	Share across all TS for which final domains are provided
	Share of BDs with intervention per TSO	Share across all BDs for which final domains are provided
	For each CNE affected by TSO intervention: share of TSs with TSO intervention	Share across all TS for which final domains are provided
	For each CNE affected by TSO intervention: Total IVA applied per TS (MW)	Taking the highest sum of IVA amongst all related contingencies
	For each CNE affected by TSO intervention: Total IVA applied per TS (%)	Taking the highest sum of IVA amongst all related contingencies
	For each CNE affected by TSO intervention: share of BDs with TSO intervention	Share across all BDs for which final domains are provided
	For each CNE affected by TSO intervention: Total IVA applied per BD (MW)	Taking the highest sum of IVA amongst all related contingencies
	For each CNE affected by TSO intervention: Total IVA applied per BD (%)	Taking the highest sum of IVA amongst all related contingencies

Core Long Term CC

EXT // run organization and KPIs

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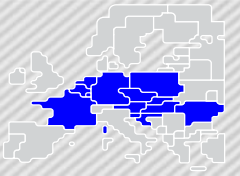


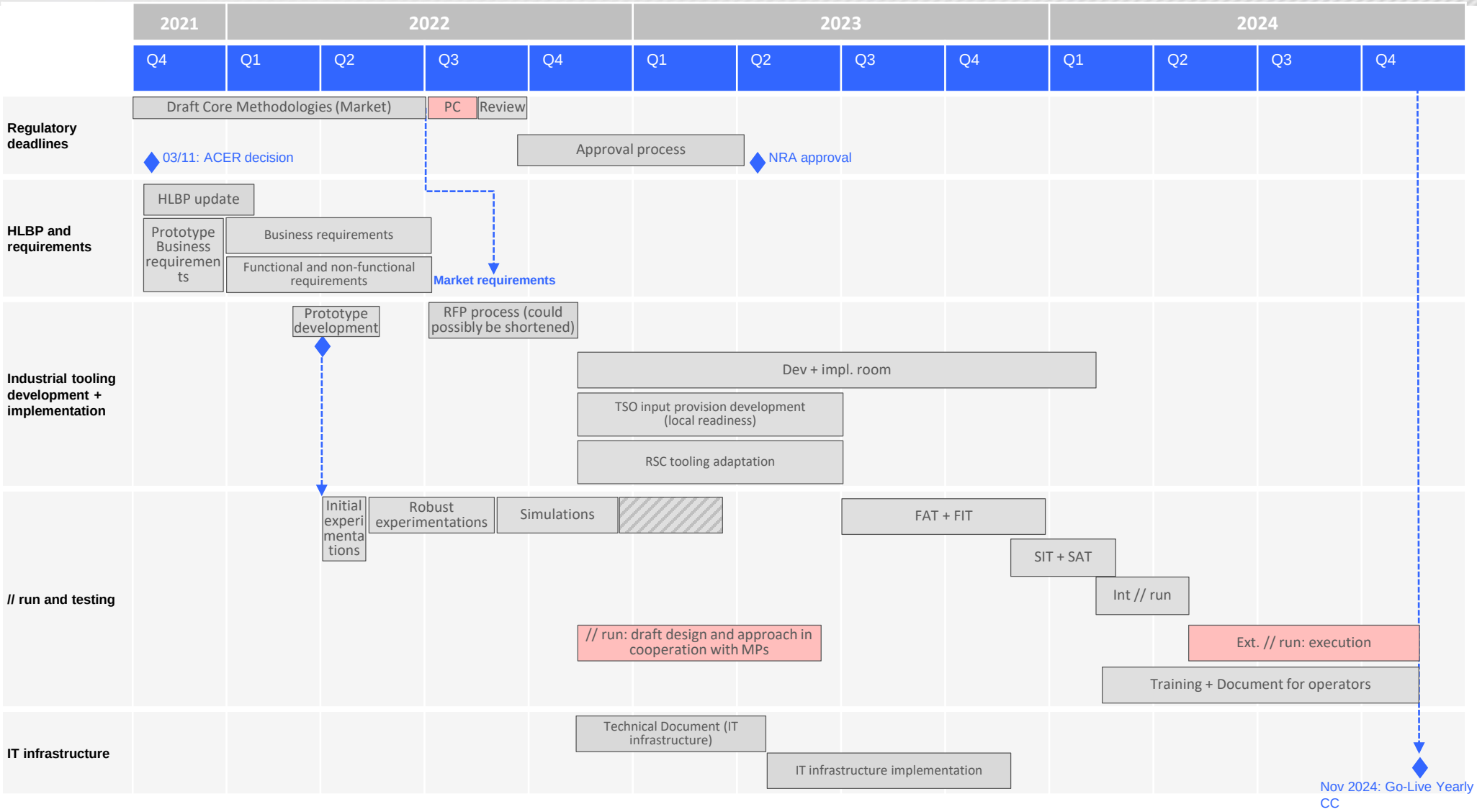
Currently existing KPIs in Core DA project, market participants to indicate if any new KPIs should be introduced for LT:

