Task Force Princess Elisabeth Zone

16th of May 2024

Agenda

[10:00 - 10:30]	Overview results public consultation TF PEZ
[10:30 - 11:00]	Market design
[11:00 - 12:00]	Balancing design
[12:00 - 13:00]	Break
[13:00 - 14:00]	Connection requirements
[14:00 - 15:00]	Dynamic and Harmonic

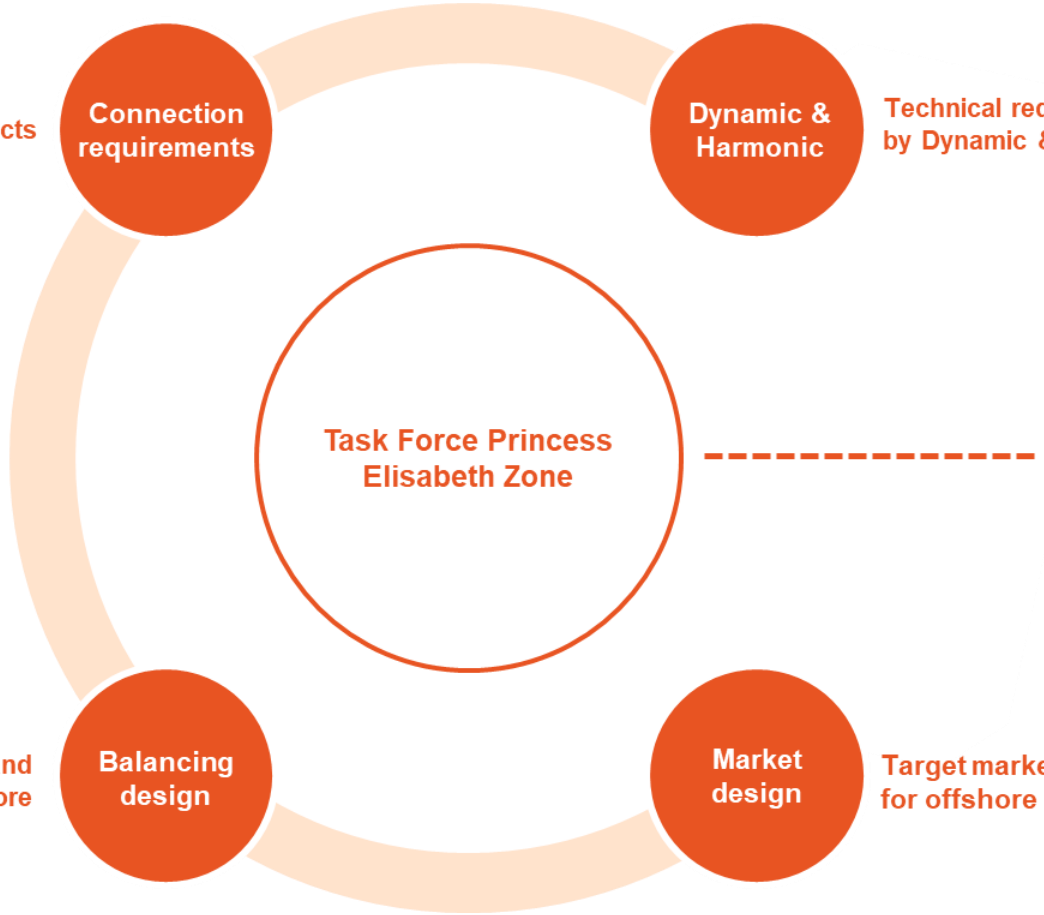
Overview results
Public consultation Task Force PEZ

Process overview

Elia organized a public consultation Task Force Princess Elisabeth Zone covering 4 main topics in preparation of the offshore tenders PEZ held Q4 2024

Reminder

Public consultation Task Force Princess Elisabeth Zone



- Summary of **2** years discussions with stakeholders
- **+250** pages
- **2** months for consultation *(20/11/2023 – 22/01/2024)*

Overview of key milestones on stakeholders engagement in Task Force PEZ

Elia communication process

2022-2024 — **Step 1 - Task Forces TF PEZ and ad-hoc workshops**

Elia organized couples of Task Force Princess Elisabeth Zone and ad-hoc workshop to present, inform and engage stakeholders with call of feedbacks in the preparation of the tender for Princess Elisabeth Zone

Nov. 2023 – Jan 2024 — **Step 2 – Public consultation Task Force PEZ**

Public consultation of 2 months was organized to collect feedback from stakeholders on all aspects presented in Task Force PEZ and ad-hoc workshops

16th of May — **Step 3 – Task Force PEZ**

Elia answers on public consultation TF PEZ: presentation of key reactions received and answers & adaptations

Beg. July — **Step 4 – Publication TF PEZ answer report**

Publication on Elia website of updated public consultation report with non-confidential questions in appendix and reference to section adapted

End Sep. — **Step 5 – Submission final technical requirements**

Submission of technical requirement to authorities including adaptation communicated in TF PEZ following public consultation and publication on Elia website

Overview of reactions

15 reactions were received from the public consultation on PEZ with ~380 questions/remarks

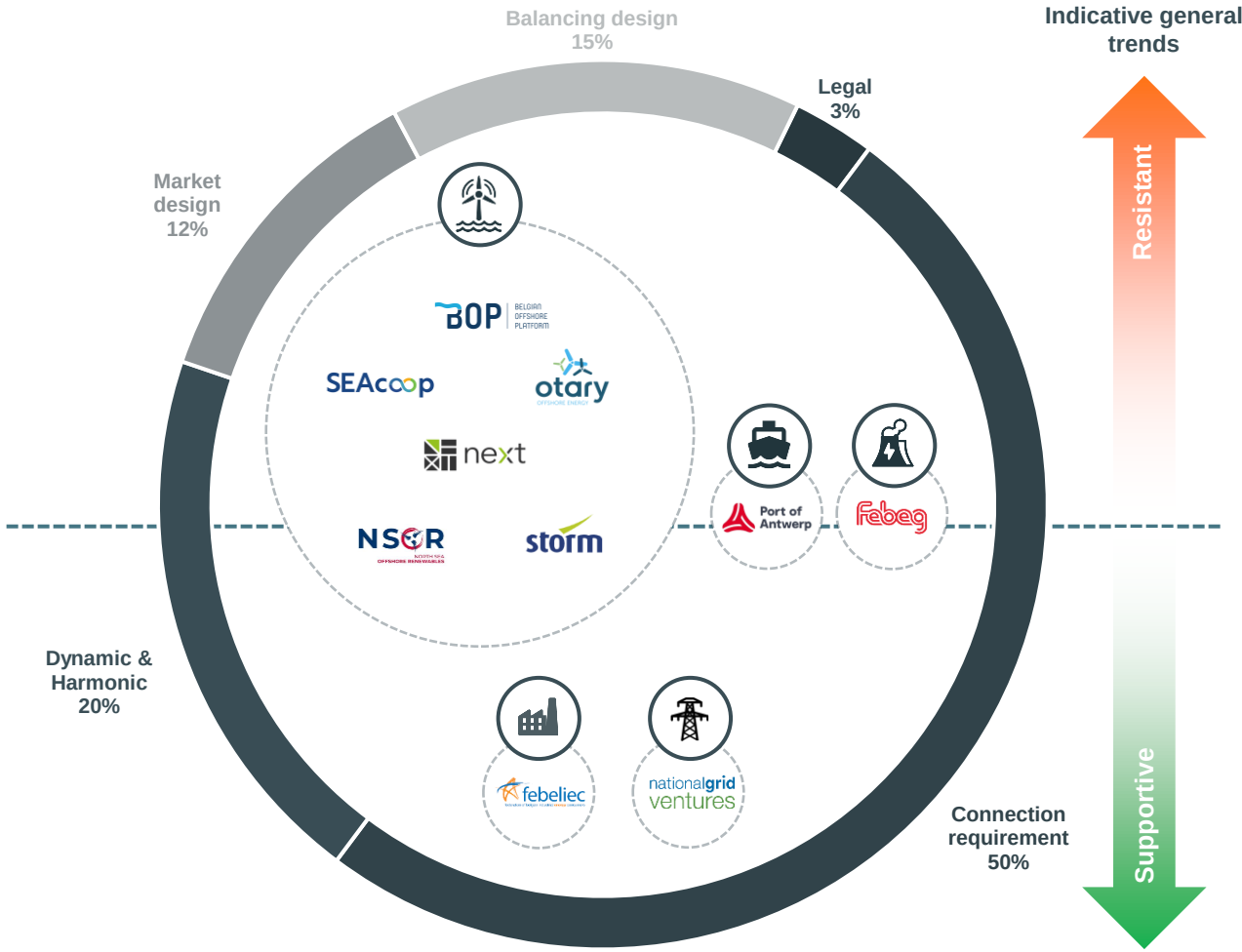
Stakeholders reactions

11 non-confidential reactions

- BOP
- Next Kraftwerke
- NSOR (=EDF renewables, Luminus and Jan De Nul)
- Otary
- Storm
- Febeg
- Febeliec
- National Grid Ventures
- SeaCoop
- Port of Antwerp
- Independant

4 confidential reactions

Overview reactions received on Elia public consultation PEZ



Main reactions identified from the public consultation

Balancing mitigation measures

While the need for mitigation measures itself is not highly questioned, some design choices are challenged with a focus on receiving remuneration for the requested measures.

CfD/compensation

Requests for financial compensation for the additional balancing mitigation measures and risk triggered by target market design

OBZ & target model

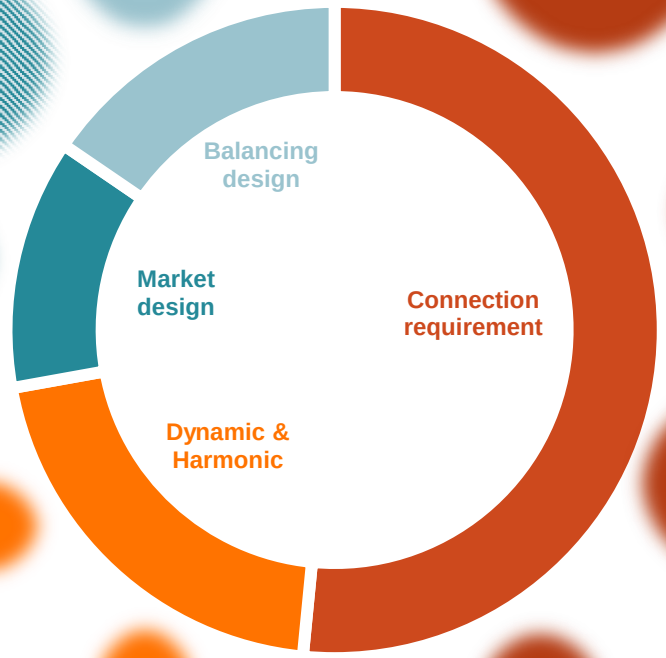
Challenge the target model and the real positive impact for the society, ask for iterative approach (HM first and then later stage/potentially OBZ to be re-assessed when arrangement with UK is in place)

Conformity process

- Rejection of principles for cost sharing in case of non-conformance
- Low willingness of OWF manufacturer to take responsibility for co-tuning of controller/future assets and simulation

Voltage management

Clarification on technical question related to voltage management



Flex access

Strong reaction against flex access and considered as red flag, or conditionally accepted with Elia commitment on period, planning and volume with compensation

Single node operation

- Request to consider split node operation given the uncertainties that can impact the business case or asking risk compensation to be covered by Elia (design choice)
- Low willingness of OWF for fine-tuning of controller with future asset

Additional info on technical requirements

Several questions received for additional information required from the manufacturer prior the tender or for the tender document

Grid design for Princess Elisabeth Island

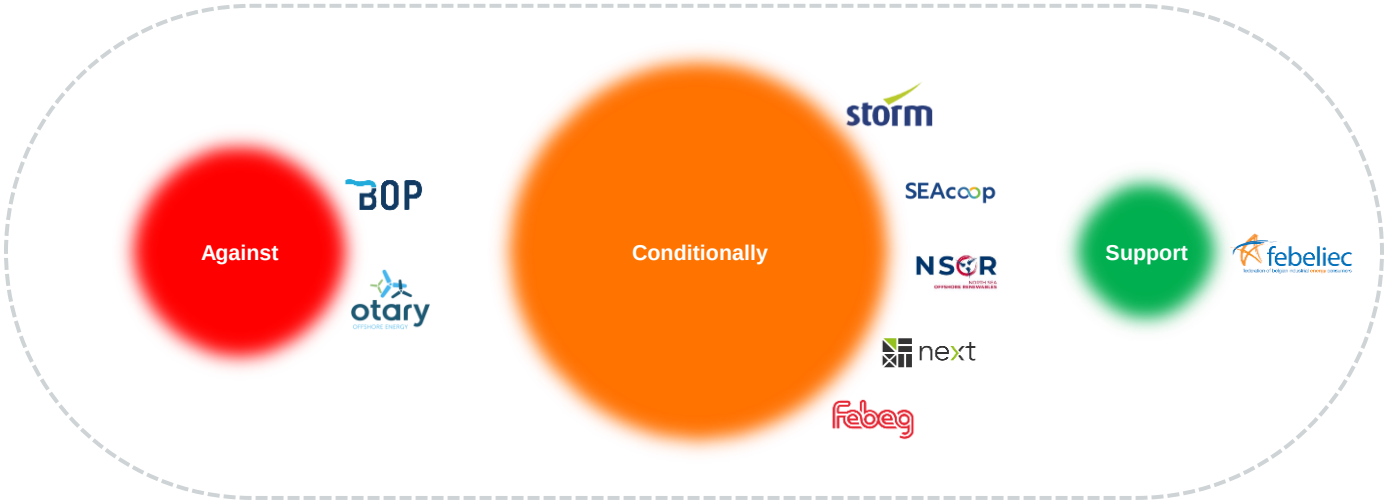
Challenges and questions on the grid design defined by Elia

General trends – for illustrative purposes only

Deep-dive connection requirements - stakeholders position

Connection requirements

Flex access



*Strong reactions received **to have firm access** while other stakeholders **are more requesting firm condition/commitment on the use of flex access (period, volume,…)** with compensation. Febeliec provides strong support on Elia proposal.*

Single node operation

***Some stakeholders are requesting to retain split node operation to avoid uncertainties and risk that can impact the business case** for offshore wind meanwhile other stakeholders ask compensation cost sharing related to design made by Elia linked with the conformity process.*

General trends – for illustrative purposes only

Deep-dive Dynamic & Harmonic - stakeholders position

Dynamic & Harmonic

Conformity process

- ***Red flag related to cost sharing in case of non-conformance during the*** *conformity process (future asset)*
- ***Willingness of OWF manufacturer to take responsibility for co-tuning of controller/future assets quite low*** *and push-back to Elia for cost.*
- ***Roles & responsibility of offshore wind in the conformity/simulation in cloud.***

D&H requirements

In general positive reactions/support related to additional requirements foreseen for PEZ. *Some stakeholders challenge the correct interpretation of new EU NC (forced oscillation) or ask clarification*

General trends – for illustrative purposes only

Deep-dive balancing & market design - stakeholders position

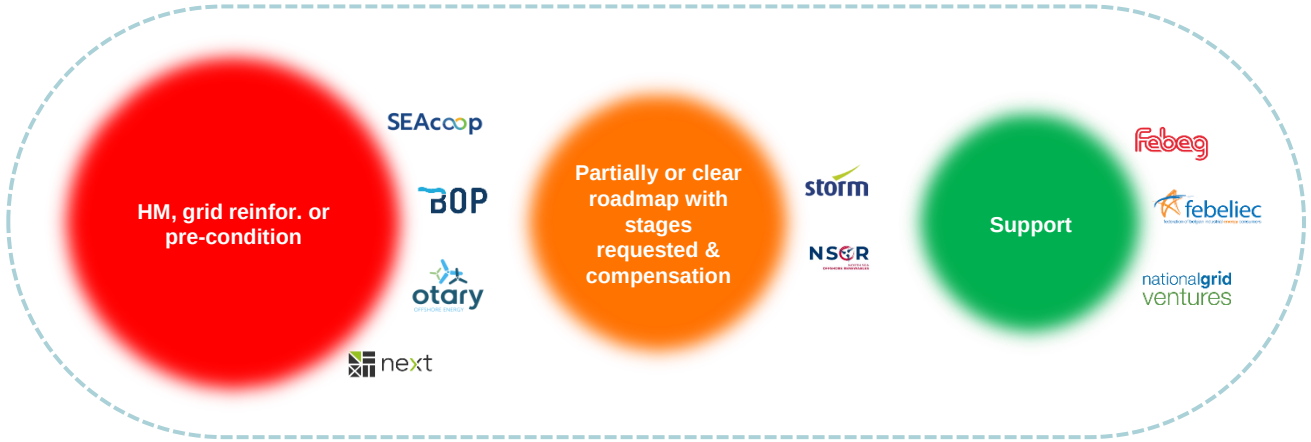
Balancing design

Mitigation measures

- *While the need of mitigation measures itself is not questioned,* ***some design choices are challenged with a focus on receiving remuneration for the measures***
- ***Febeliec strongly support the Elia proposal***
- ***NGV asks for collaboration with UK***

