

# EU Netcode Emergency & Restoration

Users Group WGSO

18/09/2018

# Agenda

1. Timing & deliverables
2. Status SGU identified and High priority SGUs

## Items related to system restoration

3. Terms & Conditions for Restoration Service Providers and consultation
4. Restoration Plan design
5. Consultation on Creg incentive study for future black start strategy
6. Consultation of design note for future restoration services as from 2021

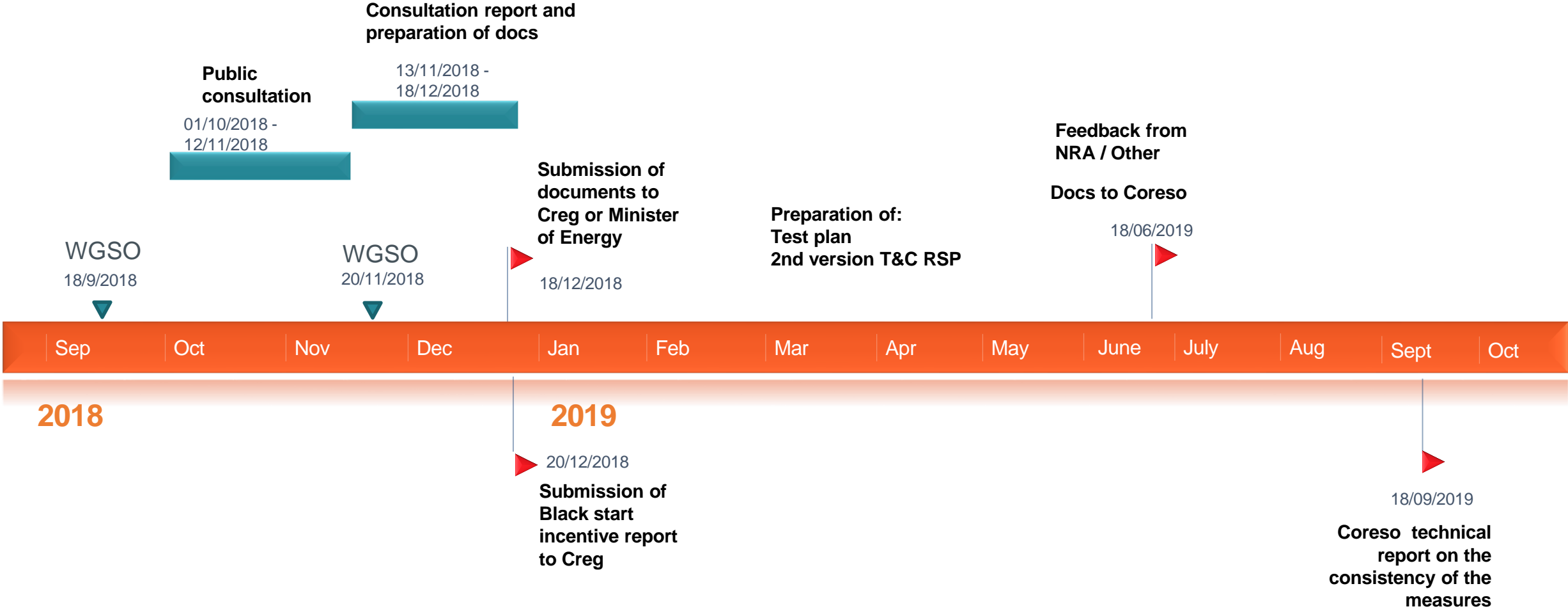
## Items related to Market Interaction

7. Rules for suspension and restoration of market activities
8. Rules imbalance settlement during market suspension

## Items related to system Defense

9. Terms & Conditions for Defense service providers and consultation
10. Defense Plan Design

# NCER timeline



Documents to submit by Elia for approval by 18-12-2018	Approval by	Public consultation
a) Terms & Conditions to act as <b>defense service providers</b> on a contractual basis	Creg/other	Yes
b) Terms & Conditions to act as <b>restoration service providers</b> on a contractual basis	Creg/other	Yes
c) List of <b>SGUs</b> identified for defense and restoration plans.	Creg/other	No
d) List of <b>high priority sgus</b> and the T&C for disconnecting and re-energizing the high priority grid users	Creg/other	No
e) The rules for <b>suspension and restoration</b> of <b>market</b> activities;	Creg	Yes
f) Specific rules for <b>imbalance settlement</b> and settlement of balancing energy in case of suspension of market activities	Creg	Yes
g) The <b>test plan</b> in accordance with Article 43(2).	Creg/other (2019)	No
h) System Defense Plan	Creg/other	No
i) Restoration Plan	Creg/other	No
j) Black start incentive study	Creg (20/12/18)	Yes

# SGUs Identified and Service providers

## SGU Identified

- Some measures of the Plans are based on capabilities that are **mandatory** for the Grid Users (“minimum operational requirements”) according to requirements in:
  - NC RFG, NC DC and NC HVDC (for new facilities) or
  - national legislation (for **existing** facilities)
- These capabilities can be directly used by the TSO in its Plans. For instance: Type C and D PGM shall be able to follow an Active Power set-point instructed by the TSO. → **ensure that new FTR contains these provisions !**
- In the design of its Plans, the TSO is requested to identify these capacities, and to **identify the concerned grid users.**

## Service providers

- Some measures of the Plans are based on capabilities that are foreseen to be provided on a **voluntary** basis according to the connection codes. For instance: A Power Generation Module providing Black start capability voluntarily.
- To use these capabilities, the TSO is requested to procure these services via “**Service Provider**” mechanism described in the code. This mechanism allows to define the obligations of each party, and conditions for the service delivering.

