# Project Inertia phase II – Cross-committee webinar

## Project Inertia Phase II: main highlights from the position paper

37th Grid Connection European Stakeholder Committee meeting (GC ESC)
Wednesday, 19th March 2025, 10.00h – 15:00h

entsoe
Reliable Sustainable Connected

# Introduction

## ❑ Project Inertia Phase II

**Milestone – Public Report**

- **updated** the results and solution measures following the analysis of the impact of system splits on the future "low inertia" configuration of the Continental Europe Synchronous Area
- **concluded** on the need to define an intended level of resilience against system splits based on foundational measures, i.e. tackle the root cause, keep inertia above a certain limit

**Milestone – External debate**

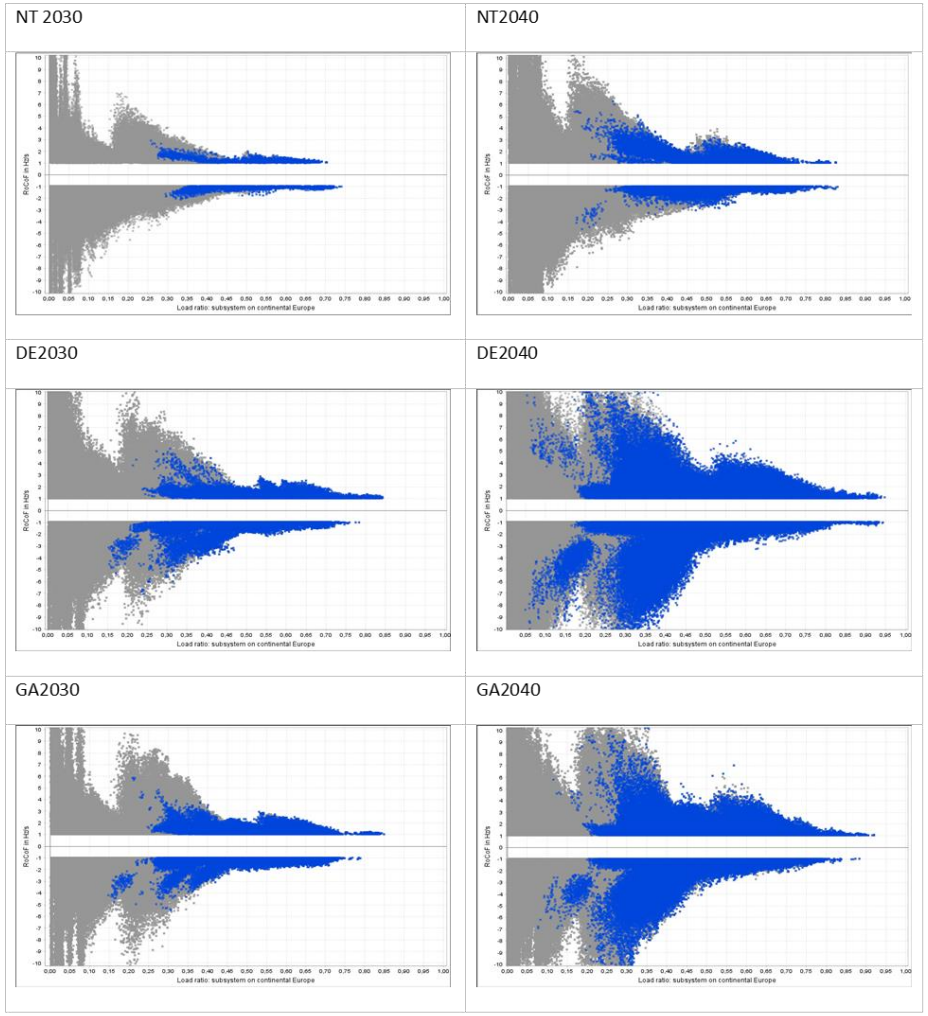
- **Presently:** put in place the external debate in order to trigger decision-making on the approach to a more resilient system, the way to allocate the inertia needs and the implementation framework, including ACER, EC and stakeholders
  - Position paper and supporting technical report
  - Supporting information and a roadmap to deliver a secure and efficient future-ready decarbonised system as part of a step-by-step, no-regret approach
- Final report by second half of 2025 (summary incorporating proposals, received feedback from stakeholders and agreed actions)

# Milestone III – Key messages (1/9)

## ❑ Project Inertia Background

- Project dedicated to **assessing on the resilience of the continental European (CE) interconnected transmission system to withstand system splits**
  - Context of future scenarios, reduced levels of total system inertia and increased power transfers through the electricity system
- Number of theoretical **system split cases where both split subsystems exceed the ±1 Hz/s operational threshold potentially leading to a total blackout (Global Severe Splits) shows a significant increase from 2030 to 2040 scenarios**
  - **Need to urgently initiate actions to counter the progressive decrease in system resilience**
  - **Present the possible solutions and mitigation measures in a structured approach**, defining and characterising foundational and enhanced response measures