KPI Category	KPI	Description
Market Impact Assessment	Limiting CNEs (Top 20)	List of CNEs which are most often limiting the amount of power that can be exchanged. For each CNE there are maximum shadow price and number of hours, when the CNE is the limiting one. Furthermore, for each CNE, there is its maximal z2z PTDF, min, max and average RAM expressed as percentage of Fmax. Allocation constraints are part of CNEs in the pivot table.
	Price Spread	Graph that shows min, max and average clearing prices in the simulated BD for all Core hubs, a graph that shows the aggregated price spread information for whole Core region and additional graphs that show hub borders for a clearer view (divided in hubs that have borders in CWE, CEE or CWE/CEE region). The graphs also show the relative part of the converged price at each border/region level.
	Most often presolved CNEs (Top 20)	List of CNEs which are most often presolved (they are part of the FB Domain used for the SDAC). For each CNE there are number of hour in which the element was presolved. Furthermore, for each CNE, there is its maximal z2z PTDF, min, max and average RAM expressed as percentage of Fmax.
	Shadow prices	Table that shows one (or more) CBall CNECs with highest non-zero shadow prices in each hour for the simulated BD. Link is also made to minRAM compliance showing RAM in % of Fmax. IVA, CVA and status of the element (CNEC vs VNEC) would require further developments. Data should be gathered from the parsed domain file.
	Social Welfare	The KPI is provided as two sub KPIs : 1. Aggregated Core and SDAC area SW 2. Distribution of producer and consumer surplus per country (for Core region) The first one presents the SW for FBI, FBP, copper plate and SDAC, with a breakdown between PS, CS and CI for Core. The second one presents per country the producer and consumer surplus
Power System Impact Analysis	Min & max Net Position per BZ hub	Theoretical minimum and maximum net position per BZ hub and per timestamp
	Max overloads at MCP per TSO, per BD - two KPIs, one showing only the maximum overload and the other the distribution	Overloads per TSO, meaning RAM of CBCOs w/o minRAM margin when negative at market clearing point.
Non-Core Exchange	Delta of Non-Core exchanges per border	Monitors the delta flow (ΔF) of non-Core exchanges between the D-2 and D-1 timeframe by aggregation of all non-Core tie-lines per non-Core border

Core Long Term CC

J.FERNANDEZ

LTCC implementation



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Long-Term Flow-Based Allocation

Workshop with market participants 24/05

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Reliable Sustainable Connected

Agenda

	SUBJECT	WHO	TIMING
1	General update on the project	H.HAIDER	
2	Update on the amendment of the methodologies	H.HAIDER	
3	TSOs' reflections on market participants' concerns	H.HAIDER M.KLOS	

1.- General update on the project

General update on the project

Amendments of FCA methodologies and "Process description" document

- The Long-Term Flow-Based Allocation (LTFBA) expert team is working to implement the Long-Term Flow-Based (FB) approach for Core and Nordic CCRs. The expert team, is working on **LTFBA on an All-TSOs' level** together with JAO.

- The following **four All TSO methodologies** are being amended to allow LT FBA:
  - SAP proposal (FCA article 49)
  - FCA CID (FCA article 57)
  - FCA FRC (FCA article 61)
  - HAR (FC article 51)

- The design of LTFBA is described in the **High-Level Market Design document** - published on the ENTSO-E website.

- The LTFBA expert team has started the drafting the **requirements and process description** of LTFBA process together with JAO and the Core and Nordic CCRs.

- **Regular contact with market participants** on the progress of LTFBA implementation is ensured through MESC meetings and through different workshops.

2.- Update on the SAP amendment

SAP Amendment

Introduction of Flow-Based allocation

- The SAP proposal has been amended with the introduction of Flow-Based allocation:
  - The **formulas** for Flow-Based allocation have been included
  - The **requirements towards SAP** for LTFBA have been included

- The proposal has also been updated with the explanation of NTC allocation:
  - **Formulas for NTC allocation**
  - Inclusion of handling of **technical profiles**

- An explanatory document is being drafted to **explain the changes** and provide examples.

- The amendment of the SAP proposal is planned to be submitted by **01/10/2022.**

2.- Update on the SAP amendment

SAP Amendment

General changes

Whereas	New paragraphs explaining the need for the amendment (introduction of Flow-Based)
Definitions and interpretation	New definition to enhance the methodology – “Technical Profile”
A. 13 – Cooperation of SAP CA Parties	Improvement of Article 13 paragraph a), to better define “user’s groups”, such as but not limited to a consultative user group with market participant associations, and operational and technical user group dealing with feedback and requests on the IT interfaces and the SAP tasks.
Other amendments	Clarifications on articles on “Capacity Curtailment and Nomination”, on “Auction Results Determination”, on “Notice Board” and on “Auction cancellation” article.