## 3: Terms and Conditions for Restoration Service Providers

# Restoration Service Provider (RSP)

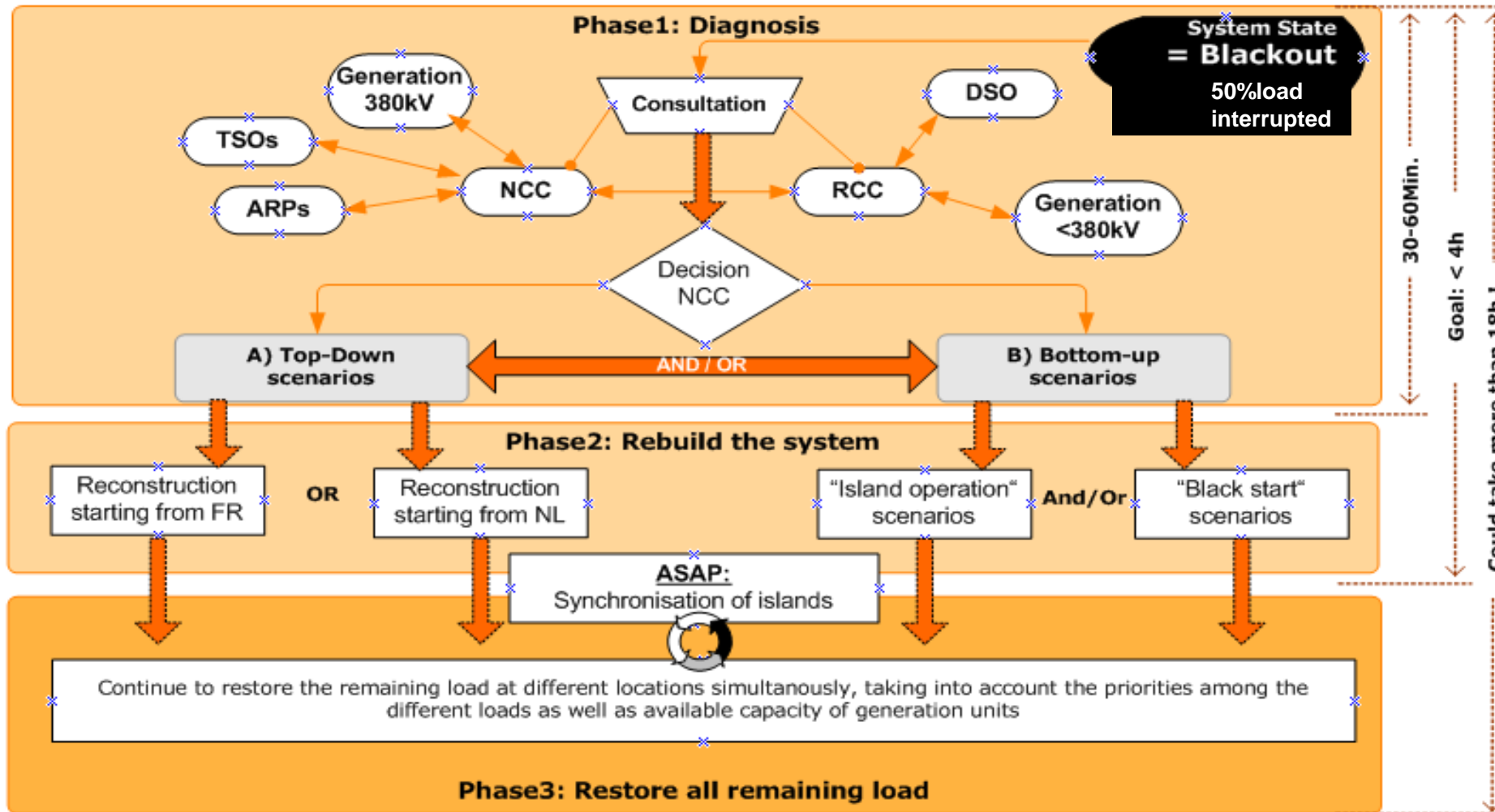
- RSP = legal entity with legal or contractual obligation to provide a service contributing to one or several measures of the Restoration Plan (RP)
- Some measures of the Restoration Plan are based on capabilities that are foreseen to be provided on a **voluntary** base, rather than based on mandatory legal requirements in European Grid Codes or National Legislation.
- To use these capabilities, the TSO is requested to procure these services via “**Service Provider**” mechanism described in the code. This mechanism allows to define the obligations of each party, and conditions for the service delivering.
- In Belgium, the only restoration service on voluntary basis is the black start service.
- CIPU units connected to the Elia grid having black start capability can participate to a tender. Actually, 5 BS units are contracted (process is currently being finalized) until end of 2020.
- **A first version of T&C for RSP will reflect the actual Black start contract provisions**
- Elia is currently preparing a new design for future black start services (next slide)
- A second version of T&C for RSP reflecting the new design concept will be submitted for approval in 2019.