Market design

Target model & OBZ



- ***Some stakeholders are against the target model and ask to consider the grid reinforcement scenario***
- *Other stakeholders (wind farm)* ***are more willing to consider the Elia target model with some clarity requested on the roadmap to limit the uncertainties****. Also ask in the target model to add the UK cooperation as pilar*

General trends – for illustrative purposes only

Overview of Elia answers

Overview of adaptations on key reactions received following public consultation Task Force Princess Elisabeth Zone

Adaptation
Clarification/additional info
No change/additional justification

Impact/importance for offshore wind tender

Connection requirements

- Flex access — *New figures flex*
- Single vs split node operation — *Split node operation reference (see next slide)*
- Technical requirements — *Additional information or clarification*
- Grid design PEI & HVDC

Dynamic & Harmonic

- Conformity process — *Adaptation non-conformance mitigation rules*
- Voltage management — *Technical clarification/adaptation*
- Forced oscillation
- Data & model provision

Market design

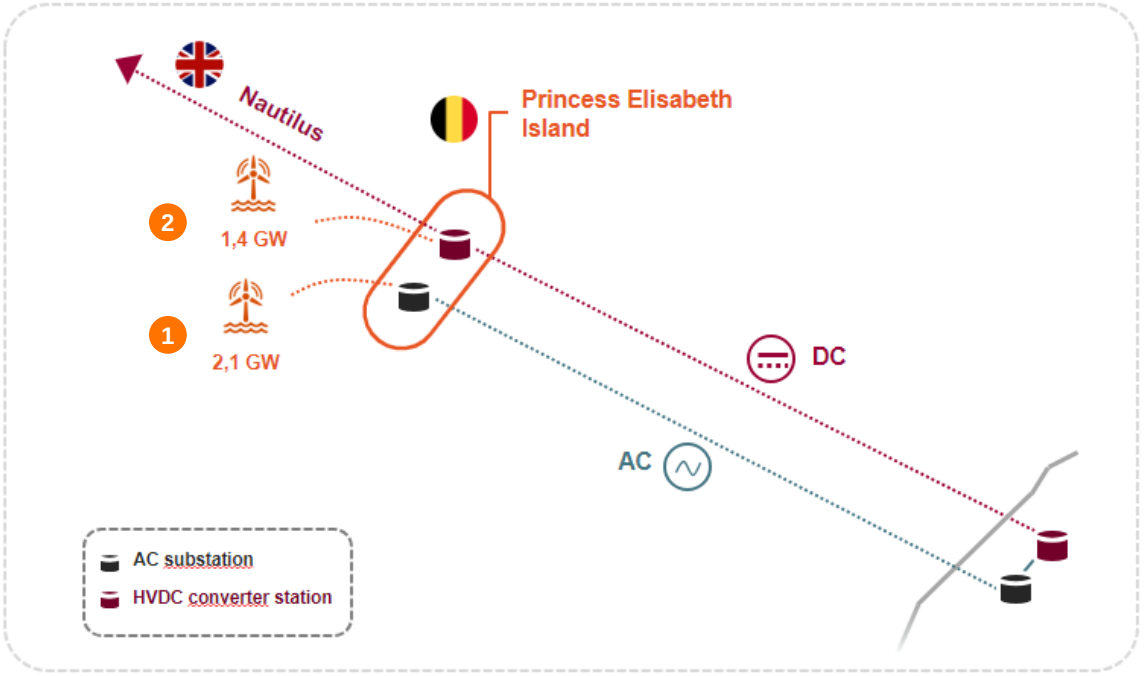
- Market design for PEI — *Split node operation implies the first 2.1 GW connected OWF remains in home market*
- OBZ timing — *Underline optionality beyond Nautilus/Triton*
- OBZ prices and cong. forecast
- Extension OBZ with energy hub

Balancing design

- Compensation mitigation measures
- High wind speed mitigation measure — *Soften HWS requirement*
- Ramp rate limitation mitigation measure — *Monitor and adapt if needed*
- Prev. curtailment mitigation measure
- Prev. cap mitigation measure

Reference operating mode for Princess Elisabeth Island

The Princess Elisabeth Island will be operated in ‘split node operation’



Operating mode for Princess Elisabeth Island

The **Princess Elisabeth Island will be operated in split node operation**, with 2 parts (AC and DC) depending on the technology used to export to the mainland the offshore wind energy produced in the PEZ. This **split node operation** means that:

1. One node with **2.1 GW offshore wind** (PEZ lot 1 and 2) is radially connected to the Belgian grid **via 6 AC cables**.
2. One node with **1.4 GW offshore wind** (PEZ lot 3) is connected to the Belgian grid **via a HVDC cable system**. This HVDC system is planned to be extended into a hybrid system, in combination with Nautilus interconnecting the PEI with the UK.

Moreover, redundancy for long term outage is also included in the reference operating mode for PEI with possibility of switching of offshore wind park from **AC to DC and inversely**. Scenarios will be developed to avoid any impact for market set-up and risk is covered by liabilities

Market design	**Fixed market design: Home Market (lot 1+2) and OBZ (lot 3) and facilitate PPA**
Balancing design	**Light improvements (see next slide)**
Dynamic & Harmonic	**Dynamic performance less challenging for offshore wind farm**

Market design

Main reactions received on market design for Princess Elisabeth Zone

Reactions

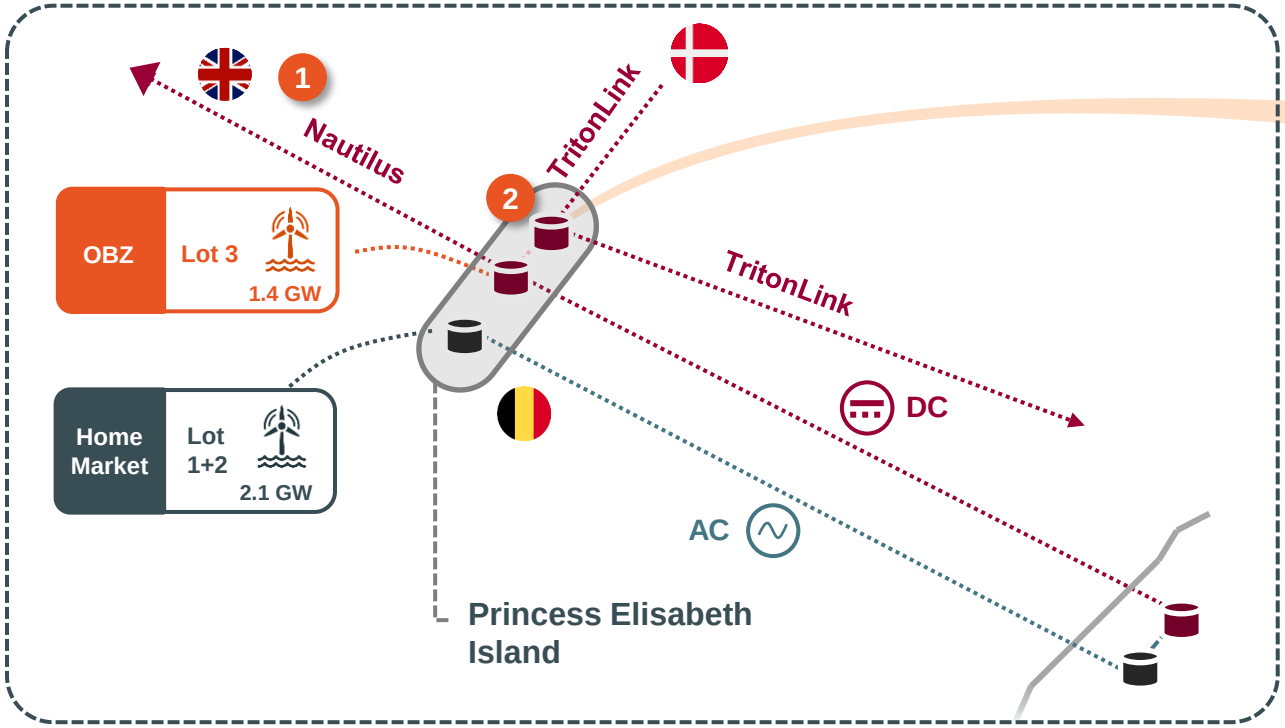
- **Market design for PEI:** uncertainty on market design related to single node operation
- **Market design for PEI:** clarity requested on roadmap OBZ
- **OBZ prices & congestion forecast:** requests for insights in the frequency of congestion & request insights in the day-ahead & imbalance prices over the coming 40 years.
- **Extension OBZ with other energy hubs**: Clarification on perspective of merging OBZs across energy hubs within the North Sea

Focus of this presentation

1. Clarification of the market design with the split node operation on the PEI: which OWF will be under Home Market Design and which OWF in OBZ
2. Which updates are foreseen in the market design with split node operation when looking to the bigger picture on European level
3. Which conditions remain with the split node operation for the creation of an OBZ

Update of the target market design (1/2)

Market design with split node operation for Princess Elisabeth Zone



Timing when the 1.4 GW DC OWF will switch to an OBZ is **not exactly known**. It will effectuate when either of both conditions is applicable:

1. **Implicit price coupling** applied on Nautilus between BE and UK
2. **DC circuit braker technology available** which allows a second HVDC interconnector to be electrically connected to the rest of the PEI

The period before one of these two conditions is met, also the 1.4 GW (lot 3) will be in a Home Market design if the wind is already connected to BE shore

Home market — Home market for **2.1 GW AC offshore wind connected** (lot 1: 700 MW + lot 2:1400 MW)

OBZ — OBZ for **1.4 GW DC connected wind** (lot 3)

Update of the target Market Design (2/2)

Impact on Core, Hansa CCR and UK

- The target market design topology within the European market coupling scheme will look as follows with the split node operation
- Main change on the OBZ scope and the Home market configuration for the 2.1 GW OWF which is AC connected, which will be included in the BE bidding zone
- No impact on the design on UK or Denmark

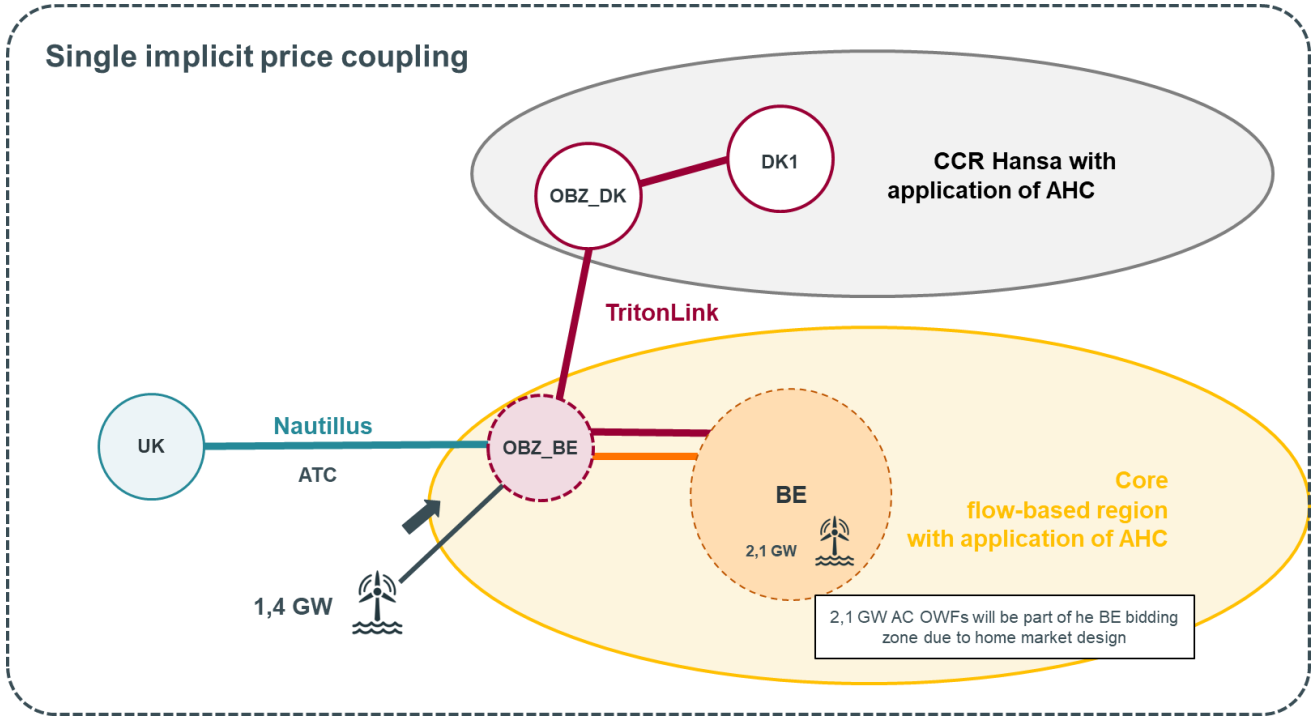
OBZ is expected to emerge in the period 2030-2035

- The trigger will be a (hybrid) interconnector being connected electrically to the PEI which is included into the electricity market via implicit price coupling and hereby puts the interconnector capacity and the wind generation in direct competition with each other during the market allocation process.

- **Elia wants to clarify that the perspective of the OBZ does not depend solely on Nautilus and/or Triton projects. These are the most concrete projects yet there are other options. Elia thus strongly advices to take into account an OBZ eventually will come for the 1.4 GW DC connected wind**

Merging OBZ across energy hubs?

- Whether or not larger OBZs will emerge when offshore grids becomes more and more meshed is not excluded
- Yet Elia considers this as questionable and unlikely that it will happen as this requires energy hubs to be dimensioned as copperplate, while within a meshed offshore grid interconnector capacity and wind generation will be very frequently into competition with each other and hereby causing congestion on the links connecting the different wind hubs



Forecasting of OBZ prices and congestion forecast

OBZ prices and congestion forecast

Requests

Market parties requested insight in

1. the **frequency of congestion** in the day-ahead
2. the **imbalance prices** over the coming 40 years

Elia answers

1. Insight in the frequency of congestion will **most likely be part of the structural congestion report,** being the first step in the official process to create an OBZ

2. Elia cannot be responsible for providing market predictions that would impact the business case of offshore wind farms. **Candidate bidders should rely on their own models and assumptions.** Therefore Elia has not assessed the accuracy of predicting wholesale or imbalance prices in an offshore bidding zone context

Summary of main reactions and answers for market design

Market design

Market design for PEI

1. Uncertainty on market design **related to single node operation**

Market design clarified with split node operation: **home market for 2.1 GW AC** connected wind and **OBZ for 1.4 GW DC connected wind** (with same conditions than before)

OBZ prices and cong. forecast

1. **Request insight** in the **frequency of congestion**
2. **Request insight** in the **day-ahead & imbalance prices** for 40 years

1. Insight in the frequency of congestion will most **likely be part of the structural congestion** report, being the first step in the official process to create an OBZ
2. Elia cannot be responsible for providing market predictions that would impact the business case of offshore wind farms. **Candidate bidders should rely on their own models and assumptions**

Extension OBZ with energy hub

1. **Clarification on perspective merging OBZs** across energy hubs

1. **Whether or not larger OBZs will emerge when offshore grids becomes more and more meshed is not excluded**, yet it is questionable if it will happen (connections between energy hubs are then to be dimensioned as copperplate)

OBZ timing

1. **Request clarity on timing OBZ**

1. Elia clarifies that the perspective of the OBZ does not depend on Nautilus and/or Triton. These are the most concrete projects yet there are other options**. Elia strongly advices the developers to take into account an OBZ will come for the 1.4 GW DC connected wind**

Balancing design

Reactions received during the public consultation on balancing design

Elia received more than 55 questions and remarks on balancing (including some elaborate position papers from some stakeholders)

- *It will not be possible to discuss all feedback received with stakeholders during this Task Force*
- *Most feedback will be incorporated in the report as additional clarifications*
- *Some remarks let to incremental improvement of the mitigation measure proposals*

Focus of this presentation will be put on presenting Elia's answer on key questions:

1. *Market roles, technology neutrality and remuneration of the mitigation measures*
2. *Design of the High Wind Speed requirements*
3. *Design of the Preventive Curtailment*
4. *Design of the Ramp Rate Limitation*
5. *Design of the Preventive cap (in a split node operation)*

1 Market roles, technology neutrality and remuneration of mitigation measures

Justification of the recommended mitigation measures

1. Elia is responsible for system security and needs to avoid system violations at any time: **system simulations** based on worst case balancing market conditions **demonstrate the need for mitigation measures to avoid alert and emergency state situations**

   - Mitigation measures are a safety net for Elia and the required wind power capabilities are therefore to be ensured via the Tender requirements

2. **The recommended mitigation measures are designed to give BRPs all opportunities to self-manage** the expected impact of storm and ramping events in the intra-day, and even up to the balancing time frame

   - No costs are incurred when market shows good performance

3. **The recommended mitigation measures are proportionate** in view of alternative solutions based on procuring additional reserve capacity, **and fair** in view of of allocation of the costs to the responsible parties (in contrast to a socialization to grid users)

4. **Elia aims to provide as much visibility and transparency today** by presenting the design principles to market parties. Nevertheless, the recommended mechanisms are subject to regulatory approval and might also be subject to system evolutions towards the connection of the first parks in 2029.