2.- Update on the SAP amendment

SAP Amendment

Introduction of allocation algorithm formulas and requirements towards SAP

A. 39 (NEW!) – Allocation algorithm formulas

New article under "Title 3 – Products, allocation methods and algorithms" detailing:

- The general principles for the calculation of the auction results (i.e. marginal price, single auction price for each BZB direction, etc.);
- the mathematical formulation for the calculation of the Auction Results by:
  1. The NTC based allocation or,
  2. The Flow-Based based allocation
- The reference to the new Annex I with the Common set of requirements for the LTFBA algorithm.

Annex 1 (NEW!) – Common set of requirements for the LTFBA

i. Requirements on functionalities and performance
  - i. General requirements
  - ii. Qualitative requirements with precision and price ranges
  - iii. Performance

ii. Requirements on algorithm output and deadlines for the delivery of results
  - i. Regarding the prices

iii. Requirements related to allocation constraints
  - i. Regarding definition of positive and negative limits of net positions

2.- Update on the FCA CID, FCA FRC and HAR amendment

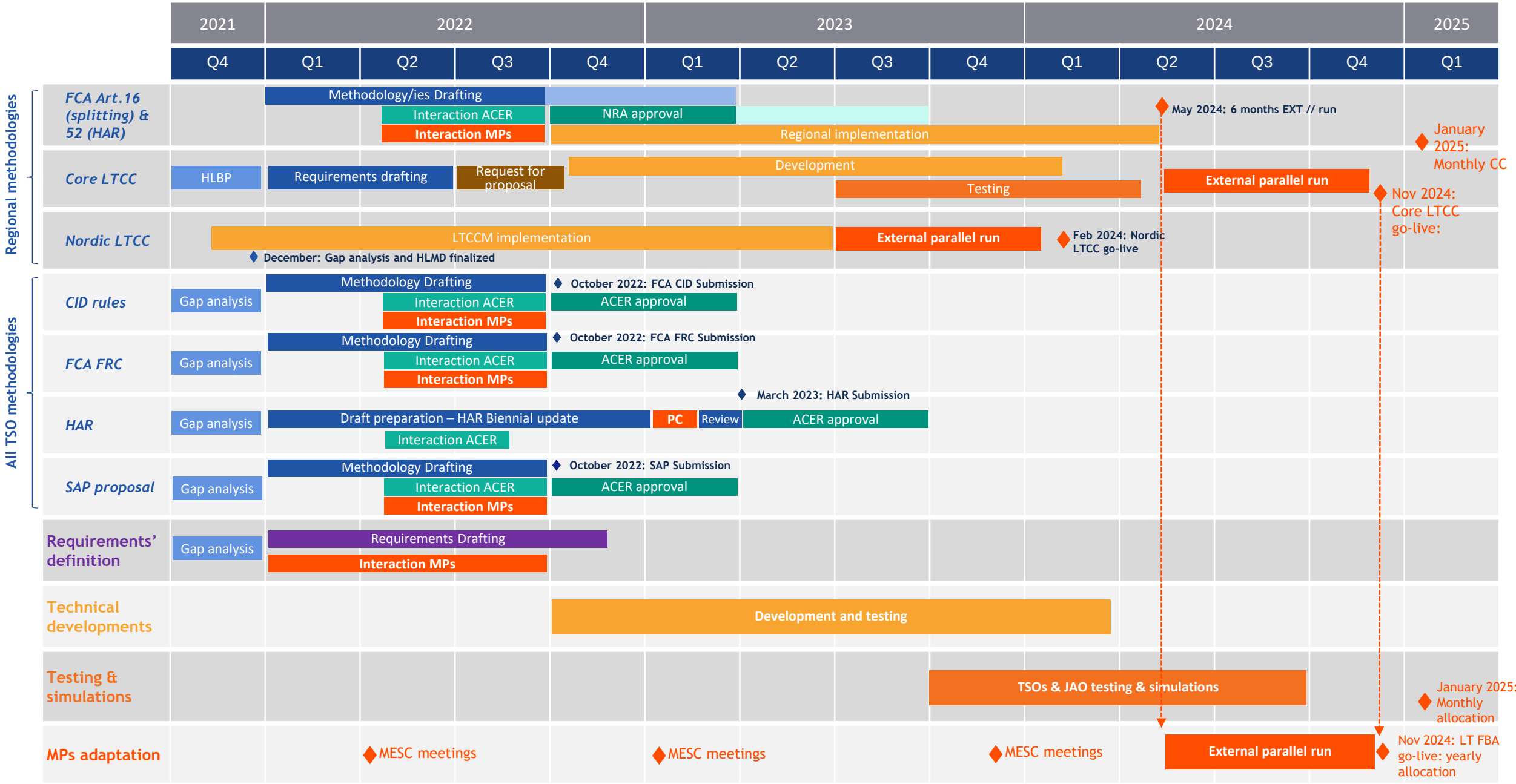
FCA CID and FCA FRC Amendment

Introduction of a new distribution of congestion income and costs

- Based on ACER guidance, it it foreseen to develop an updated FCA CID methodology **introducing specific characteristics of LT FB allocation** in the CID process. The work is progressing with joint work between FCA CID and FCA FRC experts.
- Updates in the FCA CID methodology have to be consequently considered for the update of the **FCA FRC** methodology, given the relation among the methodologies.
- The amendments of the FCA CID and FCA FRC are planned to be submitted by **01/10/2022.**