## 4: Restoration Plan design



# Actual restoration procedures

## Strategy of the restoration code



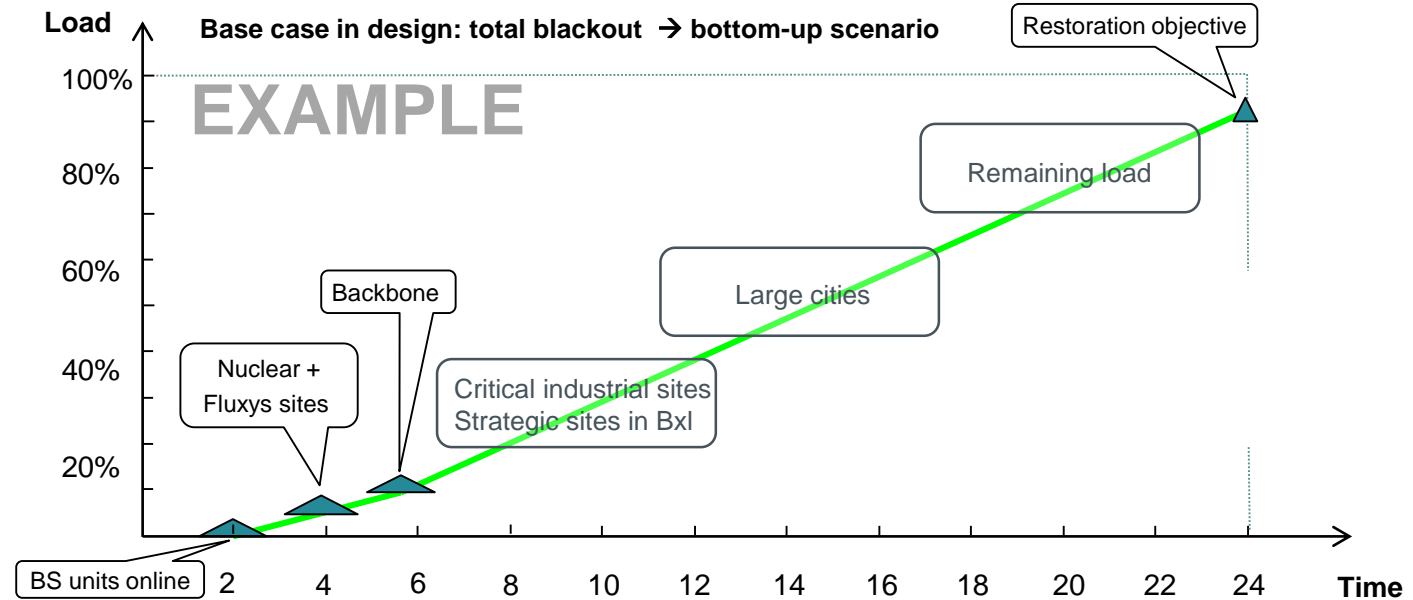
# Principles of actual restoration plan

## High priority sgu

Nuclear sites Doel, Tihange: target restoration time  
Fluxys stations Berneau, Winksele, Zelzate

In each re-energized substation

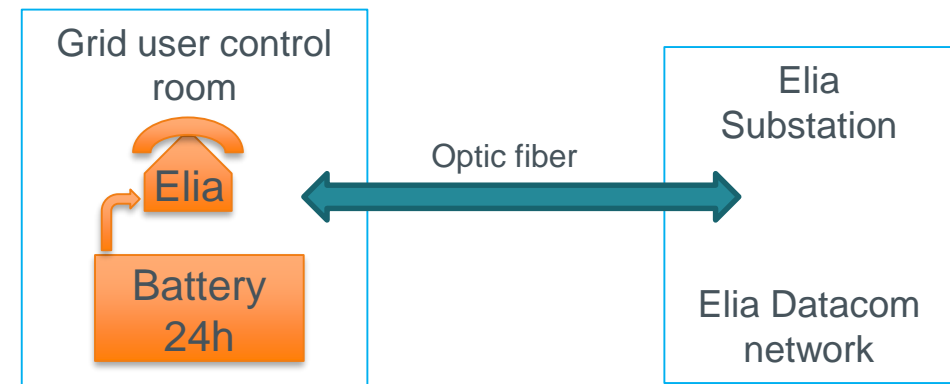
- Hospital
- TSO and DSO auxiliarie
- Emergency call centers 112, 100, 101



## Communication during blackout and restoration

Send blackout signal by sms, whatsapp, rss, website to stakeholders  
+ notification of best estimate time for restoration  
+ updates of restoration process  
+ notification if system is back to normal or alert state (NCER art 38)

Stakeholders should pre-register



# Restructured existing restoration plan

## Re-energization procedure

- Measures to apply Top Down (from neighbour TSO) and Bottom up, using black start and houseloaded plants.
- Measures to control frequency and voltage.
- Measures to build and re-synchronize islands

NEW

## Frequency management procedure(\*)

- Load Frequency Control settings
- **Appointment of frequency leader**
- Establishment of a target frequency (e.g. 51 Hz)
- **F management in case of frequency deviation or area split**
- Determination of max amount of load to be connected

(\*) Not necessarily only after blackout, but also after system split

NEW

## Resynchronization

- **Appointment of resynchronization leader**
- Measures allowing a TSO to apply a resynchronization strategy
- Max phase angle, frequency and voltage differences for connecting lines



Restructuring existing restoration plan

## Proposed structure of the Restoration plan

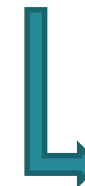


**Master document** which includes :

- Links towards re-energization procedures
- Frequency management procedure
- Resynchronization procedure
- List of essential substations
- List of units with BS & houseload capabilities