Some stakeholders question the right of Elia to intervene in the market

- **Elia is responsible for system security and needs to avoid system violations at any time**: system simulations based on worst case balancing market conditions demonstrate the need for mitigation measures to avoid alert and emergency state situations. Mitigation measures are a safety net for Elia

  - *The required wind power capabilities are to be ensured today via the Tender requirements*
  - *The procedures for activation are to be embedded in the regulatory framework towards 2029*

- **The mitigation measures are designed to give market players all opportunities to self-manage the impact of storm and ramping events** in the intra-day, and up to the balancing time frame. No additional costs are incurred for society and the parks when market shows good performance in balancing their portfolio. Elia therefore sees no issues with unrightful intervention in the market or issues with the roles and responsibilities of BRPs and TSOs.

Some stakeholders highlight that the measures targeting offshore wind parks are not technology-neutral

- **The measures recognize the balancing responsibility of parties causing the operational risks** which is according to Elia a healthy principle. When failing to self-manage (cf. previous slide) the problems, the measures are directed directly to the responsible BRP.
  - *Socialization of the costs (reserve procurement) can be considered as very expensive and unfair.*
  - *Elia believes the regulatory framework exists today to impose such measures via the LFC BOA, T&C SA and T&C BRP after approval by the CREG*

- **Elia clarifies that if it sees a need for technology specific requirements on other technologies (e.g. battery storage), it will develop appropriate proposals after discussion with stakeholders and regulator.**

Some stakeholders indicate that the measures are to be remunerated as re-dispatching measures (in line with Article 13 of the Internal Market for Electricity (2019/943) ?

- **RRL and Preventive Curtailment are balancing measures and fall outside the scope of article 13**
  - ► Elia refers to the scope of the LFC BOA (ramping limits and exceptional balancing measures), with activation procedures implemented via the T&C SA (Ramp Rate Limitation) and T&C BRP (Preventive Curtailment)

- **The preventive cap is not a re-dispatching measure** :
  - — The preventive cap follows the same principles as the **'return to schedule'** currently presented in the Icaros framework
  - — The **return to schedule** is a request to comply with the last program and does not fall under Article 13 (cf. justification in framework Icaros). Elia elaborates in detail in the consultation on the T&C SA how this should not be considered as re-dispatching (as it is a request to comply with the last program provided by the SA and not a request to deviate from this program in accordance with article 21(4) of the CSAM methodology). Note that the return to schedule is approved by CREG in the T&C SA.
    - ► Elia clarifies the return to schedule is implemented as a **return to operating margin** to maximize injections of wind power up to the operating margins of the HVDC system.
  - — In the OBZ, no **intra-day re-scheduling** is possible beyond the operating margins (no trading possibilities) which means that schedules of the parks will always be in line with these margins
  - — Without OBZ, **intra-day re-scheduling** outside the operating margins will not be permitted to avoid technically infeasible trades. An update of the schedules beyond the operating margins will not be accepted. This will be implemented via an additional exception to the freedom of dispatch (Icaros).

1. The financial implications of storm and ramp measures on the business case are limited to balancing costs and expected low in occurrence and in financial cost
2. The financial risks can be factored in the strike price of the compensation mechanism, although Elia recognizes uncertainty makes preparing the business case difficult (hence Elia's efforts on creating visibility)
3. Compensation of the mechanisms may harm incentives of BRPs to self-manage storm and ramping events.
4. **It is to be kept in mind that the presented design is a proposal of Elia and should finally be approved by CREG.**

Some stakeholders request clarifications on the financial implications and the impact for the CfD / PPA

Impact	Investment cost	Day-ahead market revenues	Intra-day market revenues	Balancing revenues	Compensation Mechanism (CfD)
HWS capabilities	*Possibly higher investment costs*	*Positive*	*Positive*	*Positive*	*Positive*
Ramp Rate Limitations	*Not expected*	*None*	*None*	*Potential balancing costs during large unmanaged positive ramps (but only if positive imbalance price)*	*None (capability based)*
Preventive Curtailment	*None*	*None*	*Intra-day market procurement of curtailed energy*	*Avoided balancing cost during the event*	*None (capability based)*
Preventive Cap	*Not expected*	*None*	*No re-scheduling is possible outside the operating margins of the HVDC system*	*No positive imbalances are possible outside the operating margins of the HVDC system. In the OBZ, no positive imbalance price are expected under conditions that the preventive cap would apply*	*None (capability based)*

- Financial risks perceived by market parties following mitigation measures can be accounted in the strike price of the CfD.
- A carve-out allows wind parks to develop part of the volume without support. This entails full acceptance of the risk.
- Elia agrees that a restrictive cap on the compensation can limit the compensation of the financial risks
- A balancing correction factor (with a CfD) should not remove the balancing incentive following the activation of mitigation measures as EU regulation requires full balancing responsibility

The design of the support mechanism is the responsibility of the Belgian government. As long as incentives for balancing responsibility are maintained, the support mechanism design is remains compatible with the proposed implementation of the mitigation measures

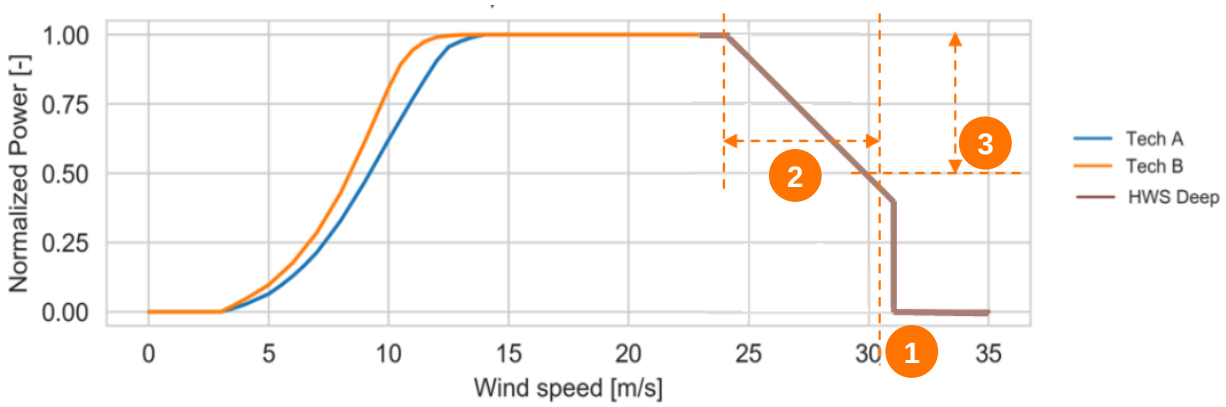
2 Design of High Wind Speed connection requirements

High Wind Speed (HWS) technology requirements

Storm cut-out

High wind speed technology

- **Elia proposes a technical minimum requirement on new wind turbines to be able to maintain generation until 31 m/sec.**
- **The recommendation was proposed by Elia in 2020 as a desirable mitigation measure to manage storm cut-outs**



Implementation as foreseen :

Respect the following requirements at turbine level, for each single turbine:

1. **sudden cut-off cannot occur before 31m/s** (for an averaging time of 10 minutes)
2. **gradual power decrease** starts at average wind speeds at least 5m/s below the sudden cut-out average wind speed
3. gradual power decrease must be provided until 50% of Nominal Power before the sudden cut-out occurs.

An alternative will be allowed on the ability of wind parks to demonstrate that the solution chosen is at least equivalent at the connection point based on:

- **Extreme events (wind speed profiles)** that need to be simulated to provide equivalent Power Output
- **Resulting ramp rates difference (power output)** shall not be worse than an equivalent behavior of the requested profile by Elia

Elia will specify the HWS technology requirement on turbine level in the Tender requirements

It will also specify it will allow equivalent characteristics as connection point level.

Elia will provide the expected behavior at connection point level towards the commissioning of the wind parks.

Design discussions on the HWS

Some stakeholders raise concerns about the possibility that some manufacturers would not comply with this requirement and ask to keep the requirements as open / soft as possible

- ➔ Towards and during the consultation, **no reactions were received from the manufacturers** indicating that the requested capabilities would be infeasible.
- ➔ Bilateral discussions with some manufacturers, and Technical University of Denmark in 2022 and 2023 indicated that **HWS capabilities would become standard technology**
- ➔ **Analysis** of the technical specifications received from latest Belgian offshore parks (2020) show that these **can already maintain 31 m/sec** (and a part even for the 10' average time)

Some stakeholders request to clarify the requirements for wind gusts and average wind speed variations within the 10' average wind speed period

Elia will clarify this in the connection requirements and refers to the table on page 14 of the original MOG 2 study. It will clarify in the report that it will only allow disconnection if wind speeds exceed a 34 m/sec average over 30 seconds and 38 m/sec average over 1 second according to the HWS Deep profile put forward.

Table 3. Generic high wind turbine protection settings for the 3 high wind scenarios

Event	Averaging time	25 Direct Cut-off	HWS Moderate	HWS Deep
Shutdown	10 min	25 m/s	28 m/s	31 m/s
Shutdown	30 sec	28 m/s	31 m/s	34 m/s
Shutdown	1 sec	32 m/s	35 m/s	38 m/s
Restart	10 min	22 m/s	23 m/s	24 m/s

While the 10' average time of 31 m/sec will be specified as hard requirements, Elia will formulate the 30" and 1" requirements as soft requirements, allowing to specify lower values when justified by the technical specifications given by the manufacturer

Original 2020 MOG 2 System Integration Study report (page 14): https://backend.orbit.dtu.dk/ws/portalfiles/portal/216341840/Elia_MOG_II_System_Integration_public_final.pdf)

3 Design of the preventive curtailment

Preventive curtailment

Storm Cut-out | Ramp down

Preventive curtailment

- Mitigation measure allowing to preventively curtail wind power after forecasted storm or downward ramping event and assessment of mitigation measures undertaken by BRPs
- Proposed in the MOG 2 study in 2020 to be integrated with the existing exceptional balancing measure for storm risk management

AS-IS storm procedure

Forecast

RMI → Storm forecasts

Send storm alerts and communicate with BRP

BRP communications

Communicates intra-day measures taken to mitigate impact on portfolio

Remaining risk > balancing reserves

Fallback

Activation of additional flexibility via activation slow-start units

Extension for Storm cut-out

Considering the volumes needed, the slow-start units that could be activated on the day of the storm in the current storm process might not be sufficient.

⇒ **Preventive curtailment of offshore wind power (from new parks)** for the remaining risk (after BRP mitigation measures), not covered by balancing reserves or <u>via slow-start units</u>

Also applicable for ramping down events

<u>Timing:</u>

Option 1 DA: allows BRPs to find the energy necessary on the day-ahead market to stay in balance but no view on activation of the slow start units. ✗

Option 2 ID: based on last (more accurate) forecasts while taking into account slow start unit activations but requires liquidity on the intra-day market ✓

Extension for Ramp Down

A forecast tool for downward ramping is to be developed*

**Feasibility of such forecast is still to be evaluated. Limited predictability may still require complementary solutions (e.g. reserve capacity increase, or exceptional balancing measures)*

Design discussion on the preventive curtailment

Market parties highlight that a wrongful forecasts by Elia of the storm or ramp would result in a cost for market parties (as it would result in intra-day procurements). This is not considered to be fair, certainly when Elia claims it is currently not yet able to well predict ramping events.

- Elia clarified in the report that a condition to apply this measure on (non storm) downward ramping events is to have reliable forecasts (by 2029). If explained that without such forecasts, complementary or other measures will be considered (such as reserve capacity procurement)

- Similar to the current storm procedure, the forecast first triggers first a coordination phase with BRPs. During such coordination, Elia takes into account all mitigations measures taken by BRPs. **Structural deviations between the Elia and BRP forecast will trigger ex post investigations to improve Elia's forecasts.**

- Despite Elia's best efforts, forecasts will never be perfect and such wrongful forecast would indeed trigger the mechanism (after accounting mitigation measures of BRPs, the expected balancing energy bids in the system, and the activation of the slow-start units). This may indeed cause a cost for the wind parks.
  - *Elia reminds again the limited occurrence of these types of events (in combination with taking into account all liquidity in the system before activation)*
  - *Note that part of the intra-day procurement cost will be compensated by additional balancing revenues (during positive prices)*

4 Design of the ramp rate limitation

Ramp rate limitations for wind power generation

Storm Cut-in | Ramp up

Ramp rate limitation

- Elia proposes to limit the maximum upward ramp rate to 15 MW per minute for the entire fleet of new offshore wind parks when the system imbalance exceeds 500 MW
- The recommendation was already put forward by Elia in 2020 as a desirable mitigation measure to manage storm cut-in and expected / unexpected ramps, as well as simplify the existing cut-in coordination procedures

SA

TSO

SA

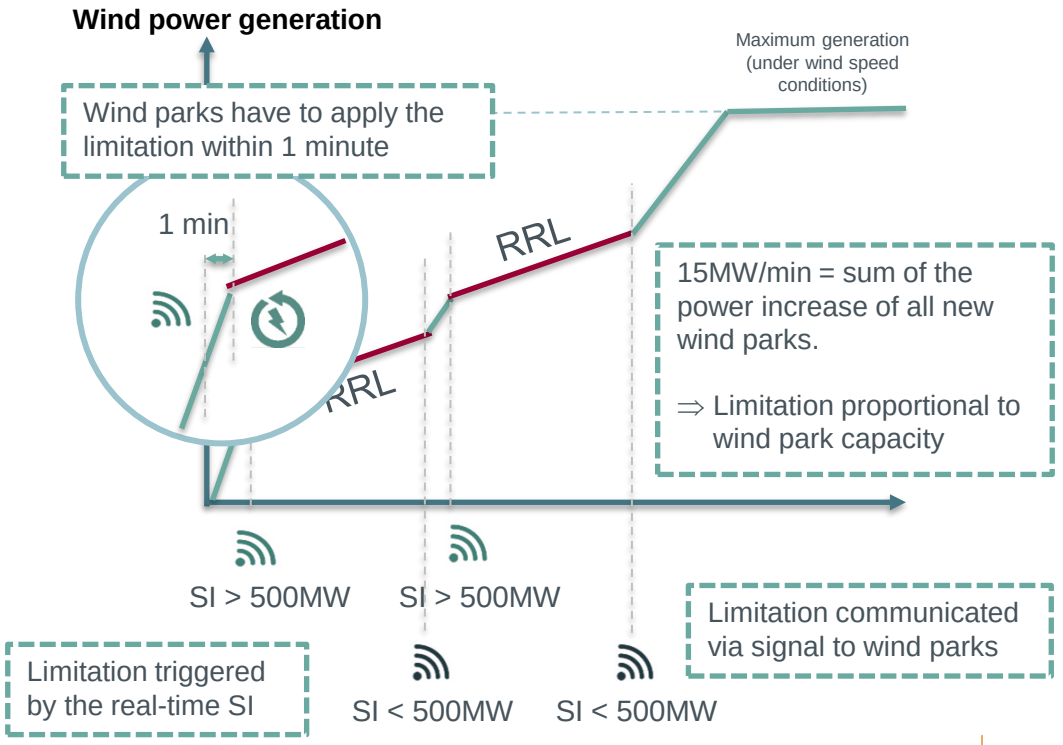
Ramping rate limitation dependent of the system conditions

When a storm event has ended, the SA Offshore Power Park Module informs Elia to cut-in by sending an IDPCR

The IDPCR will be automatically approved by Elia.

