31st GC ESC meeting – Project Inertia – Phase II

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entsoe
Reliable Sustainable Connected

Introduction (1/2)

❑ Project Inertia Phase II – Main Goals

- **Update** the analysis performed in **the report "Frequency stability in long term scenarios and relevant requirements"**
- **Push forward the analysis of the impact of system splits** on the future "low inertia" configuration of the Continental Europe Synchronous Area
- **Engage internally and externally** on the Project Inertia study findings and **on criteria defining system resilience against system splits**

- **Project Milestones**
  - **Update results and solution measures – Report in finalisation**
  - Project conclusions on the approach to a more resilient system – Report

Introduction (2/2)

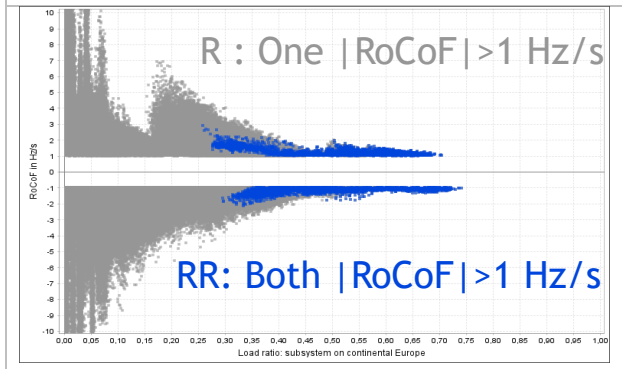
❑ Project Inertia Phase II – Analysis

- **Based on** the most recent **TYNDP 2022 long-term scenarios** and market studies
- Review, using a similar assumptions and methodology, a significant number of **combinations of system split cases in the CE synchronous area**, which separate the interconnected system into two parts
- For all combinations, the theoretical **initial RoCoF at the centre of inertia** is determined at hourly resolution of the years 2030 and 2040 and is assessed whether the combinations of subsystems after a split would be able to cope with the RoCoF resulting from the relevant initial conditions (power imbalance and subsystem inertia)
- Additionally, the project **introduced new time-domain simulations** to enable a perspective on the frequency performance of the separated subsystems after the split
- Following a system split, the analysis evaluates **if a total blackout could occur due to a RoCoF higher in absolute value to 1 Hz/s or by a frequency going outside the range 47.5-51.5Hz**
  - In this case, there is no neighbouring grid 'alive' to promptly restore the blacked-out subsystem
  - From a pan-European perspective, **Global Severe Splits (total blackout)** are regarded as the most severe ones and are used to assess the system resilience against system splits

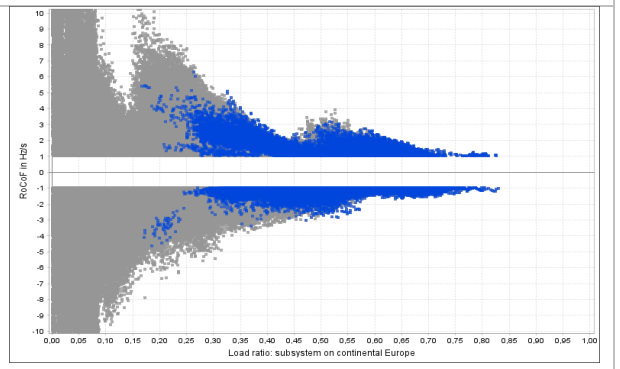
Main Results: Analytical calculations

- From the updated results, **the trends identified in the report "Frequency stability in long term scenarios and relevant requirements" are confirmed**
- Splits for which at least one island exceeds the |RoCoF| limit of 1 Hz/s and **splits for which both islands exceed this threshold are identified in a large number** and with a **visible increase from 2030 to 2040**
- **This demonstrates the progressive decline of system resilience against system splits, if no actions are initiated**