**Resynchronisation procedure per zone** and specificities of the electrical zone  
**NCC procedure**



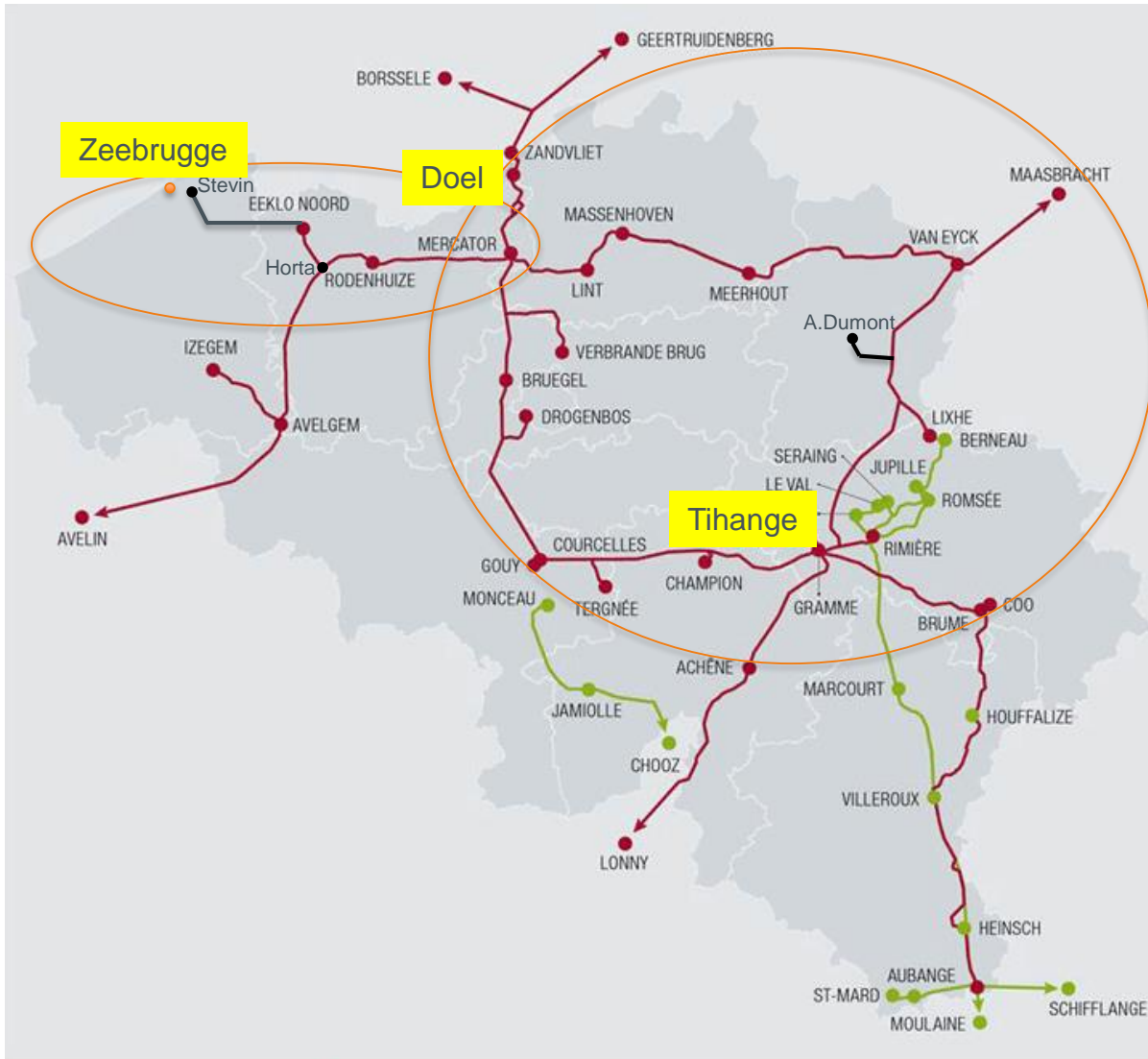
**Individual resynchronisation scenario**

These scenarios remain unchanged

## 5: Creg incentive study for future black start strategy

# Methodology to determine minimum number of BS units

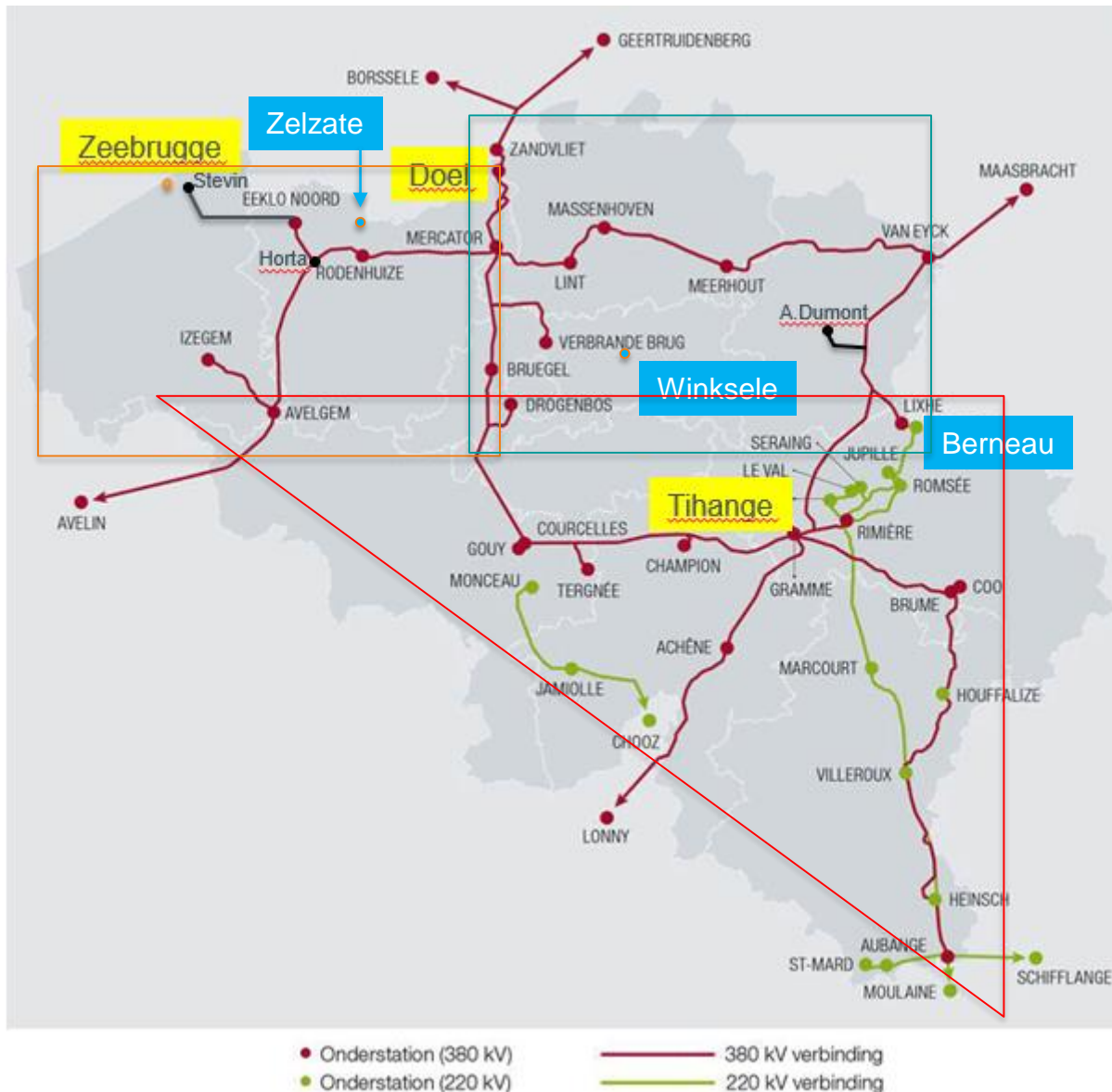
- Study horizon: 2021 – 2030, including nuclear phase out
- Determination factors for minimum required BS plants:
  - High priority grid users: location and target restoration time
  - Location of non-black start plants
  - Back – up in case black start unit is unavailable
  - Overall target: 90% of Elia connections re-energized within 24h
- We do not rely on houseloaded plants → too much availability uncertainties