Parks are subject to general ramp rate limitations depending on system conditions (system imbalance level)

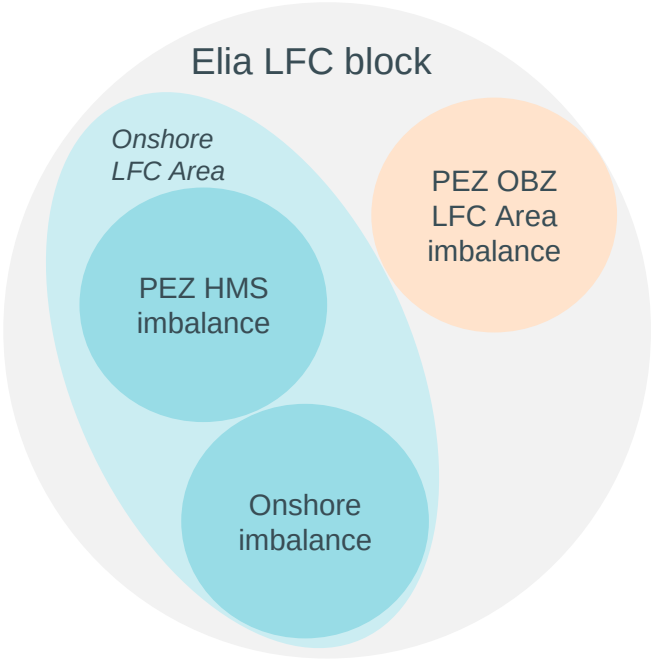
Illustration of a wind power (fleet, park or turbine) cut-in after full cut-out



Improvement of the trigger design

Market parties highlight that a trigger based on the LFC block imbalance, onshore excess imbalances can cause situations where 'balanced' PEZ wind parks are impacted by the Ramp Rate Limitations. Such situations may reduce excess generation in their portfolio and even expose these wind parks to shortages.

- **Elia recognizes the possibility of triggering the measure following onshore excess imbalances**, even when the offshore wind parks are not contributing to the imbalance.
- This undesirable situation is the counter-side of accounting netting between the onshore and offshore areas within the LFC block. This intends to minimize activations of the measure during onshore shortages.
- **Elia does not see alternative solutions which do not substantially increase complexity and reduce transparency** of the measure.
  - Elia investigated alternative solutions based on triggering the measure on the PEZ imbalance, or the Area Control Error but foresees to maintain the design of the trigger as initially proposed
  - Elia will monitor the implementation of the measure to assess the frequency and impact of this undesired situation. Elia will consider reviewing the approach if the current design leads to severe negative effects.
  - Elia remains convinced on the limited financial impact of the measure (with triggers during low or negative prices)



Splitting up the trigger signal will substantially increase complexity trough creating 'artificial imbalance signals' for the PEZ

Proposal of Otary on the design of the Ramp Rate Limitation

Otary presents an alternative proposal for the design of the ramp rate limitation. In summary :

► The activation of ramping rate limitations would be triggered only when offshore wind generation exceeds 20% of the Installed Capacity (per OWF). This approach aims to mitigate, the technological costs of prolonged and deep curtailments.

► The automatic activation of ramping rate limitations would occur when the System Imbalance surpasses +500 MW. Otary recognizes the potential reduction in workload afforded by an automatic mechanism

► Otary proposes the application of the congestion pricing (using a cost-based approach)

- **Elia is against limiting the activation of the trigger during periods of low wind**. 20% of the fleet still represent an additional imbalance of 700 MW (on top of imbalances created by other parks).

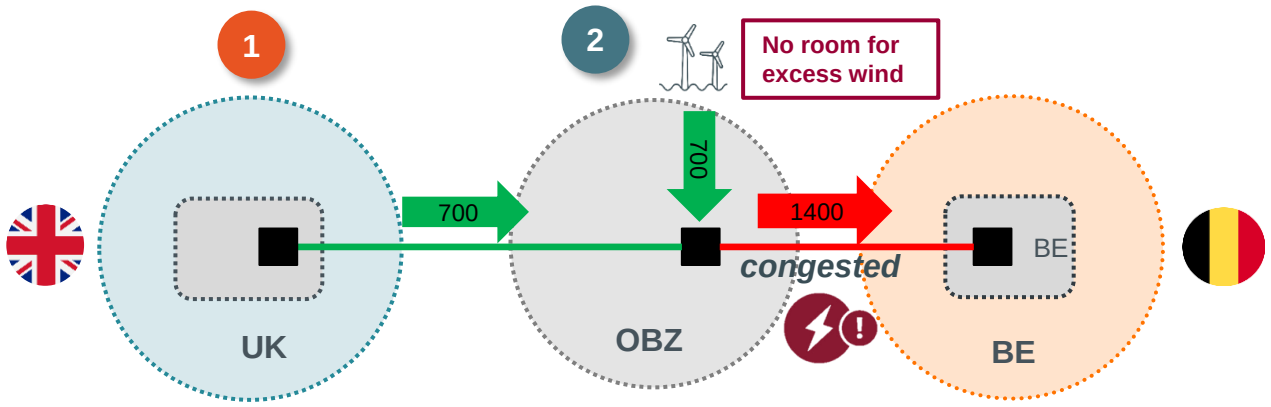
- **Elia takes note of the support of Otary on the principle to automatize** the measure and relate the trigger to the system imbalance.

- **Elia refers to its position on remuneration of the mechanism** (cf. previous slides)

5 Design of the preventive cap (in a split node operation)

Preventive cap
Reminder of the mitigation measure

Excess wind power in balancing time frame **during high export conditions from PEZ to Belgium**



1 **In the target scenario, the excess wind power can be managed via balancing cooperation via UK (Nautilus) or DK (Triton)**

- Reduction of the injection from the foreign LFC Areas to the offshore LFC Area (until ATC limitation) through downward activation of flexibility via the foreign LFC Area

2 Alternatively, it can be **managed via reducing the offshore wind power injections** through downward activation of wind power flexibility

- In case activation of downward balancing energy on wind in the offshore LFC Area is economically cheaper
- In case of absence of balancing cooperations with regions connected to the Belgian offshore area.

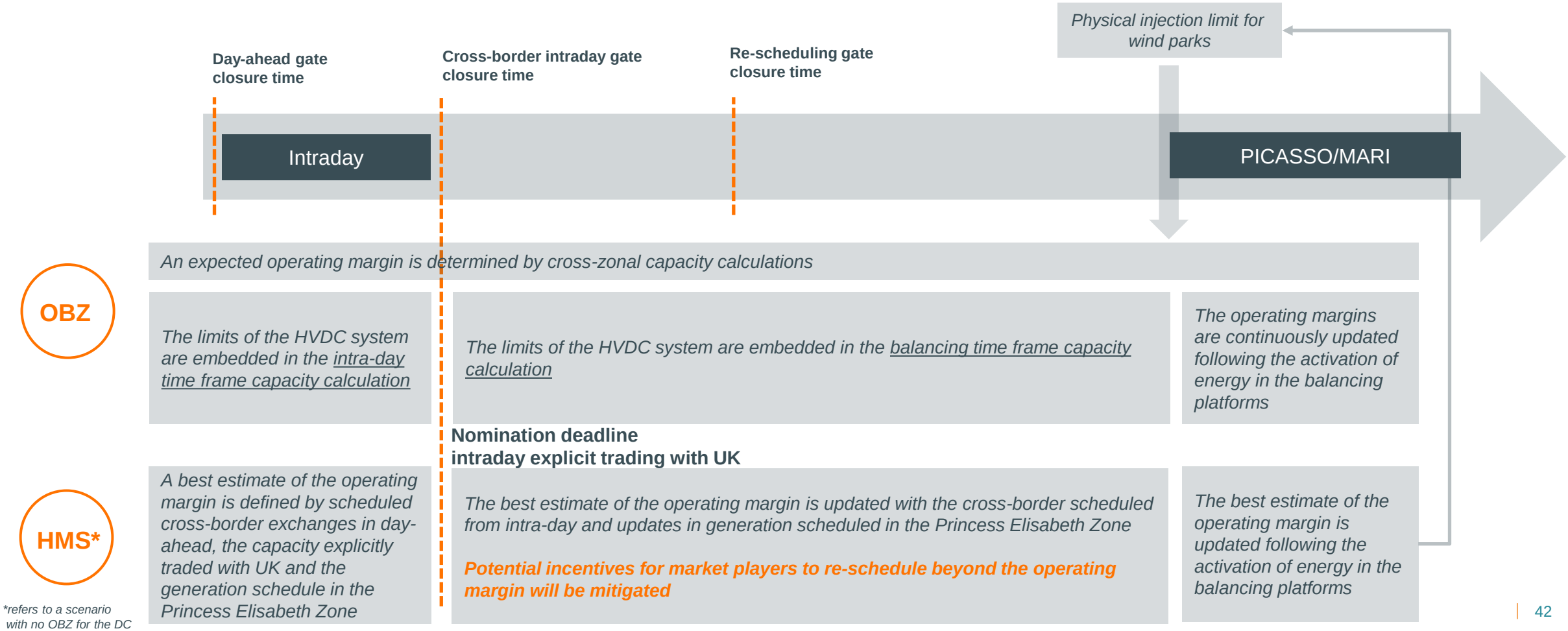
Preventive cap

(Part of) the **wind power might need to be capped in real-time** by TSO following real-time HVDC operational management in order **to maintain safe operation of the assets** in case of wind power variations exceeding the physical capacity of the cables **until the imbalance can be managed via** :

- **Export to the connected LFC Area**
- **Activation of downward balancing energy on wind**

Further specifications on the mechanism

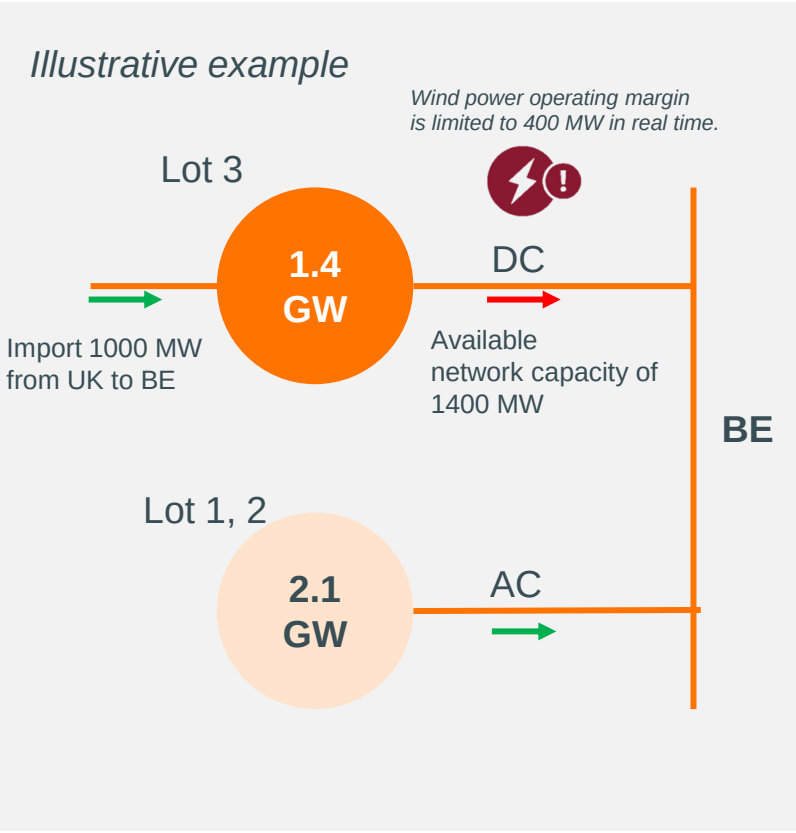
The preventive cap is implemented as a real-time injection limit enforced by Elia on the wind parks to safeguard operational security in the HVDC system. The injection limit will be determined based on the **available capacity of the HVDC system**.



*refers to a scenario with no OBZ for the DC connected wind power

Clarification on the application of the preventive cap with split node operation

Market parties highlight the uncertainty of a single-node versus split-node operation on the implementation of the preventive cap and ask for clarity on the application of the preventive cap for the lot 1, 2 and 3 wind parks.



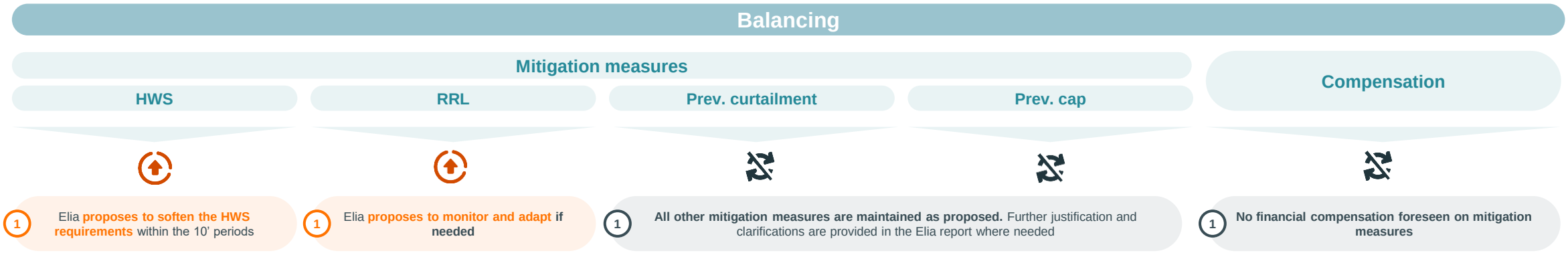
► With the focus **on split-node operation**, the preventive cap will only apply on the Lot 3 wind parks. The parks in Lot 1 and 2, connected to the AC system will fall under normal congestion management procedures.

► **During specific situations (e.g. during long duration outages or maintenances), Elia is investigating the possibility to temporary connect wind parks in Lot 1 and Lot 2 to the DC system** . During such situations, it remains possible that the preventive cap will be exceptionally applied on these wind parks.

- **Lot 1 and Lot 2 will need to demonstrate the capabilities to implement the preventive cap.** However, the measure will only be applied under very exceptional conditions and therefore not expected to have significant financial impact (and will be covered a priory with the Royal Decree on liabilities).

Impact of the public consultation on the connection requirements and the final report

Summary of main reactions and answers for balancing design



- **Following remarks of market parties, Elia proposes to soften the HWS requirements for wind variations within the 10' period**. This will impact the connection requirements.
  - Elia maintains the sudden cut-off wind speed at 31 m/sec on 10' average wind speeds as hard requirement
  - But will formulate sudden cut-off wind speeds of 34 m/sec and 38 m/sec on 1" and 30" average wind speeds as soft requirements (justified by the capabilities provided by OEM)
  - Elia confirms it will, on request of stakeholders, also facilitate the possibility to demonstrate the capabilities of wind park level instead of turbine level.

- **The foreseen trigger design for the RRL, based on the LFC block imbalance, is maintained following analyses of potential alternatives.** Elia understands this can lead to undesirable situations (where RRL is triggered following an onshore excess). Elia does not see alternative solutions which do not substantially increase complexity and reduce transparency of the measure.
  - Elia will monitor the implementation of the measure to assess the frequency and impact of this undesired situation and consider reviewing the approach if the current design leads to severe negative effects. Elia remains convinced on the limited financial impact of the measure (with triggers during low or negative prices)
- Despite discussion points raised by market parties, **all other mitigation measures are maintained as proposed**. Further justification and clarifications are provided in the Elia report where needed
  - The discussion points do not concern the connection requirements itself but relate to the design of the triggers and activation to be approved by CREG. With its proposals, Elia is trying to give as much visibility as possible but stresses it cannot fix the design at this point.

Connection requirements

- Flexible access for the 1st PEZ Tender
- Legal and regulatory framework
- Technical specifications

Flexible access for the 1st PEZ Tender

What is a flexible access ?

Reminder

Flexibele Toegang:
het toegangsregime zoals gespecifieerd in artikel 170 van het Technisch Reglement Transmissie of in de regionale regelgeving voor zover dit regime daar voorzien wordt.