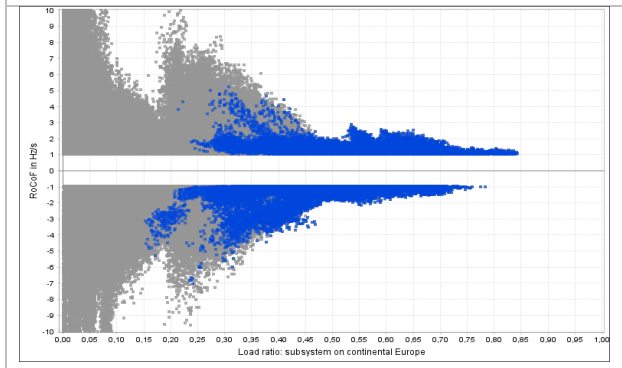
NT 2030



NT2040



DE2030



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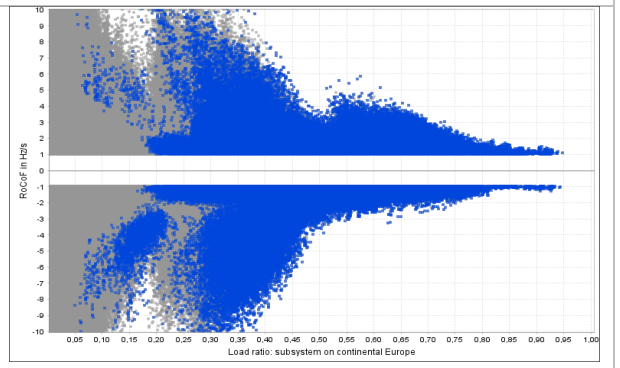
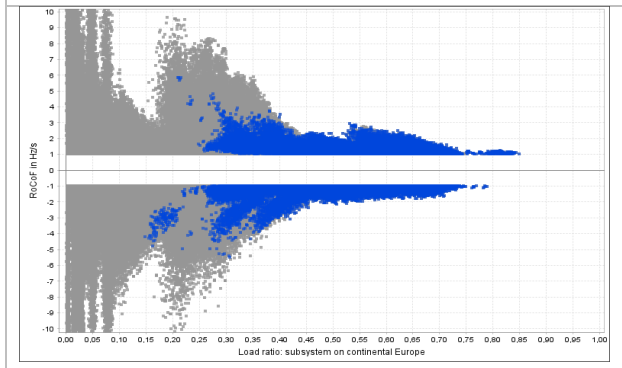
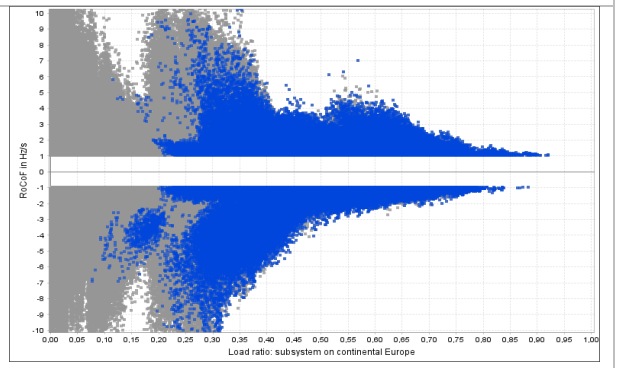