HAR Amendment

- The work is yet to be started by Q3 2022.
- The amendment of the HAR is planned to be submitted by 01/03/2023.



*Timings may slightly vary from the planning above

Any question?

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EFET European Federation of Energy Traders
SO YOU CAN RELY ON THE MARKET

eurelectric powering people

Making the LT FBA optimisation function match market participants needs

24 May 2022

MP concerns on the FB allocation (reminder)

- LTTRs are hedging instruments allowing market participants to hedge (= be protected) **cross-border transmission price risks**.

- The **risk related to the volatility of bidding zone price difference** (rather than the absolute value of the spread) is a crucial risk for the market to hedge against.
  - => The more the spread varies over time (the higher the risk of spread variation), the more LLTRs are useful to market participants (and valued)

- LTTRs should be **allocated where hedging opportunities are most needed**

  => If [optimization function = TSO income at auction] there is a risk that volumes are allocated at borders where the spread is high, even if expected variation of the spread is low

- The optimisation function presented by the TSOs in the ENTSOE document does not adress these concerns

Reflection on TSO considerations

- The FCA GL does not clearly define hedging – but it clearly mentions that hedging opportunities must be promoted ***for*** market participants

=> where market participants see the need for hedging opportunities should be privileged over maximising TSO income

- Considering the volatility of spreads in the optimisation function will require long discussions on the right metrics to use, and may delay the project – but it is ***not impossible*** as such

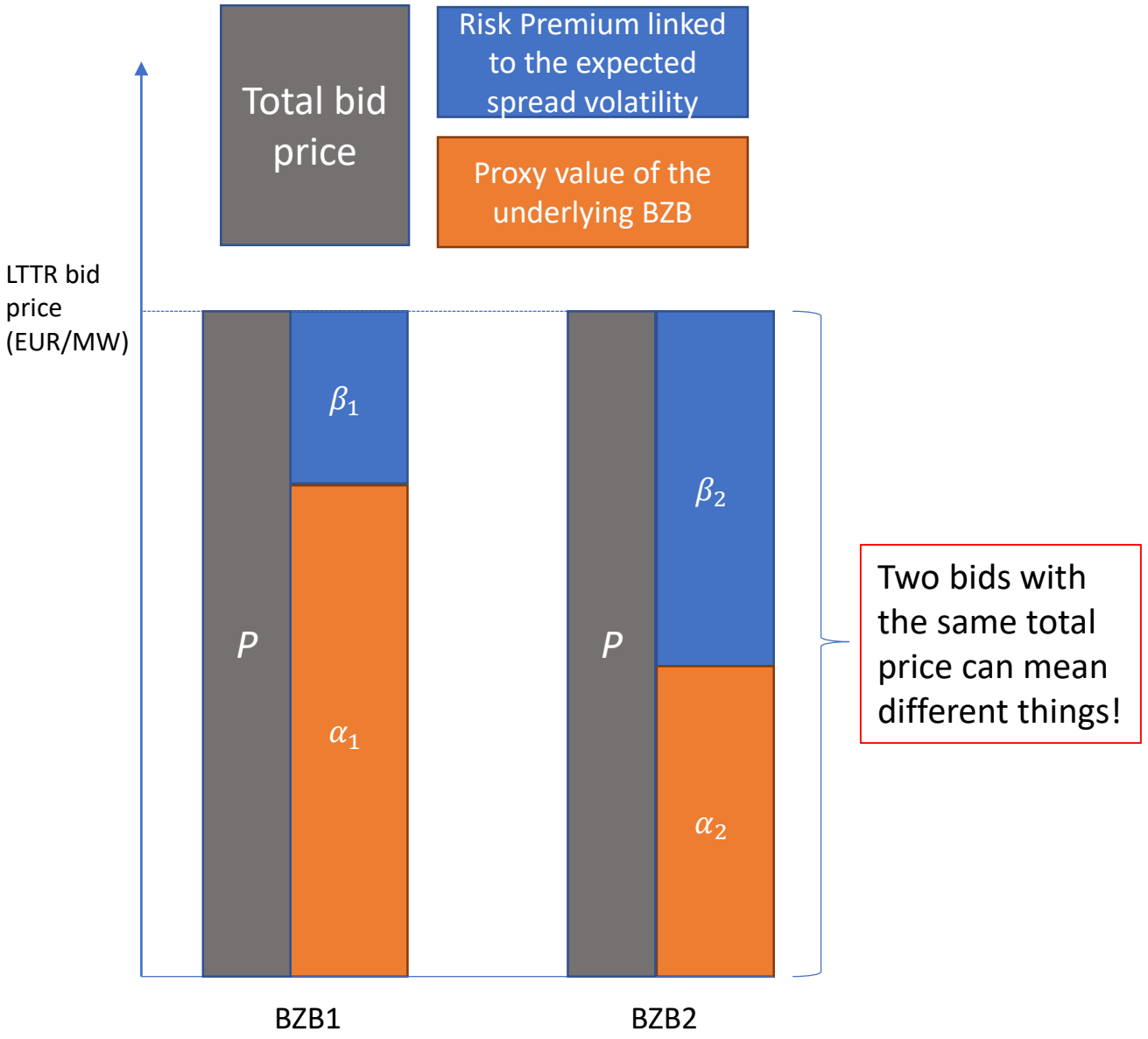
=> we do not want to delay the implementation of LT FBA, but we want to ensure that changes will be doable in the future (if not now)