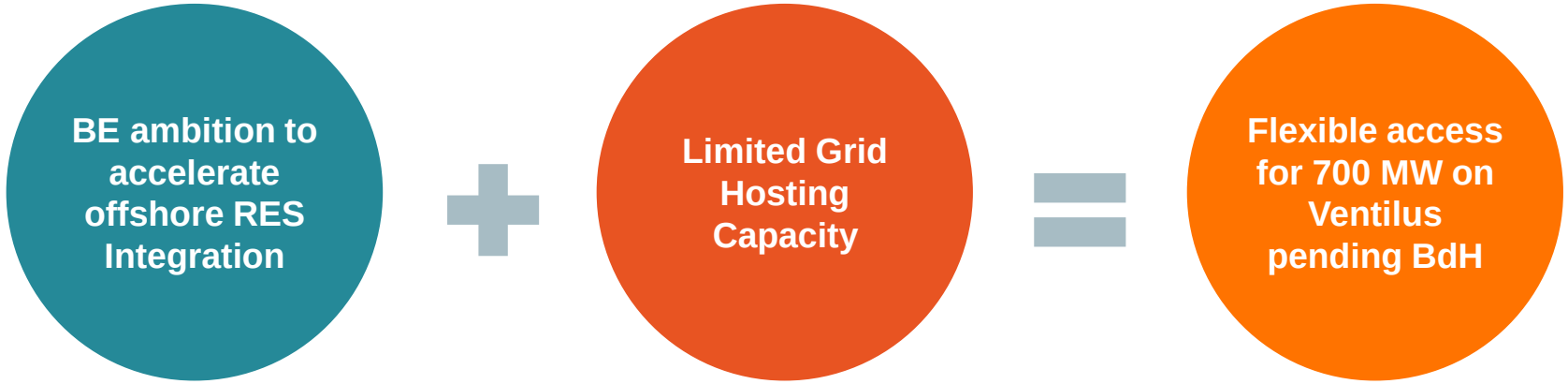
(source: current access contract – Dutch version)

Replaced by article 61 of the Code of Conduct

Flexible access :
the regime applied to a Generation Unit whose connection, in accordance with the standard rules in force, should be rejected on the basis of a lack of capacity due to congestion but is nevertheless allowed based on adjusted capacity granting criteria and on the basis that the said Generation Unit's Access to the Elia Grid, under normal operating conditions, may be limited depending on the capacity already allocated to one or more other Generation Units or the available capacity on grid components. The connection contract of the connection applicant shall lay down the said capacity allocation criterion.

(source: previous version of the access contract – 22/06/2016)

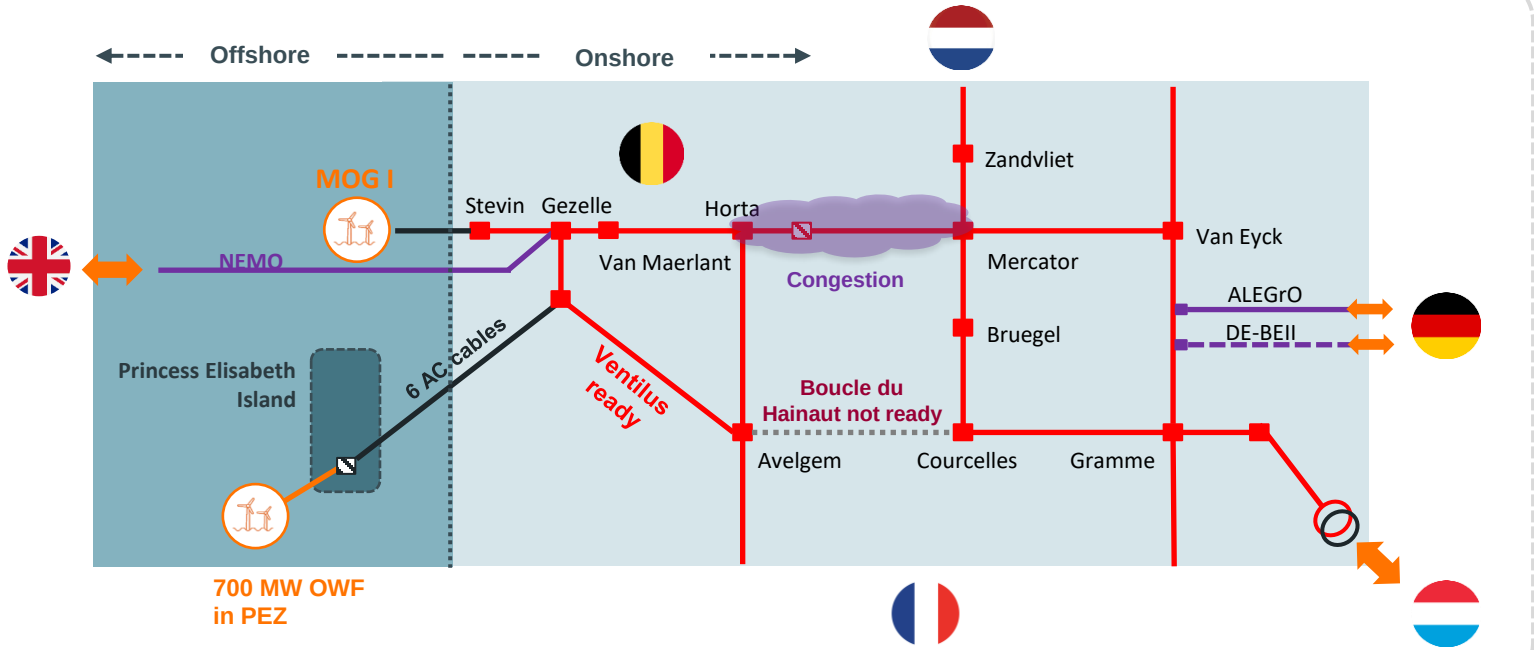
A flexible access for the first 700 MW of the PEZ is a logical consequence



The same proposition is made to any other client willing to connect faster than what a firm contract would require in terms of network reinforcements.

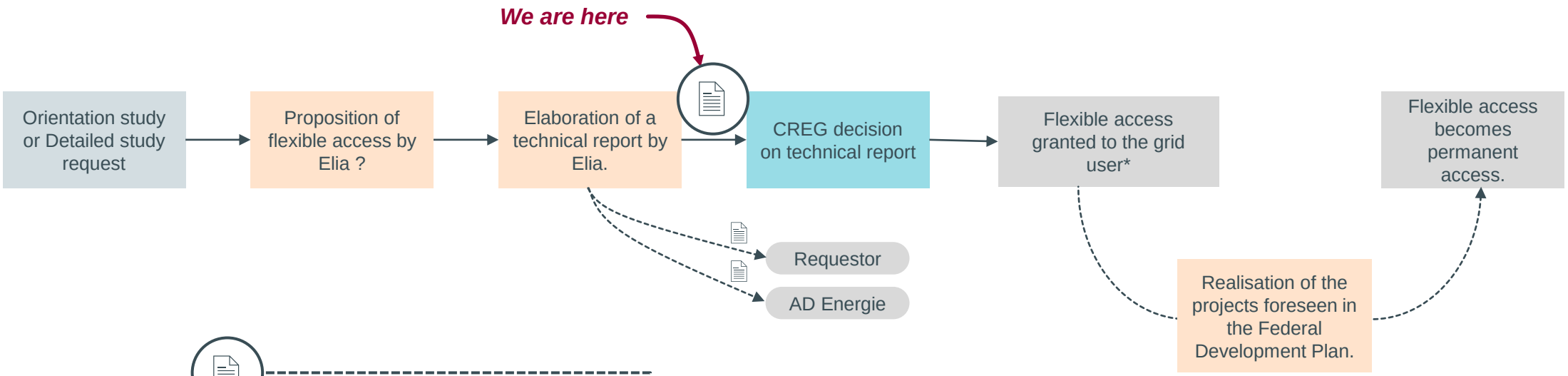
A flexible access to cover for scenario where first wave of 700 MW OWF is connected prior the realization of Boucle du Hainaut

- As highlighted in the FDP 2024-2034, **both Ventilus and Boucle du Hainaut are required to unlock the full hosting capacity for the Belgian coastal area**. As mentioned in the FDP, Ventilus (2028-2030) is to be commissioned before Boucle du Hainaut (2030).
- **Without Boucle du Hainaut, the already existing congestions on the Horta-Mercator axis remain present in the system**. These congestions are aggravated when supplementary generation is connected (e.g. offshore wind is connected).
- A maximum of **700 MW** of offshore wind (=Phase I) can already be connected to the electricity system **after the realization of Ventilus**, however **production** of these offshore windfarms needs to be **limited in case of congestion on Horta-Mercator.**



- Given the fact that congestions can already occur in N situation, this entails **preventive curtailment of possibly up to 700 MW.**
- **Such limitation** of the offshore wind production is required for **as long as Boucle Du Hainaut is not realized yet**
- As **cross-zonal market exchanges heavily determine the utilization of the Horta-Mercator line**, a good view on the congestions can only be expected after the day-ahead market coupling.

Flexible access – process defined in the current version of the Code of conduct



Technical report

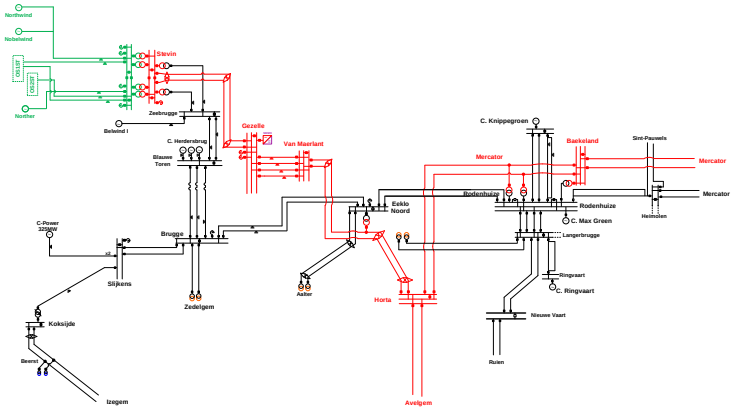
Conditions for the granting of flex access :

- ✓ Planned date for grid reinforcements foreseen in the FDP
- ✓ Available permanent and flexible capacity
- ✓ Estimation of the average duration of the curtailment on a yearly basis

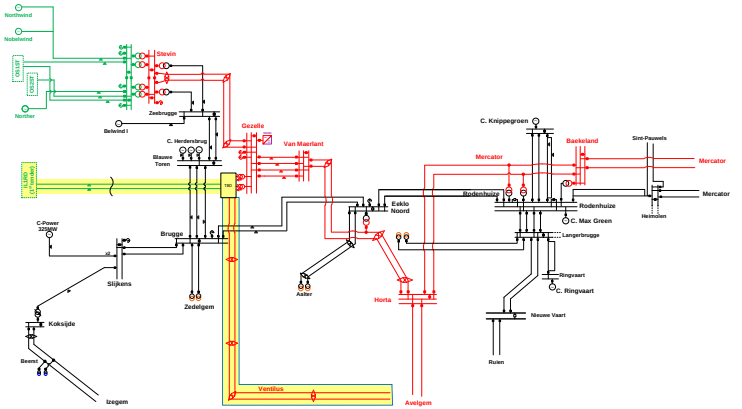
* for the 700 MW on the PEI, this will be done via the tender (art. 7, 6° KB Tender)

Reference network and expected evolutions

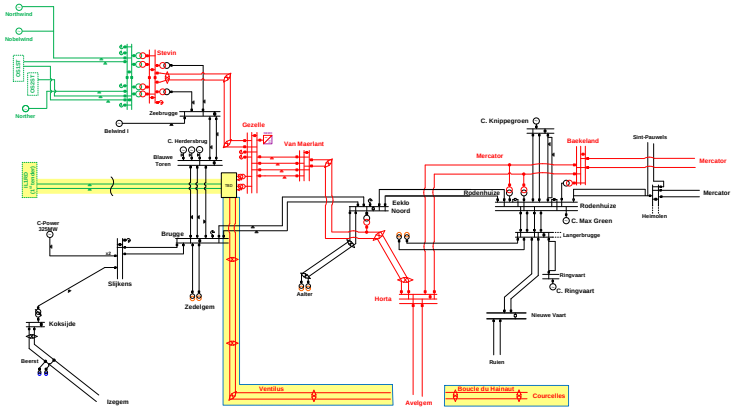
Reference network



Phase 1



Final situation



+ Ventilus

+ Boucle du Hainaut

PEZ 1st Tender (700 MW) – Flexible access
% of time and % of energy, as mentioned in the Technical report sent to the CREG

Draft

	Phase 1: after the realization of Ventilus	Final phase: after the realization of BdH
% time	1.6%	0% (Trad)
% curtailed energy	2%	0% (Trad)

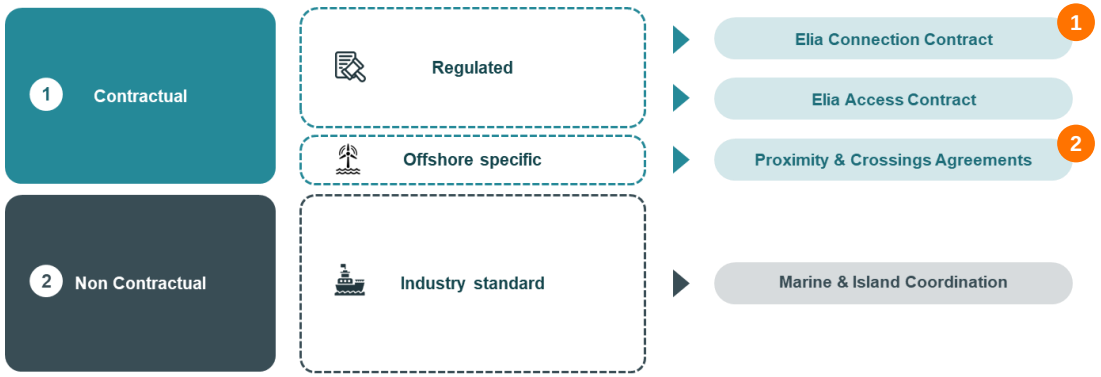
Disclaimers

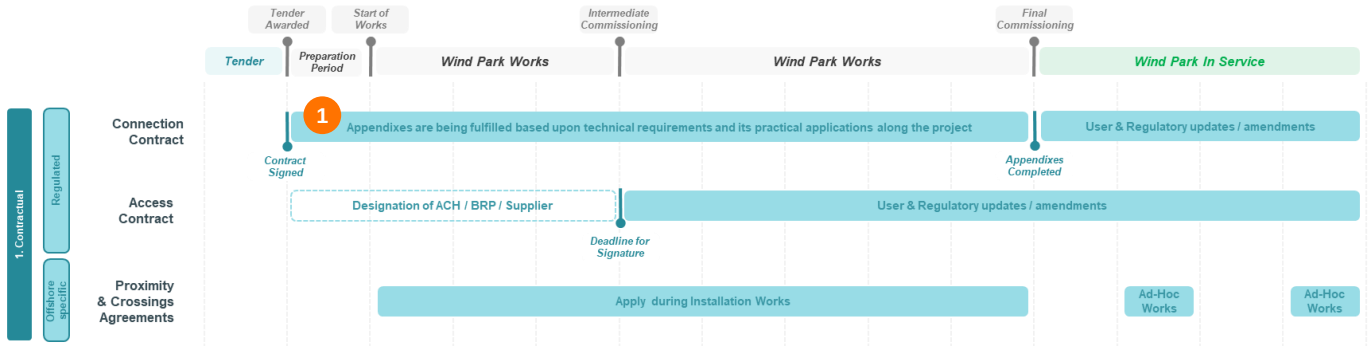
- These results are reflecting the expected situations of the electrical system in future years impacted by the study.
  - *Therefore, these results inherently involve a degree of uncertainty*
  - *Higher level of curtailed energy can't be excluded in the future.*

- These results are still to be considered as draft at this stage as the present communication doesn't replace the formal process foreseen in the code of conduct (see previous slide).

Legal and regulatory framework

Main stakeholder's reactions regarding the legal framework were focused on **Appendices Amendments** & the **Proximity Agremeent**





1 Request to Elia if **changes in the appendices** of the Connection Contract are **subject to a public consultation**?

- The appendices are indeed consulted but to be filled based on the grid user High Voltage Infrastructure & facilities and can be tailor made to specific needs or technical requirements (process related, outage limitation, planning,..).
- The appendices can refer to specific regulations that need to be complied with and followed.
- In any case, every Grid User has the opportunity to react to proposed amendments to the connection contract and its appendices during the public consultation. A public consultation is currently in ongoing and the answers will be published shortly.