One|RoCoF|>1 Hz/s
Both |RoCoF|>1 Hz/s



# Milestone III – Key messages (2/9)

## ❑ Foundational measures are needed to recover system resilience (1/2)

- **Focus is on recovering the system resilience that will be lost as compared to previous levels**, allowing the transition to a decarbonised system
- **Decision to be taken refers to how much resilience should be recovered** and accepting the risks related to a temporary or permanent loss of resilience.
- **The accepted level of grid resilience and accepted risk of blackout must involve all the stakeholders and the relevant institutions as it is not for the Transmission System Operators (TSOs) only to define these aspects**
- Presently, as foundational measure, **adding kinetic energy to the system allows to reach the target resilience level**
  - It should not, in any way, limit RES integration and the market services
  - Methodologies do not propose decisions on RES limitation or redispatching of RES
- **Goal of Project Inertia Phase II methodologies is to define a minimum level of inertia limiting the decline of the system resilience. The achievement of this minimum resilience target depends on the allocation of correct amounts of inertia in the relevant nodes on the CE SA**

# Milestone III – Key messages (3/9)

## ❑ Foundational measures are needed to recover system resilience (2/2)

## ❑ Foundational measures + enhanced response measures + preventive measures!

- **Foundational measures are essential to ensure the survivability of the split subsystem** and are the focus of the present analysis
- **Enhanced response measures** are necessary to mitigate the consequences within the split island
  - Enhanced response solution measures and RoCoF withstand capability should always be further optimised to the most extent possible. Grid Connection Requirements and defence plans address enhanced response measures.
- **Preventive measures** also important since system splits can lead to blackouts with catastrophic consequences
  - **Reducing the likelihood of their occurrence should always be pursued by implementing the learnings from previous events or by reinforcing the grid** in the face of increasingly large and variable power flows, onshore and offshore, across Europe
  - **Improving operational aspects** such as system operator observability and controllability of renewable generators, taking advantage of PMU technology to improve the monitoring capabilities of the system operator, implement dynamic stability assessment in operational planning up to real time, etc.

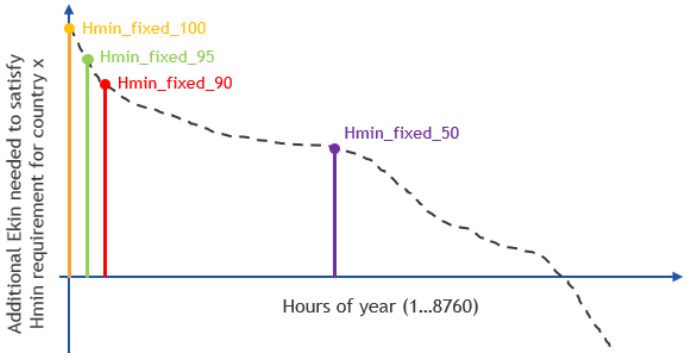
# Milestone III – Key messages (4/9)

## ❑ Recovering System Resilience is a Common Effort (1/2)

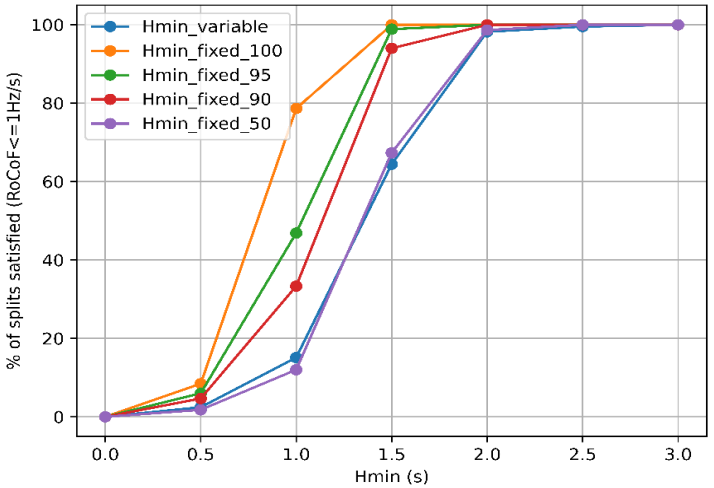
- To recover the resilience up to a certain level and to mitigate the occurrence of Global Severe Splits (GSS), **all countries of the Continental Europe Synchronous Area (CE SA) must ensure their agreed minimum levels of kinetic energy**
  - System split events cannot be anticipated, the **available kinetic energy should be, always, well distributed throughout the system**
  - The solution requires **support and commitment at the synchronous area level**, including all countries and regions, **otherwise the overall effort may be weakened, creating risk to the larger area**
- **Bottom-up approach (Hmin target equal to all countries)** is the proposed method to allocate kinetic energy across CE SA
  - The performance of the approach is robust
  - Its main principles are naturally transparent, easily communicable and independent from assumptions