GA2030



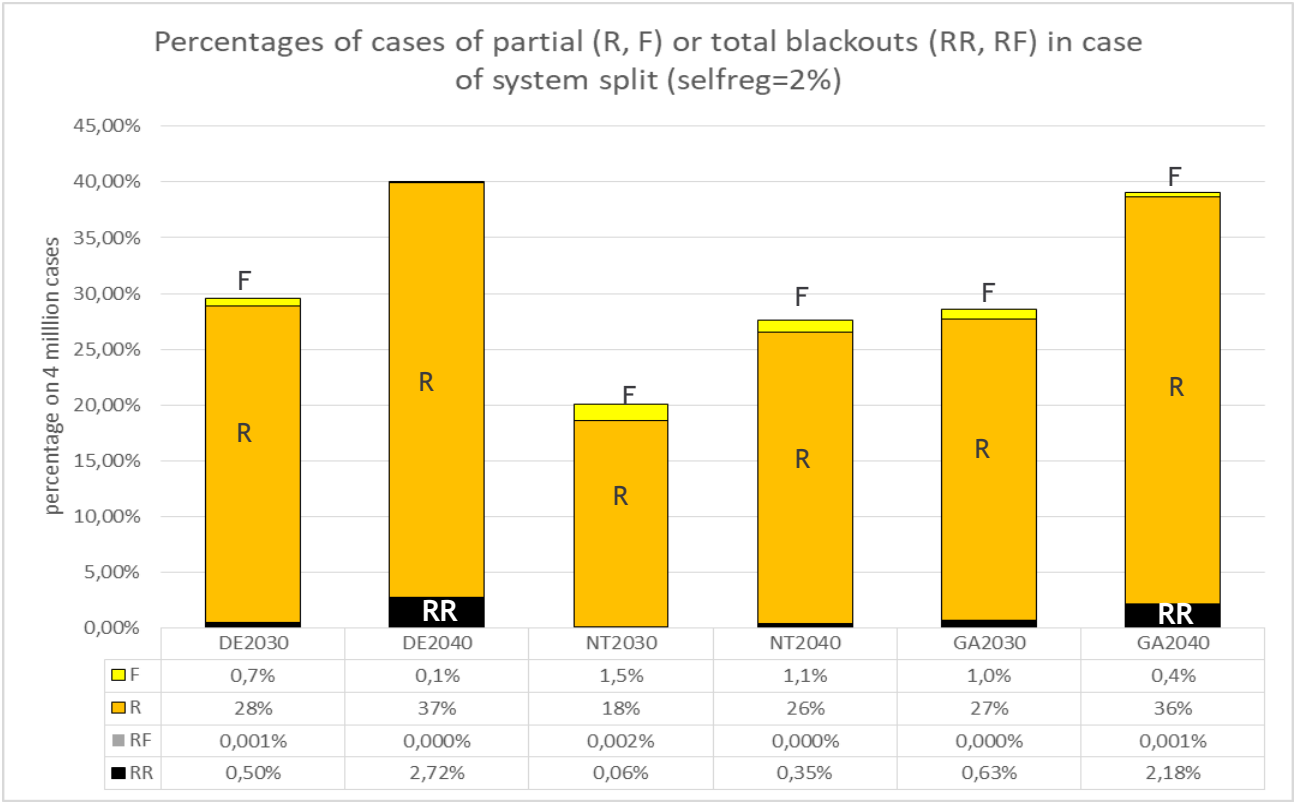
GA2040



Main Results: Analytical and time domain simulation

❑ Severity

RR Both areas: |RoCoF|>1Hz/s	**FF** Both areas: f< or f>	**RF** One area: |RoCoF|>1Hz/s Other area: f< or f>	Total blackout
R One area: |RoCoF|>1Hz/s	**F** One area: f< or f>		Partial blackout



	DE2030	DE2040	NT2030	NT2040	GA2030	GA2040
F	0,7%	0,1%	1,5%	1,1%	1,0%	0,4%
R	28%	37%	18%	26%	27%	36%
RF	0,001%	0,000%	0,002%	0,000%	0,000%	0,001%
RR	0,50%	2,72%	0,06%	0,35%	0,63%	2,18%

When |RoCoF|<1 Hz/s issues with frequency (RF and F cases) remain limited, are due to overfrequency situations and mainly for initial positive RoCoF

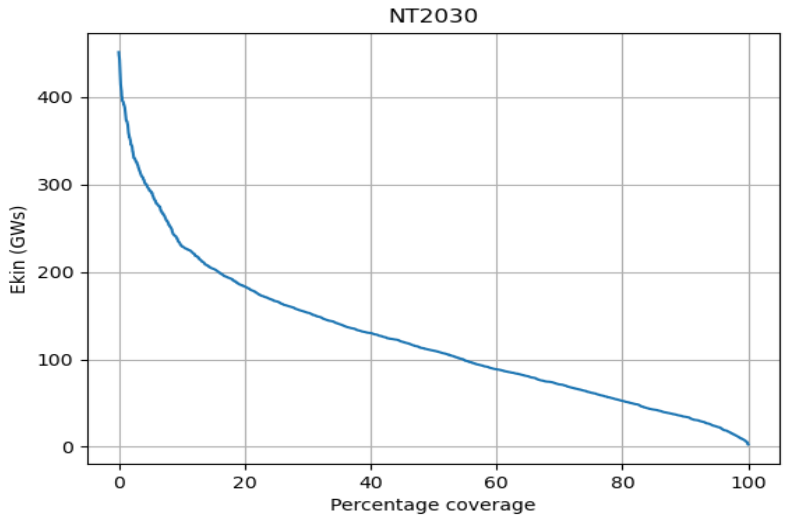
➔Need to limit the instantaneous RoCoF ➔ foundational measures