2 Request to Elia on the scope of **The Proximity Agreement** and its related financial coverage

- As for MOG I, a bilateral agreement called “**Proximity Agreement**” is foreseen to cover project & other significant works
- This Agreement is to **be signed between the domain concessionaire & Elia**
- The **Connection Contract** still applies but for works/incident **on the island** out of project phase related activities
- This Agreement will be **signed per concession** as not all concessionaires are known from the first Tender
- This Proximity Agreement is in line with the **industry standards** and best practices
- This Agreement covers the procedures, conditions and liability related to the **Proximity Activities**
- This proximity agreements covers both **Installation Works** & **Cable Crossings**
- This activities are taking place over 3 main zones
  1. Elia Domain Concession and the Princess Elisabeth Island,
  2. (Notification Area around) Wind Farm,
  3. (Notification Area around) Cables.

Proximity Agreement

Activities

- Installation Works
- Proximity activities
- Heavy curative works
- Use of lifting equipment

Scheduling

- Access to the zones
- Main planning
- + 2 alternative access windows

Damage

- Damages following proximity activities related incidents
- CAP 50 M€

Arbitration *(Planning)*

- Conflicts in the prioritization of works, taking account of the two agreed planning alternatives.
- Elia will, in all reasonableness and taking into account the nature and monetary consequences & draw up a new global planning in good faith.
- Parties shall be liable to each other up to a maximum amount of 5 M€ per claim

Connection Contract

Activities

- Preventive & Curative Maintenance

Scheduling

- Planning as communicated in the connection contract
- (Y-1/W-4/W-1)

Damage

- CAP 5 M€

Arbitration

- Elia will, in all reasonableness and taking into account the nature and monetary consequences & draw up a new global planning in good faith.
- Parties shall be liable to each other up to a maximum amount of 5 M€ per claim

Technical requirements

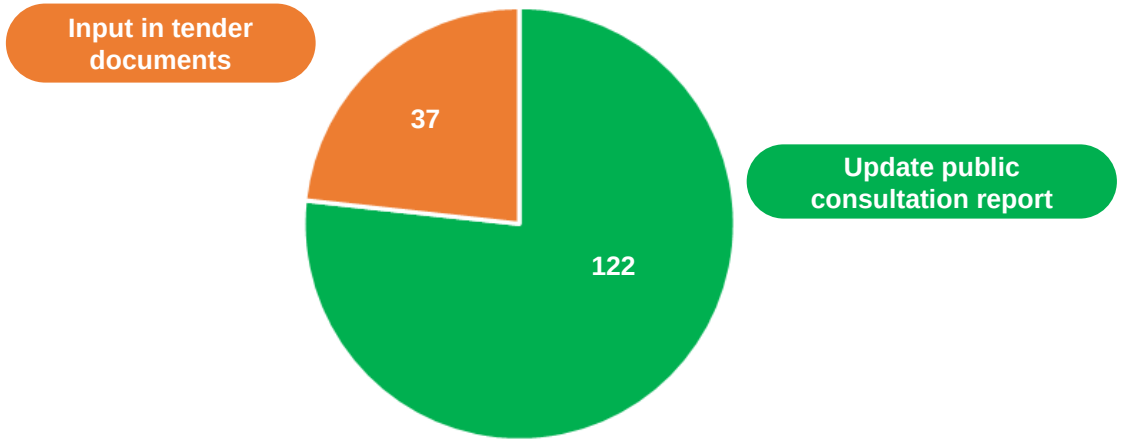
Introduction : specific questions on technical requirements

Elia received 159 questions and remarks on the connection requirements

- **122** questions have led to **additional information** that will be available in the update of the Public Consultation report
- **37** questions have **led to clarifications** that will be included in the tender documents

Focus of this presentation will be put on presenting Elia's answer on key questions about

1. Interfaces
2. Cable
3. MIC
4. High voltage & Low voltage
5. Layout



Some stakeholders request to clarify the **technical responsibilities of the different parties**

1.Interfaces
2.Cable
3.MIC
4.High voltage & Low voltage
5.Layout

- **Roles and Responsibilities** of each party will be clarified in the **Interface Matrix** which will be shared **in the tender documents**

- Relevant information such as plans of the scour protection, J-tubes, Hang-Off room and island layout will be shared in the tender documents.

- **The following elements will be part of the scope of works of the OWF :**
  - The pull-in, routing, engineering, supply and installation of Inter Array Cable incl. transit inserts on the Island
  - The design, engineering, supply and installation of the CPS
  - The maintenance, identification of spare parts and repair scenarios of all the OWF equipment

ID	Interface Topic	Interface Topic /Description	EMPLOYER		Civil Works (Offshore) Contractor	AC Substation Contractor	Windfarm
2.6	*Cable routing & installation (including fiber optic)*						
2.6.1	Cable high level corridor	Define high level cable corridor per relevant Contractor	P		I	I	I
2.6.3	Cable routing - outside DC perimeter	Routing design of cables outside DC perimeter on the Land Area	C		C	P*	P*
2.6.4	Cable routing - coordination	Coordination of cable routing design on the Energy Island	C			P	C
2.6.5	Cable culverts for HV cables	Design, supply and installation of cable culverts HV Cables	C		P	C	C
2.6.6	Cable supports for HV cables in culverts	Supply and installation of cable supports inside HV cable culverts	C				P*
2.6.7	Cable cleats for HV cables in culverts	Supply of cable cleats for cables in HV cable culverts	C				P*
2.6.8	Cable cleats for HV cables in culverts	Installation of cable cleats for cables in HV cable culverts	C				P*
2.6.9	Cable installation 66kV Submarine Inter Array cable	Installation on the Energy Island (incl. cable supporting in culverts)	C			C	P
2.6.11	Cable installation HV Land Cables on Island	Installation on the Energy Island	C			C	
2.6.12	Overlength	Design and install required overlength	C			I	P*
2.6.13	Provide space for overlength AC Substations	Provide space for required overlength	C			P	C

* Images are for illustrative purposes only

Some stakeholders request to clarify the **Offshore cable corridors**

1.Interfaces
2.Cable
3.MIC
4.High voltage & Low voltage
5.Layout

- The routing of **Nautilus and Triton** is still preliminary and depends on multiple parameters.
- Based on current knowledge, an **offshore crossing** between IAC and at least one future interconnector is to be expected.
- These crossings will be made in compliance with current **Good Industry Practices**.
- **Proximity agreements** will be required to work in the vicinity of the Princess Elisabeth Island, inside the cable corridors and in the vicinity of the wind farm concessions. The proximity agreements are currently under elaboration.

* Images are for illustrative purposes only

Some stakeholders request to clarify the **J-tube and Hang-off room**

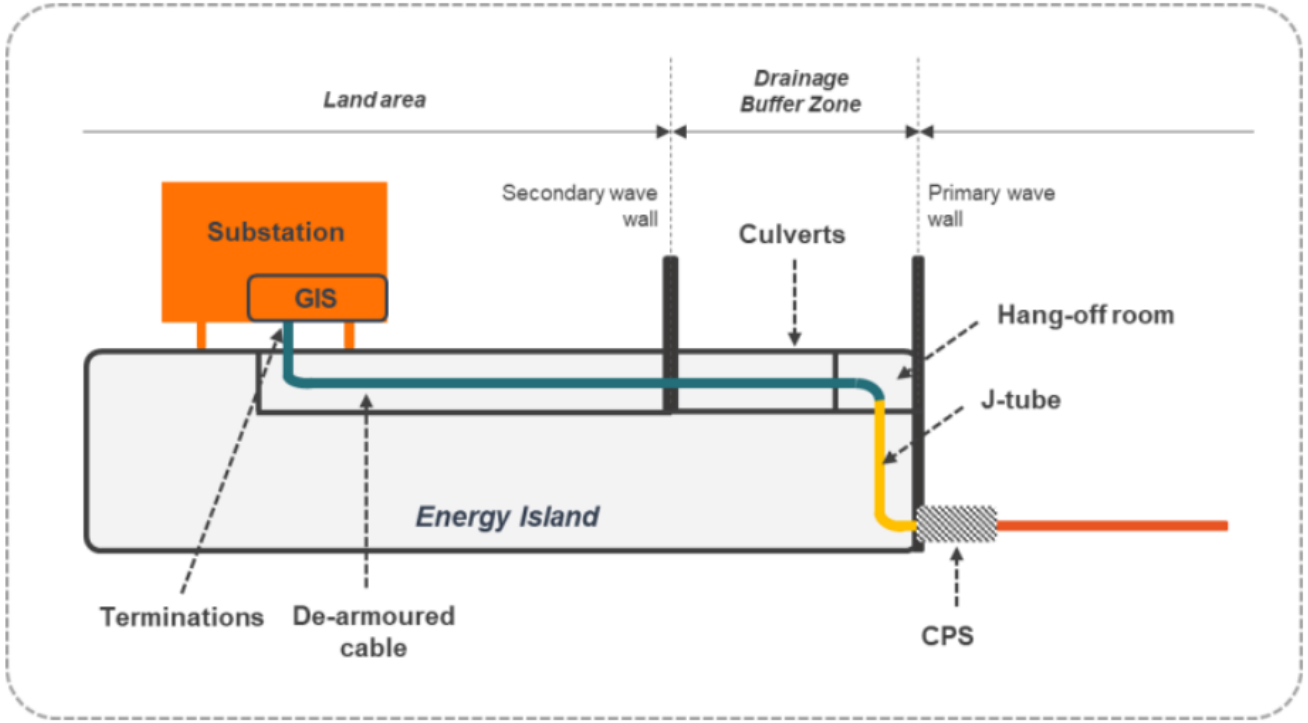
1.Interfaces
2.Cable
3.MIC
4.High voltage & Low voltage
5.Layout

J-tube

- The **J-tubes will be sealed with pull-out discs** to mitigate the risk of development of marine growth inside the J-tubes. These discs will have to be pulled out by the OWF prior the installation of the cable.
- Messenger wires will be pre-installed to the inside of the pull-out disc.

Hang-off room

- Several **strong points** will be foreseen within the hang-off room to facilitate the pull-in (e.g. temporary secure the cable during pull-in to allow f.i. to re-rig for overpull operations)
- The hang-off room can be accessed by **ladder**. An **anchor point** above the ladder will be foreseen to attach a **fall protection system**.
- **Earthing points** connected to the earthing grid of the Princess Elisabeth Island will be provided in the hang-off room.



* Images are for illustrative purposes only

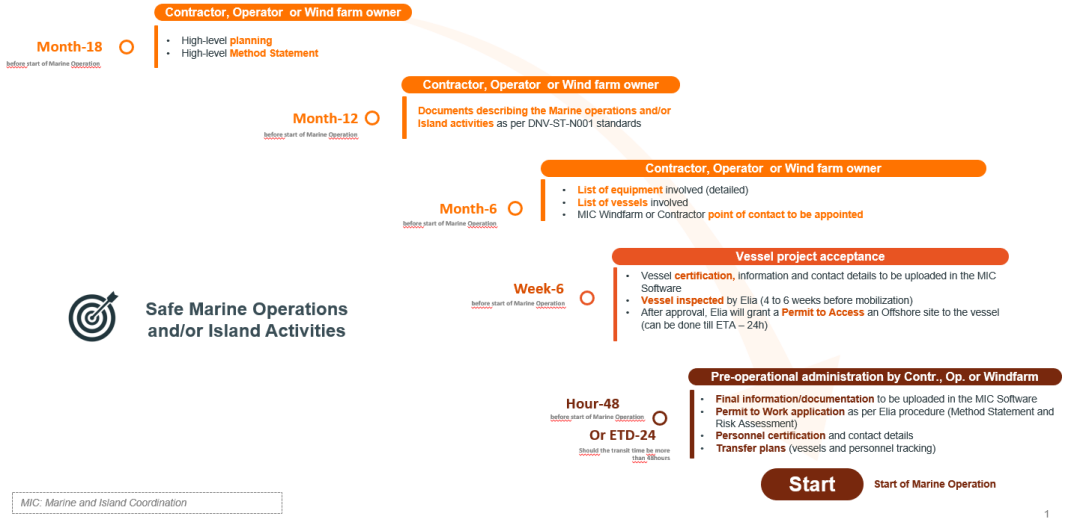
Some stakeholders request to add information about the **Marine and Island Coordination planning**

1.Interfaces
2.Cable
3.MIC
4.High voltage & Low voltage
5.Layout

- Required planning should enable Elia to **verify** whether different activities **can be performed simultaneously without any conflict or risk**

- Intent of having an indication of **high-level planning and method statement 18 months prior start of operations**
  = have an idea about activities OWF owner intends to execute

  - Elia will check if planned activities will impact other operations.
  - Elia has understanding for potential delays and schedule adjustments = Elia wants to check well in advance whether other contractors can continue their operations
  - For the safety of the project, it is crucial to have a high-level planning overview 18 months prior start of operations to avoid potential dangerous simultaneous operations.



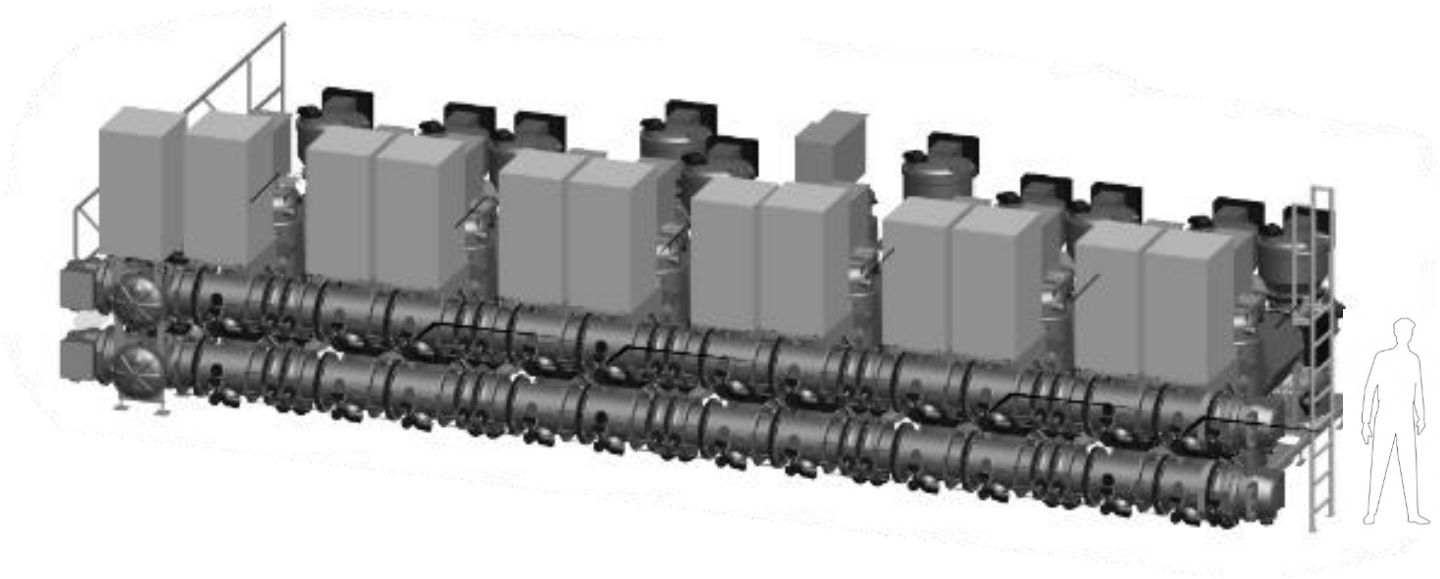
* Images are for illustrative purposes only

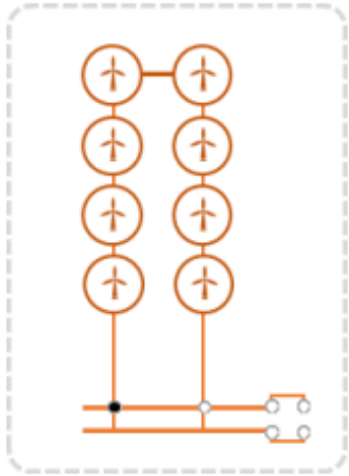
Some stakeholders request to add information about the **GIS connection** and the **maximum power of each string**

1.Interfaces
2.Cable
3.MIC
4.High voltage & Low voltage
5.Layout

- The **66kV GIS bay** has been designed for **2500 A**. The **maximum power injection** into the GIS is **limited due to the cable capacity** which is **in scope of the windfarm**.