## Step 1: Cat 1 load + N-S backbone 380 kV

Critical connections in Doel, Tihange and Zeebrugge

- Not possible to energize 3 locations with only 1 BS unit (timing + Mvar constraints)
- At least 2 BS units required to restore these loads within the target restoration time (approximately 5 hours)
- 1 BS unit close to axis Zeebrugge – Mercator
- 1 BS unit close to axis Gramme – Doel



## Proposed zonal repartition

- Island 1: North-West
  - Energize Doel and Zeebrugge in 5 hours
  - Energize Zelzate in 6 hours
  - Path to non-BS unit in cluster Gent, Brugge, Antwerp
- Island 2: North-East
  - Energize Doel in 5h + Winksele in 6 h
  - Path to non-BS unit in cluster Antwerp, Gent, Brugge, Limburg, Brussels, Charleroi
- Island 3: South
  - Energize Tihange in 5 h + Berneau in 6 h
  - Path to non-BS unit in cluster Charleroi, Brussels, Liège and Antwerp
- Depending on location and type of BS units, a fourth regional island may be required to cover Limburg and Liège

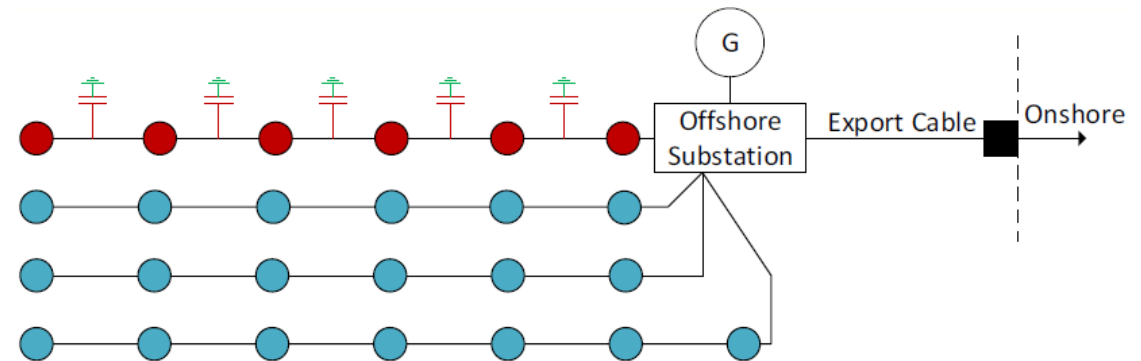
# Conclusions

- **Four BS units are required to restore the Belgian grid with bottom up strategy**
  - 1 BS unit located close to the axis Doel-Gramme to energize 380 kV backbone
  - 1 BS unit in zone North West → Preferably in cluster Gent
  - 1 BS unit in zone North East → Preferably in cluster Antwerp
  - 1 BS unit in zone South-West or South East → Preferably in cluster Charleroi
- The backbone unit and the regional units serve as each others back-up (in case of maintenance or in case of unavailability due to the blackout)
- Depending on the location and type of units offered, one extra BS unit might be required
- Less than 4 BS units would compromise the 90% in 24h target due to sub-optimal use of human resources in early restoration process.



# Black start capability: off shore wind potential ?

- Consultant [Franzer-Nash](#) assessed the cutting-edge developments on BS capability for OS windfarms
- Most turbines are able to blackstart itself and power their own auxiliaries. A small diesel generator is required on the off-shore platform to power essential service functions.
- They are close to being able to power the offshore platform. The inverters must be designed to operate in a weak grid and absorb reactive power from cables intra-WT.
- Large gap is to energize the cable between OS platform and on-shore substation and V/f control
- Other essential gaps:
  - Block demand loading
  - Wind energy availability



The off-shore wind farm technology is not mature to provide a reliable black start service at this moment. TSO should contract Restoration Services with highest probability of availability when needed.

## Black start capability: potential of PV ?



- Most inverters do not allow blackstart. Some inverters allow. They need a battery.
- Restoration of distribution grid is still uncertain: V, f control, protection, coordination. Not mature yet.
- TSO cannot rely on PV for blackstart now and in the near future.
- PV does not meet the requirements to provide the black start service at this moment.