Proposed way forward

The objective function should strive towards promoting the most useful hedging opportunities for market participants:

- **The least we request now is a place-holder in the EU HAR** (and relevant methodologies) to ensure LTTRs allocation where most needed in the future
- In practice, we propose **having the possibility to decompose the bid price in two terms** (underlying - alpha and risk premium - beta) with a option to weigh them differently
  - Gives the possibility to pursue the discussions in the coming months, while not slowing down the process
  - A method to determine the value of the underlying and the value of the risk premium should be developed and properly described
  - Once this is done, the weigthing coefficient of each component can be adapted according to the outcome of the discussions (=1/2 coeff. for each component means current ENTSOE proposal)
- If/when we agree on the consideration of the volatility of spreads, this solution would only require changing parameters, not the algorithm as such: we all know the difficulties of modifying a defined algorithm (change requests are difficult, slow and costly)

Illustration of the proposed way forward



- The algorithm should allow <u>from the start</u>:
  - considering the total bid price *P* – as per the TSOs proposal
  - and considering the separate components of the total bid price (α and β) – as per market participants' wishes

- This gives us <u>time to</u>:
  - develop a methodology to differentiate α from β
  - decide on the weights to attribute to the different components of the bid price

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3.- TSOs' reflections on market participants' concerns

Background

Comments and concerns were expressed by the market participants (EFET and Eurelectric) in the ENTSO-E and ACER's workshop on LTFBA that took place on 27 January 2022. The main concerns were:

1. Due to the competition between bids from different bidding zone borders (BZBs) during the flow-based capacity allocation, this may **result in zero allocated rights at a BZB despite existing demand on that BZB.**

2. Capacity is allocated to the BZB with higher price bids while **traders are actually more eager to hedge in borders with volatile price spreads**.

Scope of the assessment

The LTFBA expert team of TSOs has assessed and discussed both concerns and would like to present a first opinion on both.

The goal of this presentation is thus to present the TSOs´ first reflections on the allocation algorithm

3.- TSOs' reflections on market participants' concerns

Relevant framework & Regulatory Analysis

Electricity Regulation

Article 16.1: Network congestion problems shall be addressed with non-discriminatory market-based solutions, which give efficient economic signals to the market participants and transmission system operators involved (...).

***Article 16.6**: In the case of congestion, the valid highest value bids for network capacity, whether implicit or explicit, offering the highest value for the scarce transmission capacity in a given timeframe, shall be successful (...).*

FCA Regulation

***Article 3 (a)**: This Regulation aims at: promoting effective long-term cross-zonal trade with long-term cross-zonal hedging opportunities for market participants*
***Article 3 (c)**: This Regulation aims at: providing non-discriminatory access to long-term cross-zonal capacity*
***Article 3 (d)**: This Regulation aims at: ensuring fair and non-discriminatory treatment of TSOs, the Agency, regulatory authorities and market participants;*
***Article 28 (a)** The allocation of forward capacity shall take place in a way which:*
(a) uses the marginal pricing principle to generate results for each bidding zone border, direction of utilisation and market time unit;

Electricity Regulation clearly stipulates which principle to use for the capacity allocation.
FCA Regulation does not exactly define what is to be understood under hedging.

3.- TSOs' reflections on market participants' concerns

TSOs' explanation (1/2)

Capacity allocation to BZB with higher price bids

- With the introduction of LTFBA there are no longer individual BZB auctions that seek local optima. Instead, Long-Term Transmission Rights (LTTRs) in all BZBs in the capacity calculation region are evaluated in a single algorithm that seeks the **global optimum**, and a **single auction provides the results for all the borders of the region at the same time**.

- In LTFBA the scarce transmission is allocated on a regional level and all BZB compete for it. To **ensure non-discrimination** between the BZBs **the same approach for their bids' valuation shall be applied**.