- The fixed requirement from Elia is that **the loop cannot connect on the busbar 66kV**. Looping of inter-array cables stays available for auxiliary services





* Images are for illustrative purposes only

Some stakeholders request to add information about the **measurement convertors**

1.Interfaces
2.Cable
3.MIC
4.High voltage & Low voltage
5.Layout

- Elia listened to the feedback to **not impose an Elia approved convertor**. As the wind farm developer solution will be integrated in the Control & Protection room of Elia, **Elia specifies requirements to be in line with the existing IEC standards.** Elspec and Bachman are 2 brands which are proposed by the OEM.

- **Side 66kV** IAC bay, **voltage and current** will be supplied.
- **Side 220kV** transformer bay, **only voltage** will be supplied. These measurements can **only** be used for the **automatic control** of the wind turbines.
- Wind farms should opt for redundancy in case they doubt the reliability. In any case, **Elia must be present during each intervention** of the wind farm on the Island.

* Images are for illustrative purposes only

Some stakeholders request to add information about the **Exchange of signals**

1.Interfaces
2.Cable
3.MIC
4.High voltage & Low voltage
5.Layout

- As the design is not finished, Elia confirms that the design will be based on the equivalent concept of Modular Offshore Grid 1. The Elia goal of the signal exchange is to **consolidate the specific signals necessary related to the wind farms.**

- Elia uses the **protocol IEC104** for communication and can be used for e.g. wind speed and wind direction signals.

- The “Emergency Elia”, "Blackout Elia" and "Grid Restoration Elia" signals are information to a dispatching.
  These signals from wind farm to Elia are acknowledgements. A communication method via mail or SMS can be setup when no dispatching will be available.

- **Setpoint MVAr will be communicated via ReVolt** (Elia web-based platform)

Annex - Interface of signals OWF dispatch <==> ELIA IL1XX

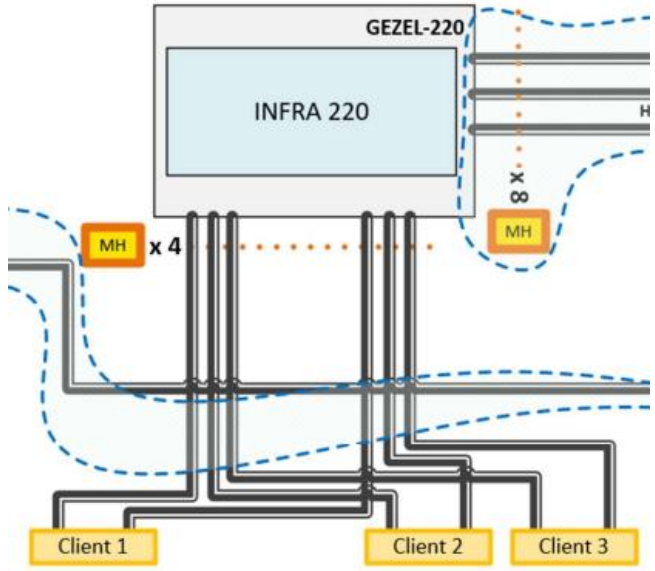
OWF dispatch ==> ELIA	From	To	Time Critical	Signal	Communication path
Real time available active power (MW)	OWF	Elia	N	Measurement	IEC104
Current voltage control mode (V control droop, Q constant, PF mode)	OWF	Elia	N	Position	IEC104
Current active power control mode (Maximum available power, limited by ELIA, limi	OWF	Elia	N	Position	IEC104
Current LFSM mode (LFSM-U on, LFSM U off, LFSMO on LFSMO off)	OWF	Elia	N	Position	IEC104
Current MW setpoint (in PPC)	OWF	Elia	N	Measurement	IEC104
Current MVAR setpoint (in PPC)	OWF	Elia	N	Measurement	IEC104
Windsnelheid (m/s)	OWF	Elia	N	Measurement	TASE2
Windrichting	OWF	Elia	N	Measurement	TASE2
Emergency Elia (aknowledgement)	OWF	Elia	N	Control signal	TASE2
Blackout Elia (aknowledgement)	OWF	Elia	N	Control signal	TASE2
Grid restoration Elia (aknowledgement)	OWF	Elia	N	Control signal	TASE2
Spare	OWF	Elia	N		
Spare	OWF	Elia	N		
Spare	OWF	Elia	N		
Spare	OWF	Elia	N		
Spare	OWF	Elia	N		
ELIA ==> OWF dispatch					
Actief vermogen meting Elia (MW)	Elia	OWF	N	Measurement	IEC104
Reactief vermogen meting Elia (MVAR)	Elia	OWF	N	Measurement	IEC104
Spanningsmeting 220kV Elia (zal afhankelijk zijn op welke TFO de string aangesloten	Elia	OWF	Y	Measurement	Convertor
Host Offline	Elia	OWF	N	Alarm	TASE2
Setpoint MW - maximum allowed active power injection MW absolute value	Elia	OWF	N	Setpoint	IEC104
Setpoint MVAr	Elia	OWF	N	Setpoint	ReVolt
Emergency Elia	Elia	OWF	N	Control signal	TASE2
Blackout Elia	Elia	OWF	N	Control signal	TASE2
Grid restoration Elia	Elia	OWF	N	Control signal	TASE2
Spare	Elia	OWF	N		
Spare	Elia	OWF	N		
Spare	Elia	OWF	N		
Spare	Elia	OWF	N		
Spare	Elia	OWF	N		

Some stakeholders request to add information about the **space available offshore and onshore**

1.Interfaces
2.Cable
3.MIC
4.High voltage & Low voltage
5.Layout

- **Offshore,** Elia will design a dedicated OWF room on the AC module with a surface of **40m² per wind farm**.
  - *HVA/C, Fire Fighting, a table according to NEN-EN 152, 4 chairs according to NEN-EN 1335 will be provided by Elia.*
  - ***No space** is foreseen **on the island layout for filters**. Study is still ongoing on the possible need for onshore filters.*

- **Onshore,** Elia will provide a space with a **max. dimension of 3,8 x 12 m per OWF** shelter on the grounds of the Elia Substation GEZEL

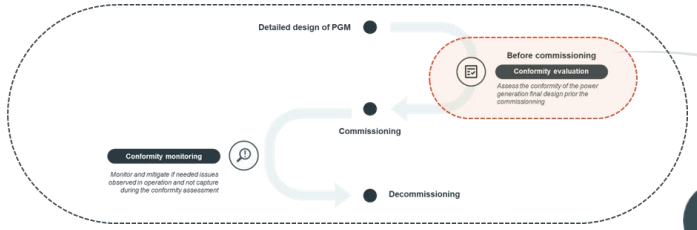


* Images are for illustrative purposes only

Dynamic & Harmonic

Overview of the evolution of the conformity process

Reminder



Conformity process

EDS

Conformity process start after reception of EDS

Energization Operational Notification (EON)

Permits to energise the internal network by using the grid connection

Interim Operational Notification (ION)

Permits using the grid connection for a limited period of time and to initiate compliance tests to ensure compliance with the relevant specifications and requirements

Final Operational Notification (FON)

Permits to operate the module which compliant with the technical requirement by using the grid. At this stage only, the owner can receive the reimbursement from the bank for the loan

EDS

- **Stage 0** — Pre-requesites : provision of general documentation & preliminary relevant system information

EON

- **Stage 1** — Kick-off & System operating envelope requirements
- **Stage 2** — Proof of compliance, data & model provision and validation

ION

- **Stage 3** — Conformity assessment
  - a. Individual SPGM/PPM/SPM within the control area
  - b. Collection + multi-PPM/SPM (NEW!)

  Collective perfor. assess. of mult. PPM/SPM within the control area
- **Stage 4** — Non-conformity mitigation (NEW!)

FON

- **Stage 5** — Commissioning and compliance testing
  - a. PPM/SPM test
  - b. Model validation
  - c. Staged tests

Main evolutions of the conformity process

Input

1. Additional information to be shared

Assessment

2. New simulation (EMT) and modelling (wide-area)
3. How to simulate
4. Scenario to be assessed

Output

5. Mitigation of non-conformity and cost-sharing

EON: Energization Operational Notification
ION: Interim Operational Notification
FON: Final Operational Notification

Overview of key reactions questions received on the conformity process

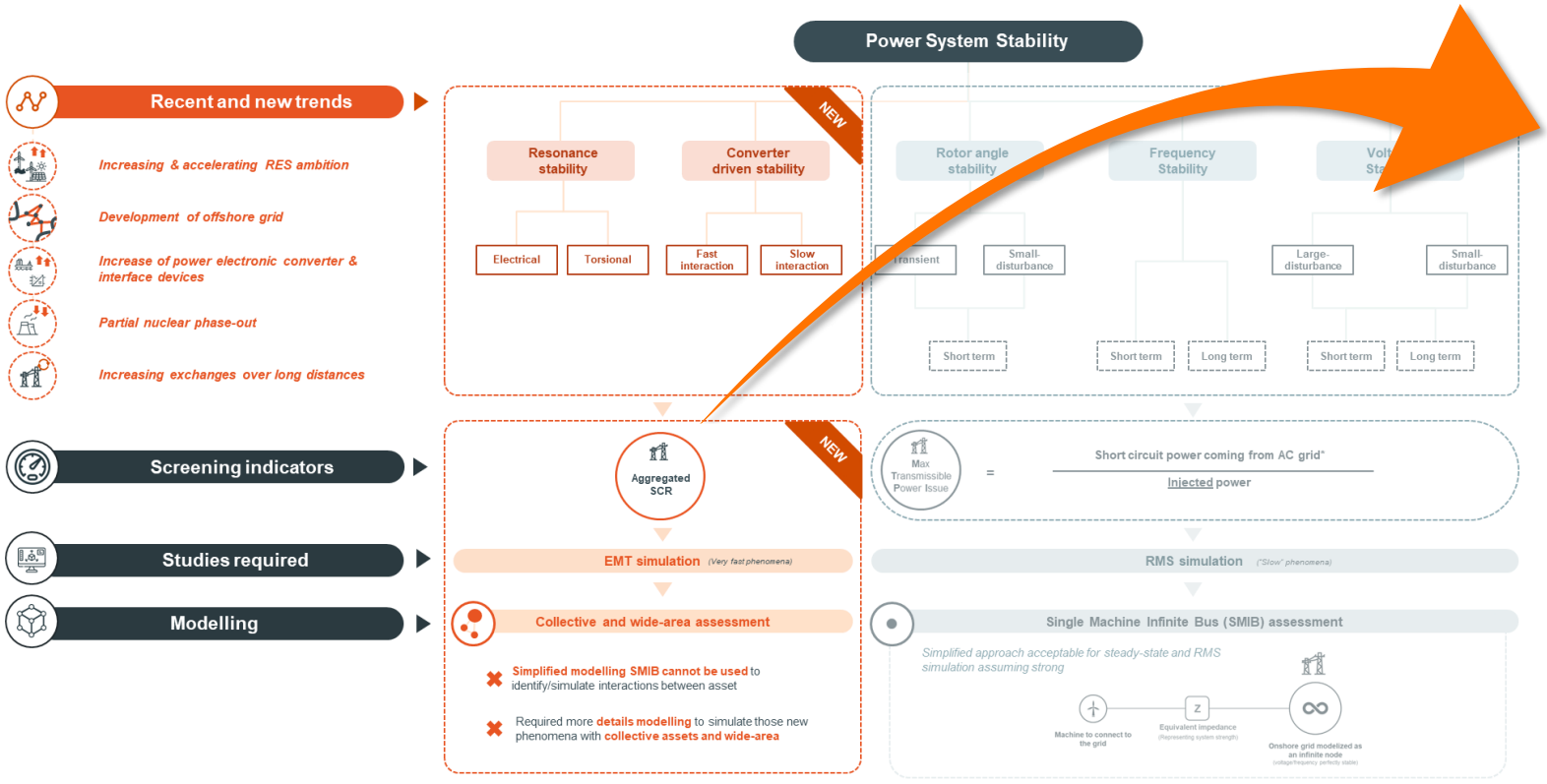
Main evolutions & reactions

1	**'EMT simulation** and **wide-area should not be perform by the Client but by Elia'**	▶	No change
2	**Against period** and **cost** for soft adaptation **after FON**	▶	**Reformulation and update**
3	**Vague statement like** "solving potential non-conformities without causing disproportionate investments" or "rough estimation of the scenario for simulations" doesn't give comfort, **and creates an open-ended risk**	▶	**Reformulation foreseen**

Elia update

4	**The process of conformity will and shall apply at the level of the "Wind Park as defined by the lots"** (and not by 350 MW offshore block as initially foreseen)	▶	**Reformulation foreseen**

BE and EU system will face massive changes in the coming years leading to **new power system stability phenomena requiring upgraded of the generic conformity process applicable for any power generating module** to properly assess the dynamic performance of new installations and to secure the grid. **The EMT simulation and wide-area are required to assess and mitigate properly these new phenomena**



Screening indicator for BE costal area

*These new phenomena will take place in Belgium with the Princess Elisabeth **Island** and especially in the single node operation*

For split node operation

Aggregated SCR $= \frac{Scc_i}{\left[Snom_i + \sum_j MIIF_{ij} * Snom_j\right]} = 1.9 < 3$

- *Snomi: Nominal Apparent Power of Assessed SPM/PPM;*
- *Scci: Minimum short circuit power at connection node of Assessed PPM/SPM;*
- *Snomj: Nominal Apparent Power of Relevant Assets;*
- *MIIFij: Voltage dip on connection node of relevant PPM/SPM j in case of 3-phase metallic short circuit on connection node of Assessed SPM/PPM as a representation of the relative electrical distance between the assets.*

Update of the generic conformity process for all future power generating module

These new phenomena, foreseen to take place with PEZ, **require to update the current conformity process** to assess the dynamic performance of the new assets **with new type of simulation** (RMS vs EMT) and **more detailed modelling** (SMIB vs multiple assets and wide-area) not currently covered in the existing process

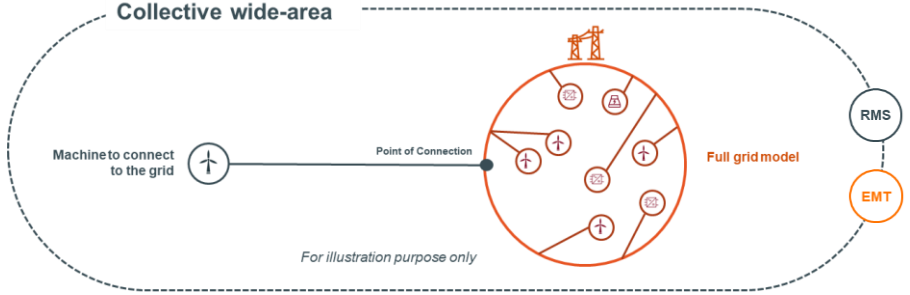
1 EMT simulation and wide-area should not be perform by the Client but by Elia

Client model | Grid model

Before tender

Detailed pre-feasibility study

Generic model | Full grid model

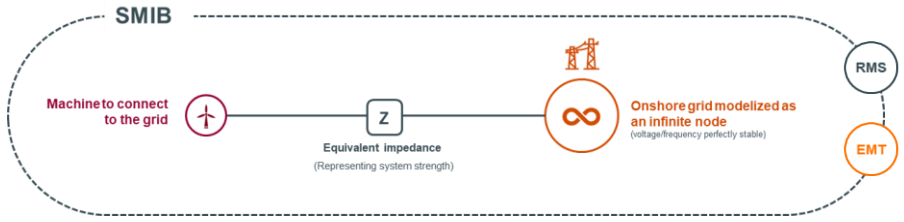


- **Elia also performs EMT and RMS simulation** with detailed modelling of the grid and generic model of the future client to **verify and ensure the feasibility**
- **Elia identify and invest in necessary mitigation measures** to ensure feasibility based on the generic model of the future client (for example SynCons, SIPS, etc)

After tender

SMIB feasibility study

Detailed model (b) | Simplified

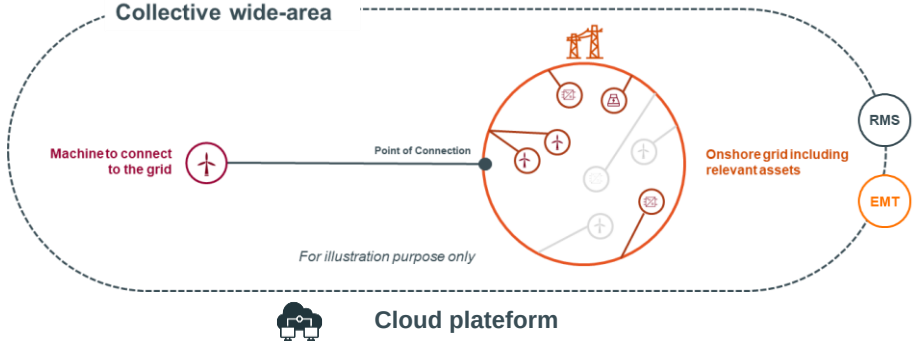


- **lobal conformity performance for design and sizing of the installation**

The client verifies the global compliance of the installation to validate the design and sizing of the installation