6: Creg incentive:  
design note for future restoration services

# Preview: short summary of design changes

## 'Larger' change

- Contract signatory: from ARP to **RSP**
- Today CIPU only >>> Open up the service to new configurations (**aggregations** of smaller units)
- Remuneration: split in **3 cost components** (capital cost, operational cost, opportunity cost)
- Before contract start: successful **prequalification** test

## Context

- More **regulation**
- Review of **needs** & geographical distribution

## 'Minor' change

- Improvement of public **tender** procedure
- Update of **availability** requirements, stricter availability control & penalty
- Review of **technical** requirements (linked to needs determination)
- Update of **compliance testing** (timing, remuneration (none), penalty) & clarification on penalties for failed tests

## No change

- **Non-conditional black start capabilities**

## 7. Rules for market suspension and restoration

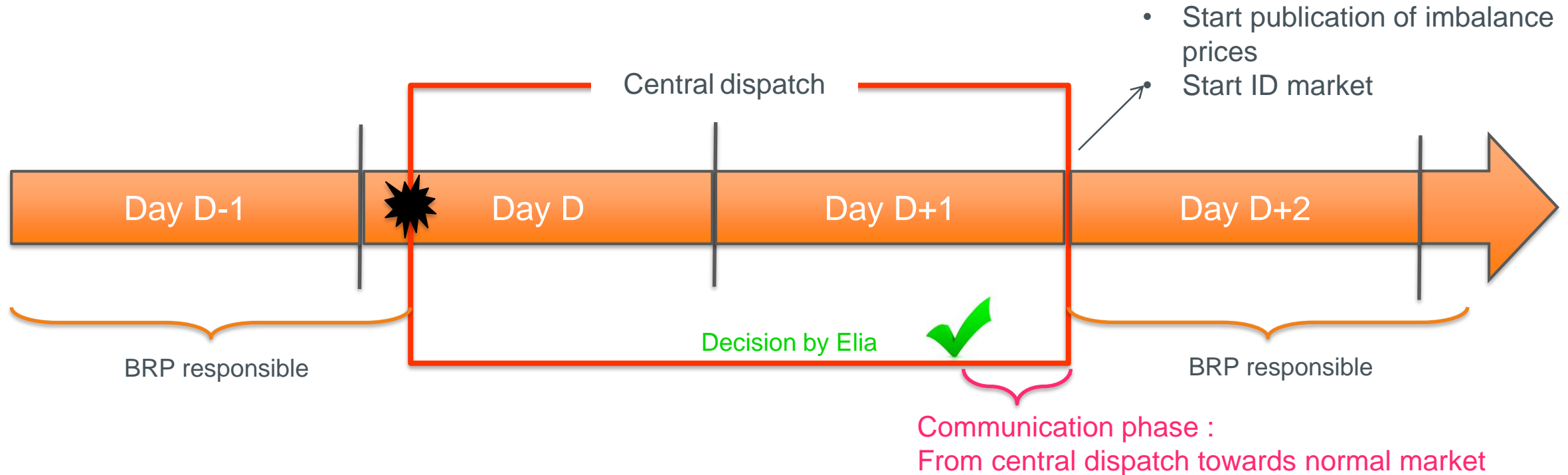
# General principles for market suspension rules

- **Keep the BRP responsibility the longest time possible** as they have a positive impact on grid stability due to the financial incentives proposed by the market
- If possible **keep market coupling active** as it will help to restore the market afterwards :
  - When BRP responsibility is put on hold, market places are no longer relevant, but can remain operational
  - If the normal cross border capacity calculation process does not work anymore, the cross-border capacity that will be allocated to the market coupling algorithm, should be set to a default value that can be 0. This default value has to be decided based on the situation.

Market suspension in case of:

- **Full blackout** : No transport of electricity is possible, the markets cannot be used; BRP responsibility is put on hold  
A full blackout is defined as zero voltages in the entire control area, except some small islands or PGMs in houseload operation
- **Unavailable tools and communication systems** : Market transactions cannot occur anymore; TSO may decide to put on hold BRP responsibility

# General principles for restoration of market activities



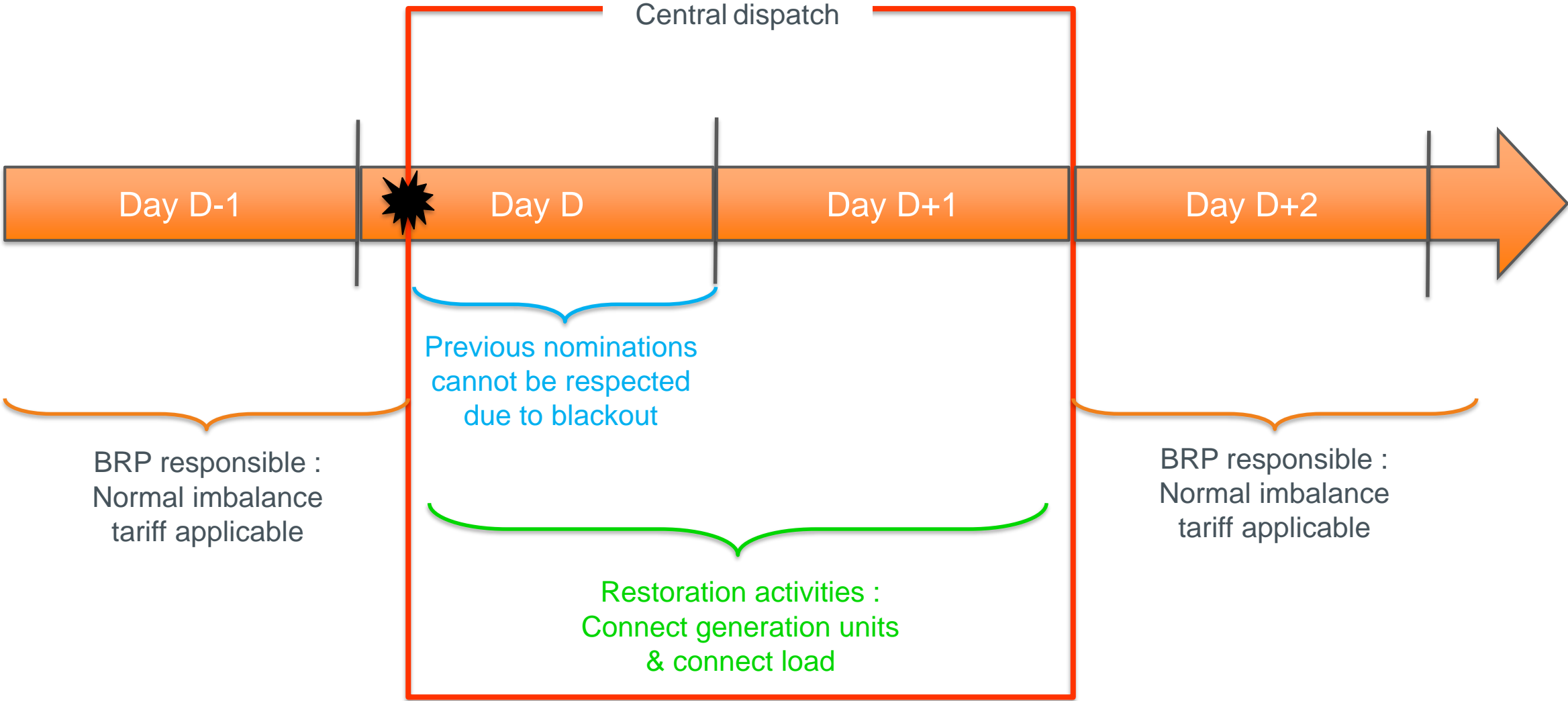
Once the grid is sufficiently stable according to Elia : **Communication phase** during which :

