Network Code on Emergency and Restoration

Public Workshop 3

8 January 2015 - Brussels

Drafting Team Emergency and Restoration

entsoe

Reliable Sustainable Connected

Agenda

12:00-13:00	Registration and lunch	
13:00-15:00	**New Low Frequency Control Scheme article** **Technical background for Low Frequency Demand Disconnection** Q&A	**Laurent Lamy** ENTSO-E Convenor of NC ER Drafting Team **Giorgio Giannuzzi** Co-Convenor of System Protection and Dynamics Expert Group **Workshop participants**
15:00-17:00	**New Market Interactions chapter** Q&A	**Fabian Heus** NC ER Drafting Team member **Ritva Hirvonen** Convenor of Market Integration Working Group **Workshop participants**
17:00	**Conclusion**	**Laurent Lamy** ENTSO-E Convenor of NC ER Drafting Team

Network Code on Emergency and Restoration

Network Code status

Laurent LAMY

entsoe

Reliable Sustainable Connected

Network Code status

- Public Consultation ended on 8 December 2014
- Sections on ***Low Frequency Demand Disconnection*** and ***Market Interactions*** marked as "to be further elaborated" in the release for public consultation
- These topics have been discussed and developed in parallel
- **Additional Public Consultation from 15 December 2014 to 14 January 2015** on these two topics

Network Code on Emergency and Restoration

Automatic low Frequency Control scheme

Laurent LAMY
Giorgio GIANNUZZI

entsoe
Reliable Sustainable Connected

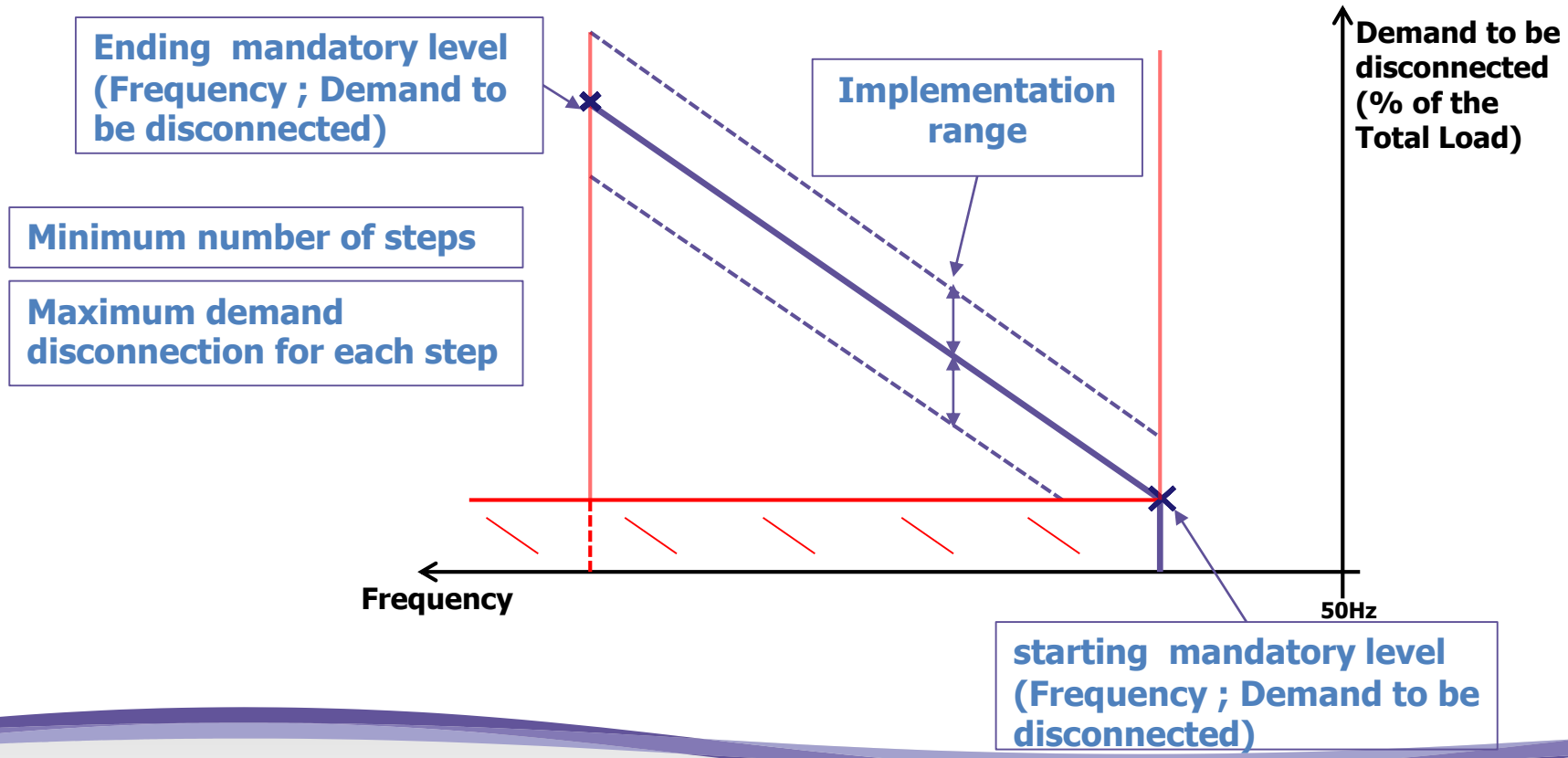
New article on automatic low Frequency Control scheme

Article 13

- **New structure:** one paragraph/type of measure
    1. **Limited Frequency Sensitive mode**
    2. **Disconnection of Energy Storage**
    3. **Low Frequency Demand Disconnection (LFDD) scheme**
    4. **LFDD based on Frequency gradient**
    5. **Special Protection Schemes**
- **Implementation period:** 5 years after entering into force of the code