- The price of a bid represents a market participant's will and commitment to pay for an LTTR – in other words **how much the market participant values it**.

- It also gives a **signal to correctly evaluate congestion in the grid** – i.e. where the congestion is valued the most by the market

- The proposed Flow-Based allocation is a fair and is **non-discriminatory approach** which considers **all the bidding zone borders and bids** of the market participants in the same way.

3.- TSOs' reflections on market participants' concerns

Let's consider a manufacturer producing **chairs and couches** from recycled materials. The producer aims at **maximizing his return** (value of produced items). In his workshop he has some resources (**wood, steel and fabric**) which are **costless however limited**. He knows exactly how much of particular resources are required to manufacture the products.

In optimal selection of the furniture:


price	100 €	1000 €	LIMIT on resources [kg]	optimal utilization of resources [kg]	value of resources (shadow price) [€/kg]
wood	8	60	650	650	8.33
fabric	0.5	5	50	47.08	0
steel	0.1	1.5	12	12	333.33

utilization factors

If optimization techniques are applied you can find the optimal solution to this problem

solution:	#42.5	#5.17
value (9417 €):	4250 €	5167 €

In Flow-Based Allocation of LTTRs:

- *LTTRs competing on auction act like chairs and couches competing for being produced*
- *Total income from auction is an analogy for value of manufactured items (9417 €)*
- *CNECs act like limited resources*
- *PTDFs are utilization factors, they inform how much capacity of CNEC is used to execute LTTRs*
- *Allocated flow is represented by optimal utilization of resources*
- *A unit of capacity on CNEC can unblock LTTRs worth a given amount of EUR. This way shadow prices evaluate critical resources*

CNEC: Critical Network Element and Contingency

3.- TSOs' reflections on market participants' concerns

TSOs' explanation (2/2)

Competition between BZBs

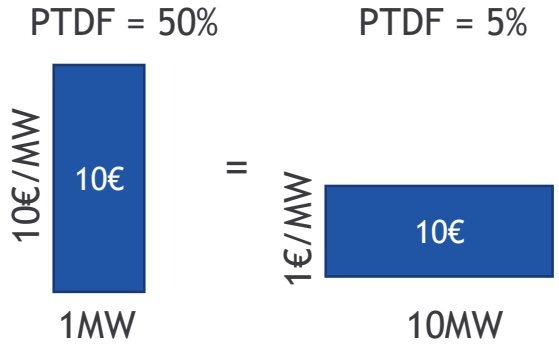
- The transactions at different BZBs (directional) **compete** for a common regional **capacity domain.**
- The **interdependence between transactions and their physical execution** (via PTDF) plays a key role in formation of results.
- The competition for the CNEC's capacity (i.e. available RAM) is not based on the **transaction price** solely, but depends also on the **allocated amount and the PTDF**. Higher PTDF translates to higher chance of acceptance of bids.
  - If the PTDFs factors of BZBs are of similar size, then there is **direct competition** between the transaction prices and there is a high dependency between two BZBs prices.
  - If the PTDF factors are very different (i.e. distant BZBs), then the price competition and BZB price dependency is **lower**.
- High prices at one BZB **do not hinder allocation on low priced distant BZB**. Significantly different prices at BZBs do not mean that bids at both BZBs cannot succeed.
- Zero capacity allocation at a BZB can happen if the transaction on a border does not **generate enough value** (other transactions are more valuable).

Example – allocation algorithm impact

1MW allocation @10€/MW with PTDF = 50%

equals to

10 MW allocation @ 1€/MW with PTDF 5%)



The equivalence of these offeres means that:

- they are equally valued (10 €)
- they use the same amount of a CNEC (0.5 MW)

TSOs consider such behavior as market based and correct

3.- TSOs' reflections on market participants' concerns

Assessment of implementation of Market Participants' requests

Usage of another objective function in the matching algorithm

1.- Using forward market spread between two borders as input data to consider the market risk premium

Extremely complex databases:

- Several organized and non-organized markets (power exchanges and brokers) exist and an index building considering all the different marketplaces where a spread product is traded would be quite complex.
- Omitting some venues for the sake of simplicity and focusing on the marketplaces with the highest traded volumes and/or liquidity would be **discriminatory**.

Risk of market manipulation:

- Some forward markets for specific borders lack liquidity and quality – the price may not correctly represent the value of electricity.
- There is a **possible risk of market abuse** where a few Market Participants could move the spread volatility easily, hence impacting the capacity allocation in the region.