➔Enhancement of dynamic behaviour (LFSM,…) will come on top of that

Study Case (1/2)

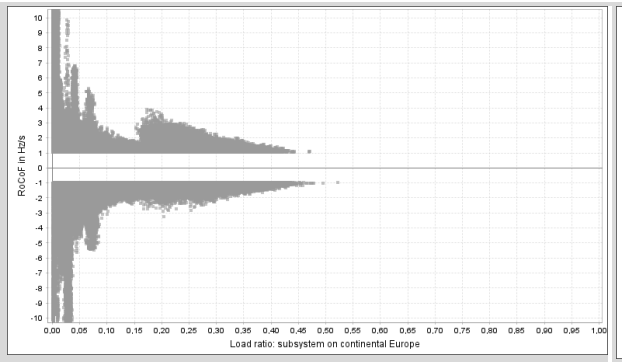
❑ Eliminate all Global Severe Splits in 2030 NT scenario

- In this situation the following kinetic energy would be required at RGCE level (if allocated with respect to the total generation running capacity) to eliminate Global Severe Splits in NT 2030

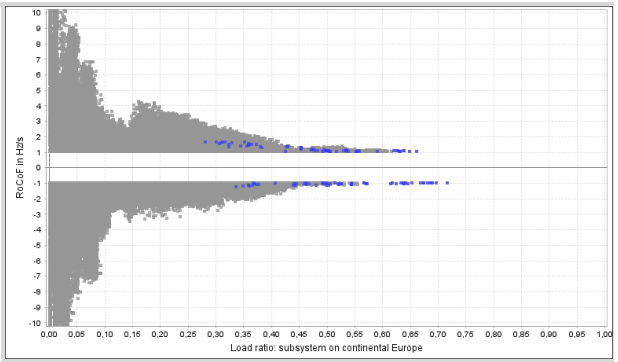


- **Even when eliminating all Global Severe Splits in NT 2030, other severe splits remain with high values of RoCoF**

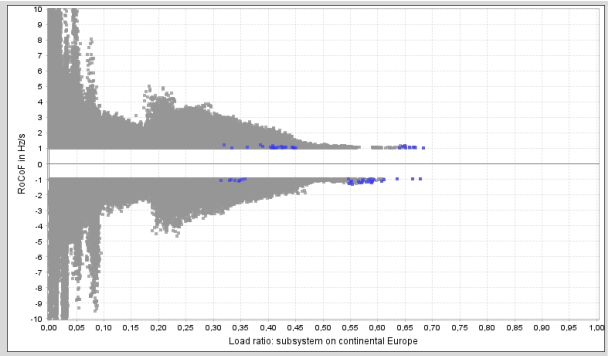
NT2030



NT2040



DE2030



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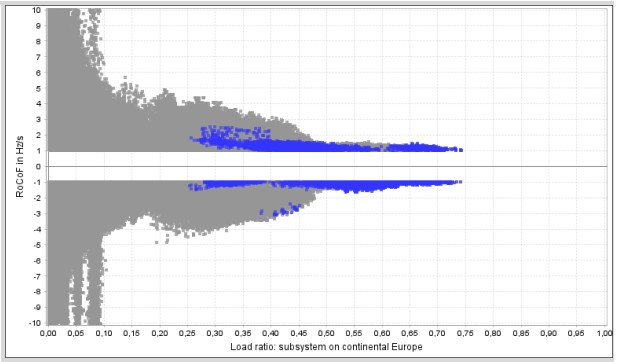
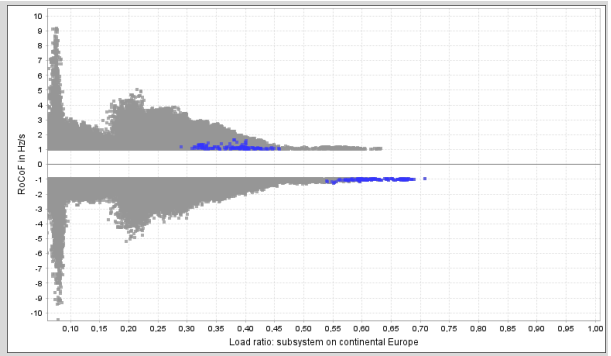
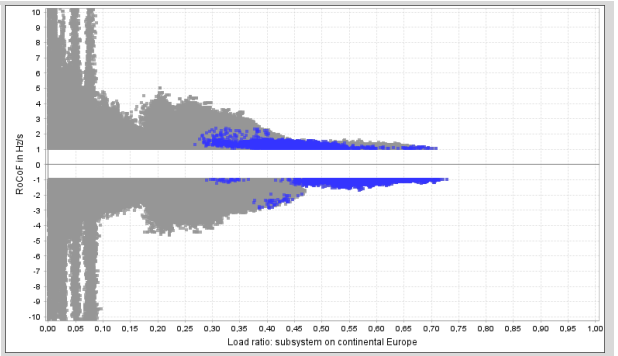