# Assessment of performance for GSS

- Option 1: meet requirements through ex-post analysis
  - Hmin_fixed_100
  - Hmin_fixed_95
  - Hmin_fixed_90
  - Hmin_fixed_50
- Option 2: meet requirements on hourly basis (theoretical approach for control)
  - Hmin_variable




A | B < 1 Hz/s

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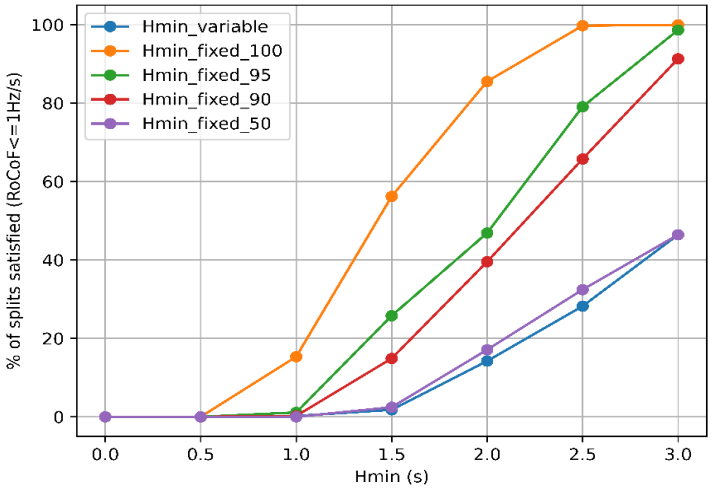
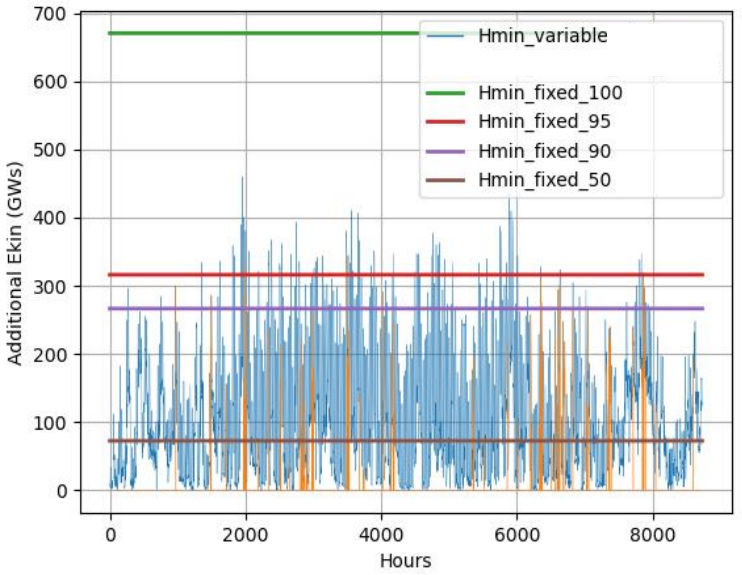



| Hmin (s) | Variable approach [Max. value] | Fixed approach 100% | Fixed approach 95% | Fixed approach 90% | Fixed approach 50% |
|---|---|---|---|---|---|
| 0.5 | 8.5 | 14.5 | 6.1 | 4.5 | 0.0 |
| 1.0 | 80.9 | 163.7 | 47.8 | 27.2 | 1.9 |
| 1.5 | 252.2 | 379.8 | 170.6 | 139.3 | 12.2 |
| **2.0** | **460.3** | **670.5** | **316.2** | **266.6** | **72.7** |
| 2.5 | 706.6 | 984.3 | 538.3 | 428.2 | 145.8 |
| 3.0 | 968.4 | 1303.5 | 793.2 | 649.2 | 221.3 |