- Day ahead, Intra day and balancing **markets are sequentially restored**. The BRP responsibility is effective once the balancing market has been restored
- **Market players could prepare** before the effective restoration

## 8. Specific rules for imbalance settlement during market suspension periods



# General principles for the imbalance settlement in market suspension periods




# General principles for the imbalance settlement in market suspension periods

<b>Imbalance during central dispatch</b>	No penalty/remuneration is applied during periods of central dispatch as Elia decides of the power set-points
<b>Previous nominations</b>	Nominations made prior to the blackout are canceled <ul style="list-style-type: none"><li>• It has no impact on the balance position of BRPs</li></ul>
<b>Restoration tariff</b>	The restoration tariff is the tariff at which <b>producers have to sell energy</b> to Elia and consumers have to buy from Elia during central dispatch Two options are considered : <ul style="list-style-type: none"><li>• <b>Ex-ante calculation</b> for the first hours of the central dispatch. Examples are :<ul style="list-style-type: none"><li>• Czech Republic: publication of emergency tariff approved by regulator on 1st Jan each year</li><li>• Australia: tariff based on 28d moving average price for week and weekend days, published each week</li></ul></li><li>• <b>Ex-post calculation</b> for the remaining duration of the central dispatch. Examples are :<ul style="list-style-type: none"><li>• Start &amp; incremental bids based upon CIPU procedures day-ahead</li><li>• Total cost of restoration (if restoration is not too long)</li></ul></li></ul>

# Communication protocol in case of market suspension/restoration

Elia must send information simultaneously to all important stakeholders when markets are suspended:

- (a) the notification that market activities have been suspended;
- (b) the notification of best estimate for the time and date for transmission system restoration;
- (c) the updates on the process for restoration of the transmission system;
- (d) the notification that the transmission system has been restored back to normal state or alert state;



Proposal: sms (RingRing),  
Website, e-mail, Whatsapp, rss

Stakeholders should pre-  
register

NEMOs must send information simultaneously to all important stakeholders when markets are suspended:

- (a) the notification by the NEMO of the suspension of their activities, if any;
- (b) the notification by the NEMO of the best estimate for time and date when market activities will be restored; and
- (c) the confirmation by the NEMO that market activities have been restored.

All stakeholders (DSOs, SGUs, BSPs, BRPs, ...) should notify that their market tools and comm systems are operational

All notifications and updates by the TSO(s), the NEMO(s) and other entities shall be published on the websites of those entities.

When notification or update on the website is not possible, the entity subject to the obligation to notify, shall inform via email, or via any other available means, at least those parties directly participating in the suspended market activities.

## 9. Terms and Conditions for Defense Service Providers

# Defense Service Provider (DSP)

- DSP = legal entity with legal or contractual obligation to provide a service contributing to one or several measures of the System Defense Plan (SDP)
- In Belgium, transmission or distribution connected entities who want to offer demand side management or provide flexibility on a **voluntary basis** can do this via recently developed platforms. E.g. Bidladder.
  - No separate contract for defense services is required !
- BSP and SGU who have remaining reserves available should activate this upon request of TSO (NCER art 21)
  
- **Conclusion: we do not see the need to introduce “Defense Service Providers” because demand side response can already be provided on a voluntary basis through the existing platforms for flexibility, which continue operation in emergency state.**

# 10. System Defence Plan

# Adjustments in current Reddingscode / Code de sauvegarde

- Generic command “**Action MW**” which contains instruction to increase active power on all production units to 95% of Pmax, will be replaced by market based activation of balancing energy + “emergency reserves”
- Action “**Starting Turbojets**” which contains instruction to start available turbo jets (small open cycle gasturbines), will be replaced by market based activation of balancing energy + “emergency reserves”
- The actual defense plan contains a set of **automatic** actions activated at **f < 49,7 Hz**
  - ~~Some industrial grid users disconnected~~
  - U-5% → direct signal to Elia transformers
  - Stop pump storage units
  - ~~Start turbojets~~

Scada-to-Scada  
signal to BRPs



Ask BRP for  
directly impacting  
the machines

- Generic command “**Action MVar**” i.e. “All production units to max Mvar” will be removed from the existing defense plan.