3.- TSOs' reflections on market participants' concerns

Assessment of implementation of Market Participants' requests

Usage of another objective function in the matching algorithm

2.- Using ex-post DA price spreads as input data to consider the market risk premium

Only partial consideration of Market Participants' request:

- Auto-regression between past DA prices spread and forward products spread for a given border is not necessarily given. (e.g. seasonality effects can be present or not and fundamental data might change over time)

Both presented options:

- Are not compatible with the legislation
- Are not compatible with the implementation´s timeline (high complexity)
- Would mean to have a different matching algorithms for DA and LT FBA

3.- TSOs' reflections on market participants' concerns

Conclusion (1/2)

Chosen approach and consideration of market participants' feedback

Option	Advantages	Disadvantages
Status quo - same algorithm used for any explicit allocation i.e. - maximize the value of accepted bids.	• It fulfils allocation of LT capacity considering competition given by market situation • It is compliant with legislation • It can meet the implementation deadline • It has the same principle for the matching Algorithm for both DA and LTFBA • It is already in operation for similar problem – technical profiles	• According to the expectations of the market participants, the approach does not fulfil the inclusion of risk premium

3.- TSOs' reflections on market participants' concerns

Conclusion (2/2)

Chosen approach and consideration of market participants' feedback

- **TSOs acknowledge market participants' concerns** about the change in the allocation form and the challenges the new approach will have for them and for their daily processes. TSOs are **keen to cooperate with market participants on the transition**.
- The suggestions raised by market participants are **worth further investigations,** to which TSOs are open for. However, such discussions cannot be included in the LTFBA go-live in Q4/2024.
- Technically, flow-based capacity represents an **evolution of the current situation** (technical profiles). TSOs understand that the evolution of the allocation algorithm principles will be progressive following the legal framework.
- TSOs find that the originally proposed allocation method is **in line with the regulation** and that the underlying principles are market based.
- The current go-live deadline already supposes a **significant challenge** for the TSOs and JAO to adapt all the necessary processes and methodologies in time. Additional discussion on the algorithm could **hinder the timely implementation of this first phase of LTFBA.**

TSOs welcome any solution that market participants may want to bring forward and propose to assess the feasibility of its implementation in the future, within the legal framework

TSOs call market participants to further discuss improvements to the allocation algorithm once it has been implemented.

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	AGENDA	
10:00-10:10	Introduction	ACER & ENTSO-E
	SESSION 1: CORE AND NORDIC LONG TERM FLOW-BASED: CAPACITY CALCULATION	
10:10-10:20	Nordic TSOs planning on the implementation of LT CCM	Nordic TSOs
10:20-10:30	Core TSOs planning on the implementation of LT CCM Feedback from market participants on external parallel run Organization and Key Performance Indicators	Core TSOs
10:30-10:40	Market participants' feedback and proposals Discussion	MPs All
	SESSION 2: CORE AND NORDIC LONG TERM FLOW-BASED: ALLOCATION	
10:40-10:50	LT FB allocation: general update on the process and allocation methodologies	ENTSO-E
10:50-11:00	Discussion	All
11:00-11:20	Optimisation function – alternative proposal	EFET & Eurelectric
11:20-11:40	TSOs' reflections on market participants' concerns	ENTSO-E
11:40-12:00	ACER's reflections on market participants' concerns	ACER
12:00-12:55	Discussion	All
12:55-13:00	Wrap-up	ACER

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Long-term flow-based capacity allocation

ACER's reflections on market participants concerns on long-term flow-based capacity allocation