Wide-area feasibility study

Detailed model (b) | Detailed grid model (a)



- **Dynamic performance for tuning of the installation**

The client verifies the dynamic performance of the installation and perform software change if needed (only on control command)

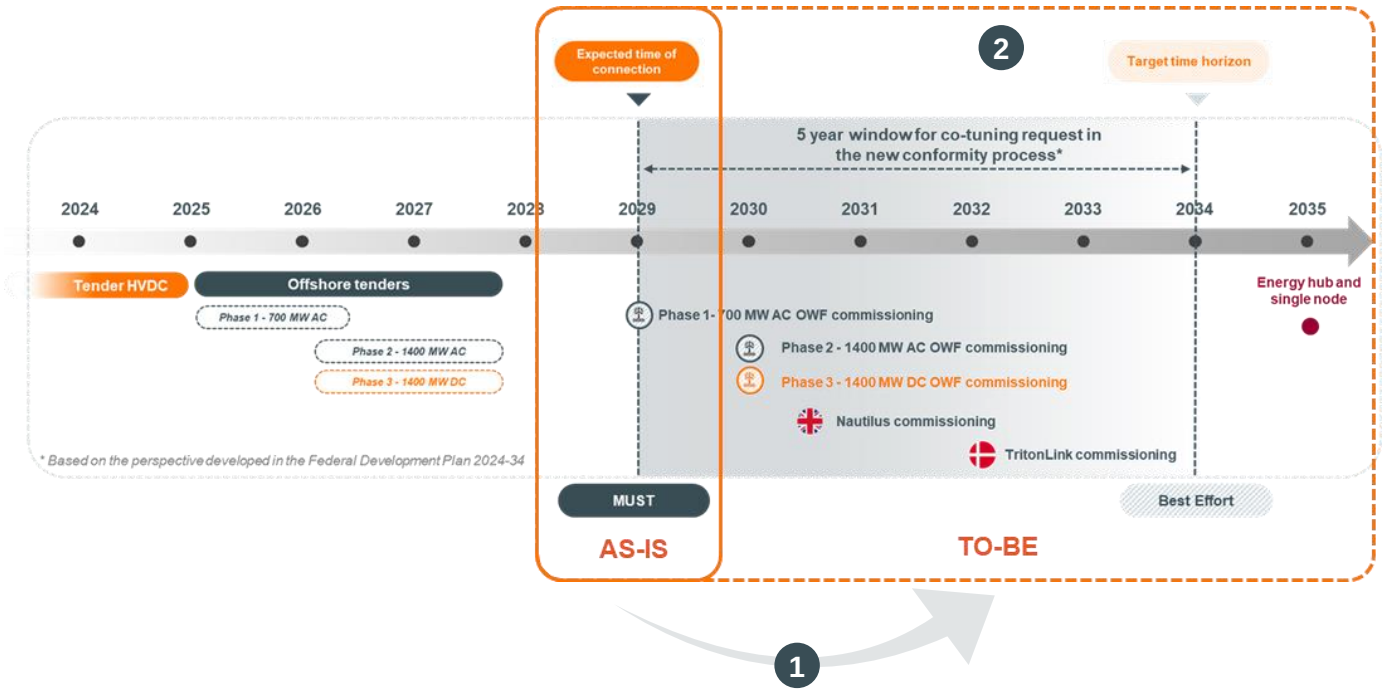
a. **Elia put at disposal the detailed models develop to perform the pre-feasibility with which the feasibility was demonstrated** with generic model for the future client (cloud platform)

b. The client uses **its details models instead of the generic model used by Elia** to perform the simulation to verify the compliancy and can directly assess impact of design or control retuning if needed. This allows an efficient process instead of several iteration between Elia and OWF

2 Against period and cost for soft adaptation after FON

Update

Period | **AS-IS: 5 years** for max **5 times** request ▶ **5 years** for **3 times** request ✚ **Equity criteria**



1

- ***This extension is necessary to provide comfort to all new assets just being connected and coming later*** *(offshore wind or others) to still be able to make feasible their connection to the grid and limiting the need of multiple retuning of existing ones after their FON*
- ***It is proposed to keep the 5 years*** *as it is already a compromise between*
  - *the ideal 10 years horizon plan to ensure flexibility with the coming system change (offshore/onshore) from the development plan, and*
  - *the consideration of realistic application into contractual framework agreement with manufacturers/consultants*
- **The number of time requested for potential soft adaptation is reduced from 5 to 3 with equity principle**

2

Equity criteria for conditions to request investigation and implementation of performance improvement after FON

Following criteria will be added to ensure fairness in the way Client would be requested to investigate and if approved, implement improvement of their dynamic performance

"Rotating application of the request of assessment/implementation, starting from the oldest eligible Committed Asset"

The application of the non-conformance mitigation is scoped as much as possible to limit risk for all parties. Reduction of the number of time requested for soft adaptation is reduced from 5 to 3 with equity principle. The cost principle remains the same to give the correct incentive to offshore vendors to include this in their contract

3 Vague statement like “solving potential non-conformities without causing disproportionate investments" or “rough estimation of the scenario for simulations” doesn’t give comfort, and creates an open-ended risk

1 **EMT simulation** and **wide-area** should be not perform by the Client but by Elia → **No change**

“The TSO, as appropriate party, should perform wide area EMT simulations as it has been done before and not the grid user. The resulting risk for dynamic instabilities observed during wide-area network studies is the outcome of the planning choices made by Elia and should not be transferred in full to the compliance process of individual connections. Otary considers this a red flag.” - Otary

Clarification and justification with demonstration

2 **Against period** and **cost** for soft adaptation **after FON** → **Reformulation and light Update**

“After the FON is granted to the PGMs and during the ongoing lifetime of the PGM installation, ELIA should have possibility to expect from the already connected generators, under reasonable conditions, to adjust their settings and even perhaps control modes to optimize the global system performance”. This is a statement that can have major impact on Committed PGM's. It should at least be subject to a well described procedure, including a CBA and that takes into account the technical (im)possibilities of the concerned PGM. Cost allocation of such adaptations to be discussed. Otary considers this a red flag” - Otary

fine-tune the application

3 **Vague statement like** “solving potential non-conformities without causing disproportionate investments" or “rough estimation of the scenario for simulations” doesn’t give comfort, **and creates an open-ended risk** → **Reformulation foreseen**

Vague statement like “solving potential non-conformities without causing disproportionate investments" or “rough estimation of the scenario for simulations” doesn’t give comfort, and creates an open-ended risk - Otary

- Clarification in the wording foreseen to better scope the application and will be only limited to retuning of the dynamic performance of the control **without affecting the sizing or the need of additonal equipments in the installation**
- No rough estimation of the scenarii for the simulations. **Number of scenario/events to be simulated will be estimated as best as possible**. Nevertheless, slight/limited adjustments might still be needed in function of the evolution of the system and the design proposed by the Client.

4 Clarification on the application case of the conformity

The process of conformity will and shall apply at the level of the "Wind Park as defined by the lots"
(and not by 350 MW offshore block as initially foreseen)

The design and implementation of the control strategy of the Wind Park is the full responsibility of the Client.
Nevertheless, this design and implementation shall have to right granularity to respect the requirements applicable to the Offshore PPM Type D

Needs for situation in operation N and N-1

In this respect, and to ensure secure operation of the system in N and after contingency, it is important that

- ***The voltage and MVAr control capabilities are implemented in line with the principles defined the PEZ public consultation report*** *(chapter 3.4) for which the capability of controlling the reactive power with a droop has to be performed taking into account the voltage of the HV side of the transformer to which they are connected while the reactive power shall be monitor and controlled at the level of the 66kV busbar they are connected to*
- ***The capability to remotely control*** *or limit the active power shall apply at the level of each 220/66 kV transformer proportionally to the power connected to each string*

Resilience needs in case of forced outage TFO 220/66 kV

In case and only in case of forced outage of one 220/66 kV transformer, as part of resilience solution, the wind turbines initially connected behind the lost transformer shall have possibility to be connected via other transformers

Must have

- Operate this group of wind turbines in Q control
- Remotely control or limit the active and reactive power together with the other wind turbines connected to the same 220/66 kV transformer

Nice to have

- Operate this group of wind turbines in V droop control of the 220kV side of the new transformer behind which they are connected

The application of the resilience solution might require manual actions to adapt control mode or adjust measurement references of the control of the concerned wind turbines. The events that will need to be considered in the simulations and tests for the ION and FON stages of the conformity process for the assessment of Voltage/Mvar and Active power controllability shall depend on the control design proposed by the client and shall be defined in coordination between ELIA and the client during the EON stage.

Clarification questions on D&H

Forced oscillations – clarification on reference used

Pre-read

Reactions

- **Clarification**/question on the **reference used** to defined the technical specifications related to active power forced oscillation
- **Clarification on the value to retain** in the range described for the active power forced oscillation criteria

Elia answer

- ELIA confirms that the proposed requirement is a **copy-paste of what ENTSOE and WindEurope** have jointly submitted to ACER as input for the amendment of the RfG NC. The proposed requirement is the result of common discussion between ENTSOE and WindEurope who decided to extend the frequency range to the one which might potentially put at risk interaction with inter-area modes.
- The goal of the common ENTSOE/WindEurope proposal is defining how to keep limited active damping to ensure acceptable behaviour
- ELIA **doesn't intend to go further** than what has been proposed by ENTSOE and WindEurope
- ELIA **confirms that default values** will be used for the conformity of Princess Elisabeth Zone Offshore Wind Farms

Conformity process – criteria to perform simulation and measurement unit for tests

Pre-read

Reactions

- **Clarification** on the aggregate SCR index calculation versus other indicators
- **Challenge on the criteria used** to trigger needs for RMS and EMT simulation in the conformity process vs criteria from CIGRE TB671

Elia answer

- Elia understands that CIGRE TB 671 was developed 10 years, and published 8 years ago. The level of penetration in countries and states such as Australia, Ireland, Texas and UK was significantly below the current levels. Furthermore, the main issue back then was the connection of a few remote and radial, 100-200 MW, wind farms in a very weak part of the network. Such an analysis does not require wide-area modelling then and now. However, a further challenge being experienced globally since then is high concentration of many GW range power electronic interfaced devices in weak or strong part of the network likely resulting in adverse interactions if not carefully planned and studied. These interactions are often very low frequency meaning that they can travel well within the power system and interact with other power electronic interfaced devices nearby or even sometimes relatively far. This can only be studied by wide-area modelling. None of these were the premise of CIGRE TB 671. However, we note that also CIGRE has published many technical brochures and journal papers related to the wide-area modelling especially in the past couple of years. This includes CIGRE 881 and 909, and several to be published TBs. Therefore, it is our view that while CIGRE TB 671 will remain as an excellent source for SCR calculation methods it was not intended and should not be used for determining when wide-area studies are required. Last but not the least, 10 years ago even if the need for wide-area studies were to be identified, none of the simulation tools back then or the computing power available were capable of supporting such wide-area studies.
- The aggregate SCR is a variant of the MIESC (Multi-Infeed Equivalent SCR) where the main reason for the difference was to simplify the way to compute while keeping the spirit of the screening index. Another difference is that the aggregate SCR calculations in TB 671 is based on a pre-selected number of power electronic interfaced devices. However, a quick pre-selection of plant's of relevance/importance is not possible in Belgian power system due to the small and concentrated size of the power system, with no radiality in the system. As such the use of voltage difference is to facilitate selection of plant's of relevance/importance based on a deterministic criteria which would not be possible based on original CIGRE TB 671 formulation. Moreover, ELIA would like to stress that the proposed aggregate SCR has been developed with the support of one of the lead author of this CIGRE brochure.

Reactions

- **Clarification on the possibility to install measurement asset** on Elia assets for the test phase

Elia answer

- **Elia confirms that Client will have the possibility to install its own measurement device as explained in the connection requirement (see slide 67).** Moreover, for the purpose of the tests, PMU (phase-measurement unit) that will be installed by Elia might also be used

Voltage management – clarification on capability and protocol for communication

Pre-read

Reactions

- **Clarification** on the **capability of switching** between “reactive power” vs “voltage control” mode and cyber-IT risk & remuneration
- **Clarification** on IEC **protocol** requested to be used for the **MVAr set-point** versus ReVolt

Elia answer

Switching capability

- Regarding the cyber/IT risk, Elia understands the criticality and the cruciality of the reactive control mode switch. Nevertheless, this is only one of the possible "TSO inputs" to the wind farm control system that are also impacting the control philosophy and IT/OT security of the wind farm. **Elia will use the same level of high IT security** as for the other signals exchanged with the wind farm.
- Modalities and conditions for the change of voltage control mode are similar to the ones described in "3.4.3. Offshore wind farm behavior for reactive power set-point reception" and **no specific developments are foreseen for this.**
- Elia would like to underline that the possibility to remotely switch control mode is **not expected to be a remunerated service** but a base, non remunerated, capability of the wind farm.
- In addition, **the choice of implementation of the automatic change** of the control mode (fully automated or via remote "manual" intervention of a human operator) is **left to the respondent**, provided that the time response of this change is compatible with Elia requirement and will not require on site intervention.

Communication protocol

- For the MVAr set-point, **Elia confirms that ReVolt interface will remain of application for the provision of MVAr set-point from ELIA to the Client.** The list of signal exchange for OWFs is adapted

Technical requirements Dynamic & Harmonics – general reactions

Pre-read

Reactions

- **Challenge** on the additional requirements related to Dynamic & Harmonics consideration versus **industry capability**

Elia answer

- ELIA reminds that the requirements for offshore wind farms defined in the **Federal BE grid code remain the basis, unless improved or completed by the content of the consultation report**

- ELIA **confirms the proposed new requirements have been designed considering the industry capabilities**

- **Forced oscillation requirements** have been jointly defined with Wind Europe
- **Voltage control capability** has considered reactive control capability of +/- 5% at the level of wind turbines' terminal based on information from industry
- **High Voltage Fault ride through capability** has been based on both discussion taken place in the RfG amendment process and capability from installation existing in ELIA grid

Summary of main reactions and answers for Dynamic & Harmonic

Dynamic & Harmonic

Conformity process

1. **Challenge screening index** used to trigger the need for EMT and wide-area simulation
2. **Propose that TSO should** perform EMT simulation and wide-area simulation
3. **Client's installation** model used in the conformity process
4. **Red flag on criteria for mitigation to provide** after FON
5. **Request to be able to install measurement** devices on island for test phase

1. Selection of screening criteria is based on worldwide reference and based on expert references that will be detailed in the report
2. Elia performs EMT and wide-area simulation in pre-phase (to check feasibility and make investment) – tuning of installation is OEM resp.
3. **Elia justifies** model used for pre-phase and for conformity process
4. **Elia soften the criteria with equity principle and reduced frequency for potential controller tuning**
5. **Elia confirms** that client will be able to install measurement on Elia CT

Voltage management

1. **Interface to use to send MVAr setpoint** IEC104 protocol vs ReVolt (Elia)
2. **Clarification on application of voltage performance (access point, connection point, string level, ..)**
3. **Challenge req. on capability** to shift reactive **control mode** (needed when DC connected) and voltage control mode (needed when AC connected)
4. **Compensation for missing revenues when DC connected (no MVAr service can be provided)**

1. **Elia corrects** that ReVolt interface will be used for MVAr set-point and not IEC104 protocol
2. **Clarification on application of voltage performance (access point, connection point, string level, ..)**
3. **Capability needed in split node operation for redundancy case where wind farm can be shifted from AC to DC and inversely**
4. **No remuneration/compensation** is foreseen for services not needed

Forced oscillation

1. **Clarification on Elia requirements vs. ENTSO-E/WIndEurope requirements** in the EU NC amendments
2. **Clarification on the reference value** to retain in the ranges described for forced oscillation criteria

1. **Elia confirms that the requirements** for forced oscillation are exactly the **ENTSO-E/WindEurope req.**
2. **Elia re-confirms the reference is the default value** proposed by ENTSO-E/WIndEurope proposal

Thank you