## Possible **actions to be activated by Elia** (case by case)

- Use of reactive power devices in coordination with RCCs and DSOs;
- Request (or control if available) additional voltage/reactive support from power plants;
- Requesting maximum or minimum values of Reactive Power to specific PGMs of type C and D
- Requesting additional Reactive Power support from Nemolink or Alegro
- Help from Tennet or Rte
- Manual load shedding (art 22)

## 10. Defense plan – back up slides



# System Defense Plan (NCER art 11)

## 3 automatic control schemes and 5 manual operation procedures

(a) system protection schemes including at least:

(i) automatic under-frequency control scheme in accordance with Article 15;



*Working group in place*

(ii) automatic over-frequency control scheme in accordance with Article 16; and



*Answers to questionnaire received. The LFSM-O is sufficient*

(iii) automatic scheme against voltage collapse in accordance with Article 17.



*Elia is already compliant (blocking on-load tap changers on transformers, no automatic under-voltage load shedding, no special protection schemes)*

(b) system defence plan procedures, including at least:

(i) frequency deviation management procedure in accordance with Article 18;

(ii) voltage deviation management procedure in accordance with Article 19;

(iii) power flow management procedure in accordance with Article 20;

(iv) assistance for active power procedure in accordance with Article 21; and

(v) manual demand disconnection procedure in accordance with Article 22.



Define for this procedures:

- Involved parties
- Activation criteria
- Measures to be activated

# Frequency deviation management procedure

<b>Objective</b>	<b>Support frequency</b> before the nomination of a “frequency leader”, probably in case of system split
<b>Involved actors</b>	<ul style="list-style-type: none"><li>• Identified SGUs</li><li>• DSOs</li><li>• DSPs</li></ul>

<b>Activation criterion</b>	Frequency deviations > 200 mHz
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## Automatic actions that will take place

- All contracted primary reserves have been fully activated automatically.
- Automatic activation of Limited Frequency Sensitive Mode;
- Automatic reaction or manual adjustment of energy storage systems and HVDC
- Load Frequency Control (Automatic activation of secondary reserves) will be in “frozen mode”

## Possible actions to be activated by Elia before a “Frequency leader” will be appointed

- In case of persisting low frequencies: step-by-step activation of normal and **Emergency reserves**
- Smooth active power reduction by lowering voltages by 5% in distribution systems
- As last resort measure in case of slow frequency collapse (between 49,8 and 49 Hz): manual load shedding (art 22)
- Automatic load shedding in case of fast frequency collapse (below 49 Hz)

# Voltage deviation management procedure

<b>Objective</b>	Bring power flows back within operational security limits
<b>Involved actors</b>	<ul style="list-style-type: none"><li>• SGUs identified</li><li>• DSOs</li><li>• Neighboring TSOs.</li></ul>

<b>Activation criterion</b>	<p>Voltage is out of the operational limits:</p> <ul style="list-style-type: none"><li>• 0.9pu-1.05pu for connection points on 400kV or (360kV–420kV)</li><li>• 0.9pu - 1.118pu for connection points on 150kV and 220kV<ul style="list-style-type: none"><li>• (198 kV – 245 kV) for 220 kV</li><li>• (135 kV – 168 kV) for 150 kV</li></ul></li></ul>
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## Modifications to existing defense plan

- Existing “Action Mvar” i.e. “All production units to max Mvar” will be removed from the existing defense plan.
- In case of voltages out of operational limits in a region, launch “Emergency Elia” signal + detailed analysis of the situation.

## Possible actions to be activated by Elia (case by case)

- Use of reactive power devices in coordination with RCCs and DSOs;
- Request (or control if available) additional voltage/reactive support from power plants;
- Requesting maximum or minimum values of Reactive Power to specific PGMs of type C and D
- Requesting additional Reactive Power support from Nemolink or Alegro
- Help from Tennet or Rte
- Manual load shedding (art 22)

# Power flow management procedure

<b>Objective</b>	Bring voltages back within normal operational limits
<b>Involved actors</b>	<ul style="list-style-type: none"><li>• Identified SGUs</li><li>• DSOs</li><li>• DSPs</li></ul>

<b>Activation criterion</b>	Power flows are outside of the operational limits (overloaded system elements, excessive loop flows, ...)
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Possible actions to be activated by Elia to relief the overload **before activation of the defense plan:**

- Countertrade and redispatch as described in CACM
- Activate specifically located reserves to relief the overloads
- Cross-Zonal Allocated Capacity curtailment.

Possible actions to be activated by Elia to relief the overload **as part of the defense plan:**

- Elia may start/stop/change setpoints/disconnect SGUs directly or indirectly through DSOs (manual action on a case by case basis)
- Manual load shedding in the zones required to relief the overload (art 22)

Manual or automatic opening of a cross border interconnector shall be among the last measures to be considered.

- Always coordinated with other TSOs, unless an immediate risk for personal safety or equipment damage exists.

# Assistance for active power procedure

<b>Objective</b>	Bring voltages back within normal operational limits
<b>Involved actors</b>	<ul style="list-style-type: none"> <li>• <b>Any</b> BSPs</li> <li>• <b>Any</b> SGUs connected to Elia's LFC area</li> <li>• Other TSOs in normal or alert state.</li> </ul>

<b>Activation criterion</b>	Based on the operational security of the grid in case of <b>absence of control area adequacy</b>
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Actions Elia should activate before the emergency procedure :

- Activation of balancing energy bids (free bids + contractual reserves) + inter-TSO contracts
- If excessive ACE persist, Elia sends a “**Balancing Warning**” (via RSS feed) to BSPs to send more energy bids.

Modifications should be made:

- A specific signal for the activation of “emergency reserves” is to be developed ≠ balancing warning
- Adjustment in T&C BSP and in SGU connection agreement is required concerning activation of “emergency reserves”

If excessive ACE persists and becomes critical for system security, the assistance for active power procedure is activated (Emergency State)  
This includes:

- Activation of **non-contractual inter-TSO assistance** (as available)
- Activation of the **emergency reserves by BSP and SGU**: reserves that BSP or SGU have physically at their disposal, but were not offered to the market as balancing energy bids (non-CIPU units, demand side reduction, ...)

In case it remains insufficient:

- Smooth load reduction U – 5%
- Manual load shedding plan activation (art 22)