- FCA Regulation has two main objectives

  1. Promote effective long-term cross-zonal trade

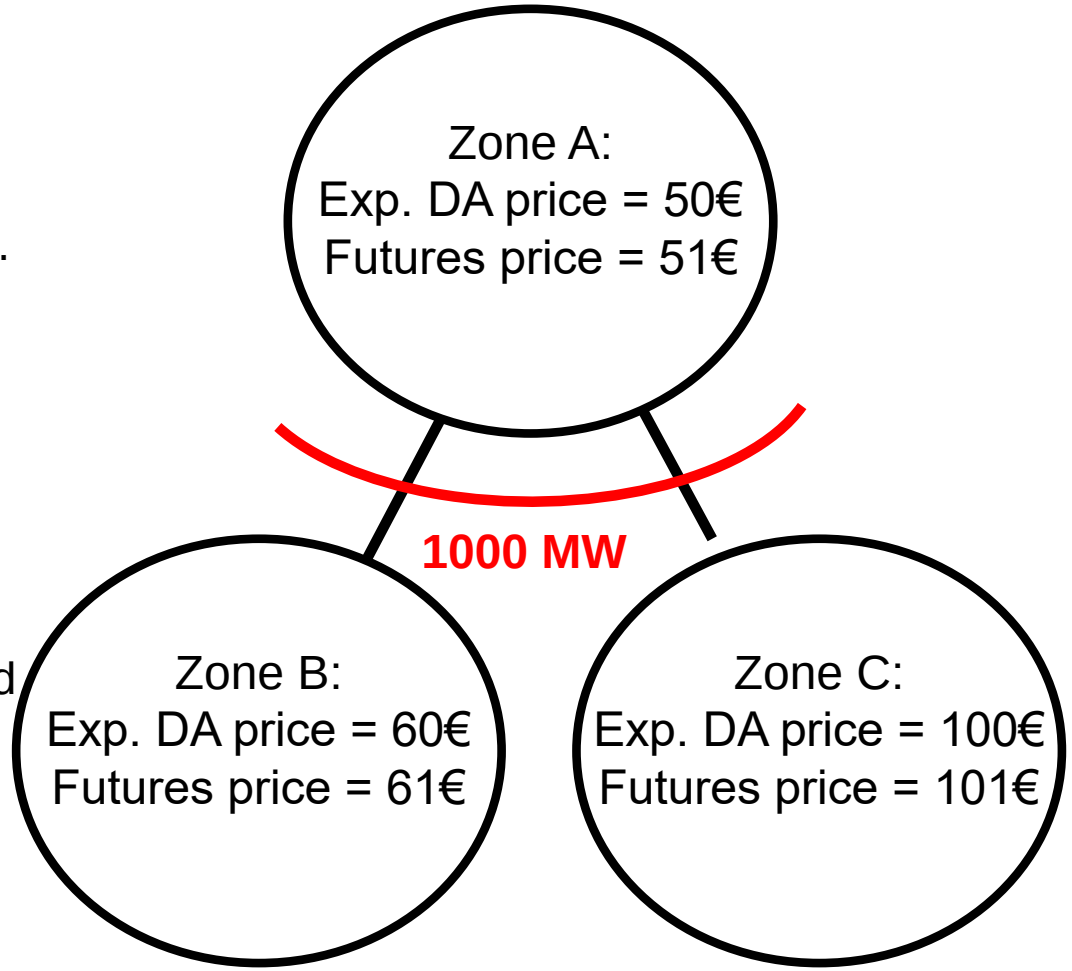
  2. Provide sufficient hedging opportunities

- Both objectives are important and they largely overlap: long term trade is also a hedge
- Market participants proposals would make sense if hedging volatile prices would be the only objective of long-term capacity allocation, however…
- … long-term capacity allocation also serve to facilitate long-term cross-zonal trade – the demand to find the cheapest supply in long-term timeframe

Long-term flow-based capacity allocation

ACER's reflections

- Expected DA prices are based on DA coupling principles
  - 1000 MW is expected to be allocated to A-C
- If in LT timeframe 500 MW would be allocated to each border (e.g. due to minimum capacities)
  - Futures price in B will decrease
  - Futures price in C will increase
  - These futures prices would not reflect expected DA prices and would not be based on expected physical realty
  - Supply for futures in B would be artificially increased or demand decreased
- Distortions of market forces and price signals



Long-term flow-based capacity allocation

ACER's reflections

- MP's proposal raised a number of questions:
  - How to ensure the most efficient cross-zonal trade?
  - How to ensure that demand meets the cheapest supply?
  - How to unambiguously isolate risk premium from expected price spread?
  - What is the basis in academic literature, practice or legal framework?
  - How to ensure consistency between long-term and day-ahead price signals?

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Thank you!

Appendix

Elaborated example

Let's consider a manufacturer producing **chairs and couches** from recycled materials. The producer aims at **maximizing his return** (value of produced items). In his workshop he has some resources (**wood, steel and fabric**) which are **costless however limited**. He knows exactly how much of particular resources are required to manufacture the products.

price	100 €	1000 €	LIMIT on resources [kg]	optimal utilization of resources [kg]	value of resources (shadow price) [€/kg]
wood	8	60	650	650	8.33
fabric	0.5	5	50	47.08	0
steel	0.1	1.5	12	12	333.33

utilization factors

If optimization techniques are applied you can find the optimal solution to this problem

solution:	#42.5	#5.17
value (9417 €):	4250 €	5167 €

***FBA**: LTTRs competing on auction act like chairs and couches competing for being produced*

If shadow price is 0, it reflects the fact that some type of resource is not critical, i.e. has not been fully used. Increasing such limit (eg. From 50 to 55) would not give any additional benefit to furniture produced, as other resources are more critical.

*Shadow prices evaluate resources which authentically limit the production. E.g. additional unit of steel could give another 333 € of total income – in **FBA**: a unit of capacity on CNEC can unblock LTTRs worth a given amount of EUR.*

LTTRs concerning particular border (price difference between a pair of neighbouring zones) is represented by a piece of furniture. In more complex example, different couches (on one border) would compete with multiple chairs (from other border). Even though each chair and couch can be priced differently when sold by manufacturer, they all share the same utilization factors (the proportion of wood, fabric and steel) remains the same. This represents different LTTR offers from a border which can be priced differently by market participants but they share the same PTDFs.

***FBA**: CNECs act like limited resources*

***FBA**: Allocated flow is represented by optimal utilization*

***FBA**: Total income from auction is an analogy for value of manufactured items*

***FBA**: PTDFs are utilization factors, they inform how much capacity of CNEC is used to execute LTTRs*