GA2030



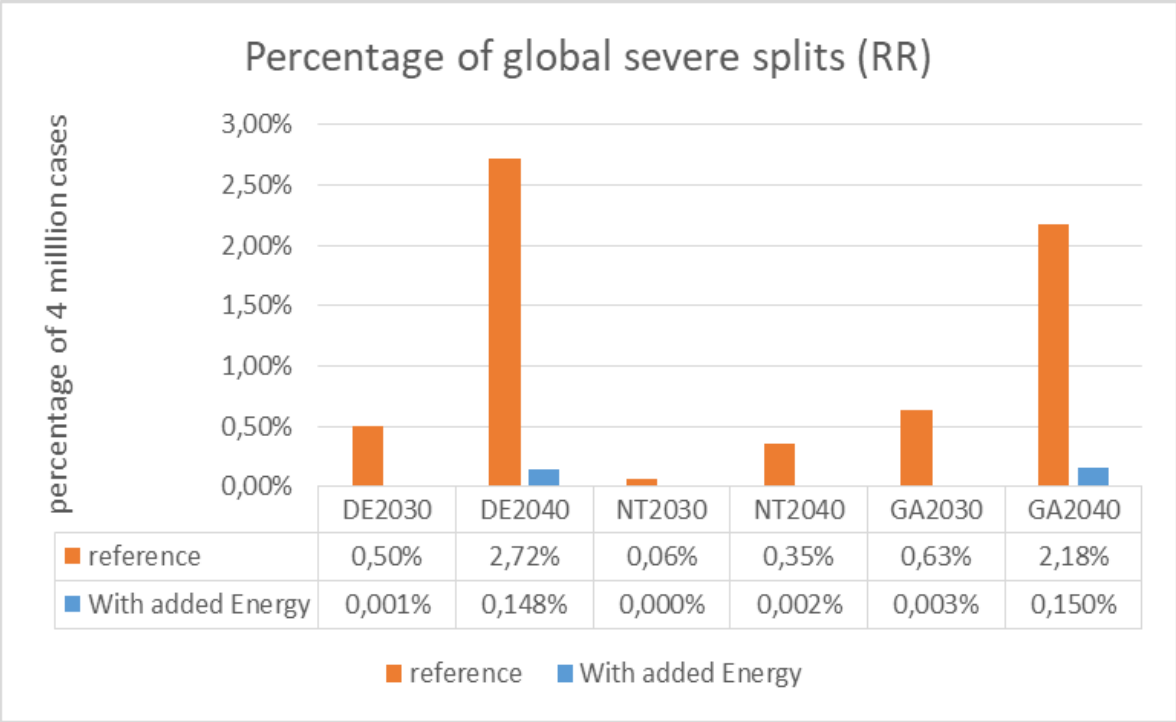
GA2040

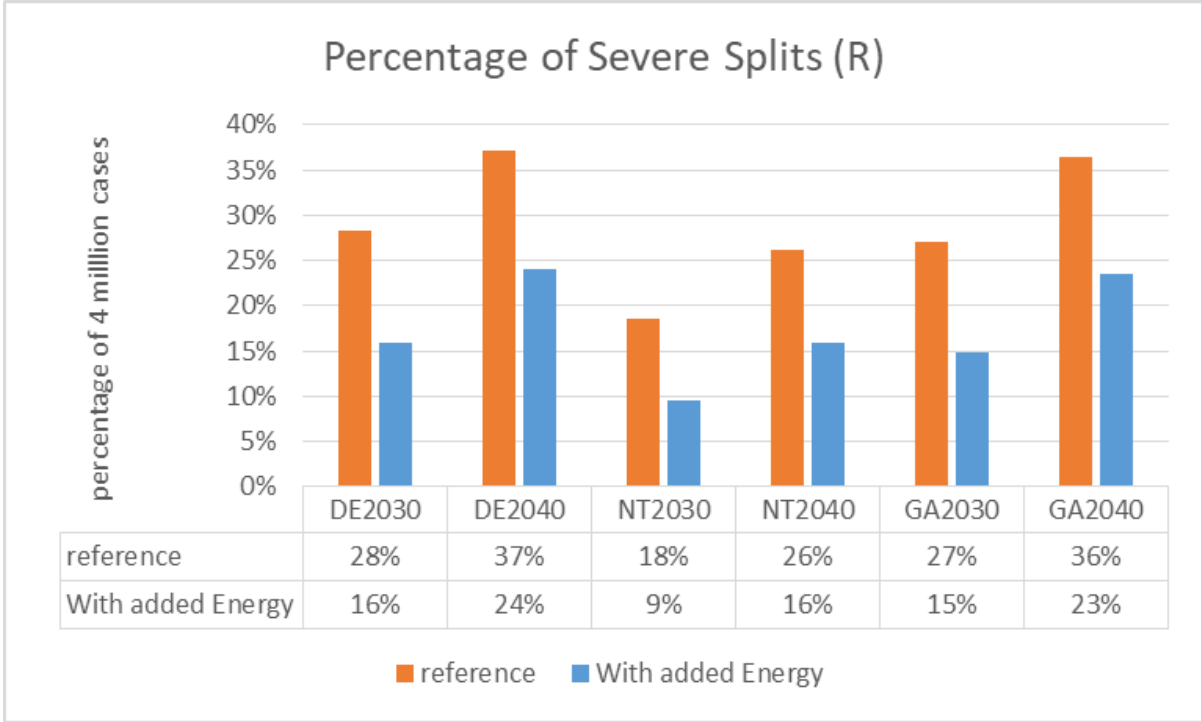


Study Case (2/2)

❑ Eliminate all Global Severe Splits in 2030 NT scenario

- With the increase of kinetic energy, thus inertia, the number of global severe cases (RR=both |RoCoF|>1 Hz/s) is null for scenario NT 2030 and significantly decreases for other scenarios also:





Solution and mitigation measures

❑ Overall approach

- The solution measures should be divided in **foundational measures** and **enhanced response measures**. The latter building on the commonly agreed minimum level of resilience intended for the system
  - **Foundational measures**
    - Keep inertia (kinetic energy) above a certain limit
  - **Enhanced response measures (building on foundations)**
    - Enhanced withstand capabilities for stable grid operation during high frequency gradients
    - Frequency containment support to limit the nadir/zenith of the frequency
  - **Market restrictions (last resort measures)**
    - Reduction of the power exchange and deployment of must-run units

Final Notes

❑ Restore system resilience

- Foundational measures (minimum kinetic energy) will provide a given level of resilience (limit the initial RoCoF to reduce impact and possibility of black-out, create the conditions for System Defense Plans to work)
- Although Global Severe Splits can be reduced, other severe splits, which are not global, will still remain having very high values of RoCoF - **need to maintain withstanding capability in Power Generating Modules**

❑ Urgency of foundational measures

- Synchronous Condensers, STATCOMS with GFC and Storage and Power Park Modules with GFC and storage will be necessary. Those solutions will also bring added benefits to system stability in terms of, e.g., voltage control
  - **In the short term, installation of SCs and STATCOMs with GFC and storage**
  - **As soon as possible, deploy PPM with GFC and Storage** to build a volume that can effectively support the system (supported in RfG 2.0 requirements)
    - According to RfG 2.0 implementation timeline it is expected that before 2028 wide deployment of Grid Forming Capabilities is not expected, and only then will the availability of such capabilities start to increasingly grow. This means that from today until at least 2028, large volumes of Power Park Modules without any Grid Forming Capabilities will continue to enter the system.

Thank you!