# Milestone III – Key messages (5/9)

## ❑ Recovering System Resilience is a Common Effort (2/2)

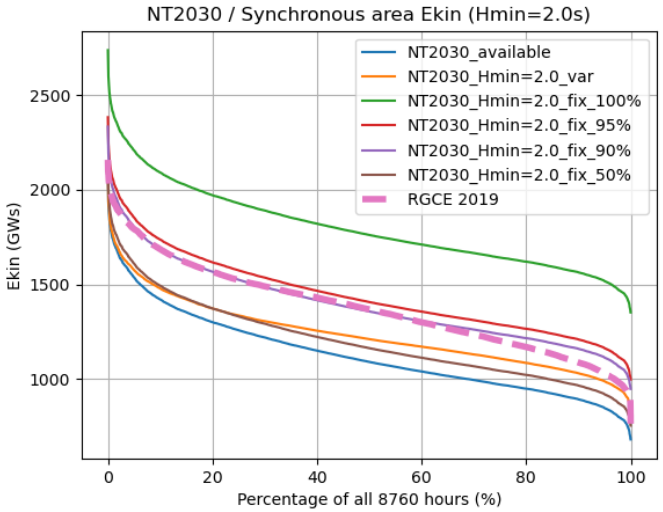
## ❑ Important clarifications

- **Not all GSS situations or other split situations where one subsystem could experience blackout can be avoided**
  - **Avoiding a significant number of GSS situations is** not a complete solution or definitive metric per se, but, as a minimum, **a very important reference of the resilience of the system** that should be safeguarded.
- An efficient approach to the challenge posed by the decrease of inertia levels should **aim at recovering the system resilience focusing on the system performance avoiding GSS, rather than defining GSS as a design incident** to be covered
  - System splits are out of range contingencies and should continue to be treated as such
  - System splits do not define the maximum system imbalance that the system has to withstand without deploying defence plans

# Milestone III – Key messages (6/9)

## ❑ Step-by-Step, No Regret Approach to Recover System Resilience (1/2)

- Project Inertia proposes a step-by-step approach, aiming for no-regret and achievable steps, while continuously reassessing the needs and suitable solutions => **gradual and sustainable recovery to the system resilience**
- Chosen **targets and allocation methods do not lead to an over-dimensioned system** (i.e., significantly more kinetic energy than we have today in the synchronous area)
- Long-term kinetic energy **targets can only be met with the contribution from all foundational measures**
  - Synchronous Condensers, STATCOMs with Grid Forming Capability and storage, Power Park Modules with Grid Forming Capability and Storages
  - Countries should decide the best mix of solutions to meet their targets



# Milestone III – Key messages (7/9)

## ❑ Step-by-Step, No Regret Approach to Recover System Resilience (2/2)

- A **common implementation framework for PPMs types that will be required with GFC and non-inherent storage** at system area level **is beneficial for an even distribution of inertia** across the synchronous area
- Pilot projects are **necessary to gain experience about the actual performance of large-scale Grid Forming Technologies with storages**
  - Grid Forming Technology is not yet widely available on the market and no larger related demonstration projects exist
  - An urgent “trial” period is strongly recommended for smooth introduction in our power systems of such devices with the required resilience
- **Inertia markets can be helpful but could have limitations**. Due to the nature of the system split challenge, such markets would be essentially implemented in local control areas creating risks of market liquidity and prices, if not properly designed

# Milestone III – Key messages (8/9)

## ❑ An implementation Framework and Roadmap are needed (1/2)

- It is necessary to establish a **framework to implement the minimum inertia targets** and to **continuously monitor its implementation and effectiveness**
  - Support the necessary TSO investment decisions in terms of necessary assets (e.g., Synchronous Condensers or STATCOMs)
  - Support mandatory application of future RfG requirements (e.g., GFC with stored energy requirements for generators)
  - Methodology proposes ex-post assessment of yearly inertia levels
  - Framework must be agreed by RGCE TSOs and accepted by decision makers
- Monitoring and checking the fulfilment of minimum inertia needs
  - **Based on ex-post operational monitoring** of yearly minimum equivalent H at CE countries
  - A common methodology for estimating inertia must be developed and agreed by all TSOs of CE synchronous area to enable a comparable basis between all countries

# Milestone III – Key messages (9/9)

## ❑ An implementation Framework and Roadmap are needed (2/2)

- A feasible and agreed roadmap with decision makers and stakeholders is necessary and urgent
- Resilience targets should be defined for the short/medium-term and long-term. Project Inertia proposes:

**As soon as possible**

any device able to provide inertia like PPMs, STATCOMs, Synchroous Condensers shall provide inertia.

RfG 2.0 IGDs should support TSOs in defining adequate technical requirements to provide the identified needs. This also ensures a level playing field across Europe.

**In parallel**

always incentivise optimisation of enhanced response measures and preventive measures.

**By 2035**

reach Hmin= 2 sMW/MVA in 50 % of time in a year. For the first steps, part of the targets can be largely ensured with technologically available TSO assets.

**In a long-term target**, subject to reassessment based on the return of experience

all countries shall ensure Hmin = 2 sMW/MVA in 90 % of time in a year. Such total kinetic energy does not exceed the total kinetic energy levels available in the past for CE.

## ❑ Regular reassessment of needs

- Long term needs and global resilience level: should be reassessed every two years in the regular TYNDP IoSN
- Country needs (actual coverage of equivalent inertia year duration curve): should be reassessed on a yearly basis via ex-post operational monitoring
  - enable performance results similar to those obtained from the study (If monitoring shows more available inertia than estimated → less additional needs to reach the same Hmin)

# Thank you!