Low Frequency Demand Disconnection scheme

- **New approach for the LFDD**
  - Definition of the target to be reached, with implementation range, minimum number of steps and maximum size of steps



Low Frequency Demand Disconnection characteristics

Parameter	Values CE	Values Nordic	Values Great Britain	Values Ireland	Measuring Unit
Starting mandatory level: Frequency	49	48.7 – 48.8	48.8	48.85	Hz
Starting mandatory level: Demand to be disconnected	5	5	5	6	% of the Total Load
Ending mandatory level: Frequency	48	48	48	48.5	Hz
Ending mandatory level: Cumulative Demand to be disconnected	45	30	50	60	% of the Total Load
Implementation range	±7	±10	±7	±7	% of the Total Load for a given frequency
Min. nb of steps to reach ending mandatory level	6	2	4	6	Number of steps
Max. Demand disconnection for each step	10	15	10	12	% of the Total Load for a given step

Technical background for the LFDD

New approach and parameters for the Low Frequency Demand Disconnection is based on the following technical background

Technical background for the LFDD

Under Frequency Load Shedding Report

Dedicated Task Force has started the work; these steps were done:

- Build up dynamic models and corresponding parameter fine-tuning
- Definition of scenarios
- Run of the simulations

Done around 700 simulations in few months!

Low Frequency Demand Disconnection Study

Evaluate different load shedding strategies to define binding requirements for the coordinated under frequency load shedding plans of Continental Europe.

Under Frequency Load Shedding: compromise between a quasi-linear control target and a rigid fixed pre-set load disconnection

General approach

- Evenly geographically distributed and effective shed load between TSOs as well as within a TSO area,
- Same reference for frequency and load shedding steps across the interconnected system,
- Ability to compensate the maximum credible active power deficit of the system,
- System implementation ensures the effectivity of LFDD: it means a minimal necessary shedding of load,
- Compensate disconnection of dispersed generation disconnection at unfavourable frequencies
- Avoid over frequency (overcompensation), overvoltage and power transients that can lead to an additional loss of generation.

Additional constraints

- Compensate statistical failed trip by load shedding relays and conventional generation lost during the under frequency transient,
- Avoid splitting of network by intervention of line protection and, if necessary control network splitting scenarios,
- Duly consider the net effect of loosing embedded generation located on the load feeders subject to load shedding

Additionally, some general considerations:

– Acceptable time delay,
– Optional use of frequency gradient (ROCOF function) and other additional inputs.

Optimal total shedding load in percentage of total load
Optimal frequency stepping for a system with dispersed frequency relays implemented (fi, n),
Optimal number of load shedding stages in percentage of total load (Pi).

Scenarios

- High load NO/YES RES
- Low load NO/YES RES
- Medium load and «as is» evaluations
- UP to 16 different load shedding strategies checked
- For each strategy and scenario 8 different power increasing deficits were tested
- Total load to be shedded for each plan between 20 % and 60 %

What is the maximum credible deficit ?

Experience shows that

- Deficit is unpredictable
- Network splitting can create large areas with very big deficit
- Generation lost during the transient can increase drastically the initial deficit

Some considerations on results

LOAD SHEDDING PLAN IS NOT A SOLUTION "UNIVERSALLY" VALID

IS A DRASTIC AND EXTREME RESORT WHEN SYSTEM IS IN CRISIS LIKE AN ADRENALINE INJECTION !

FOR EACH STRATEGY THERE IS A PERCENTAGE OF SUCCESS AND FAILURE

Result analysis

	Accepted when a) final frequency in the range 49.9 Hz – 50.1 Hz and b) maximum overshoot below 50.2 Hz
	Critical when c) final frequency out of the range 49.9 Hz – 50.1 Hz but within 49.2 Hz – 50.2 Hz, OR d) maximum overshoot reaches 50.2 Hz
	Rejected e) final frequency out of the range 49.2 Hz – 50.2 Hz and f) overshoot reaching 50.2 Hz

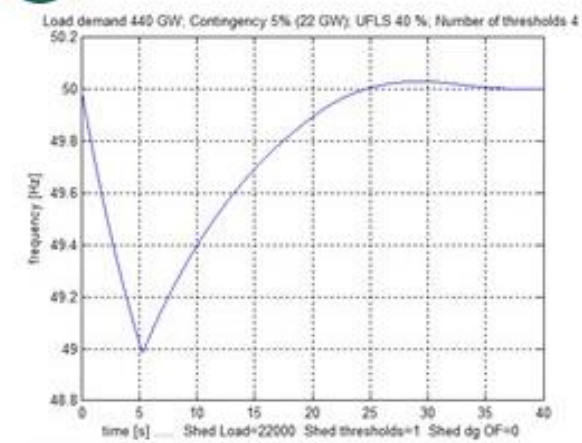


Figure 4: Correct behaviour as expected

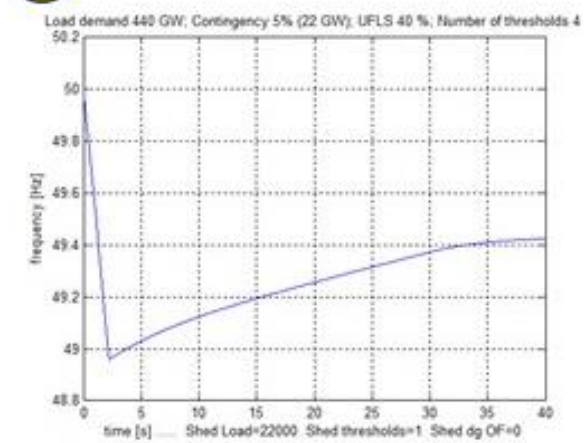


Figure 5: Low end frequency

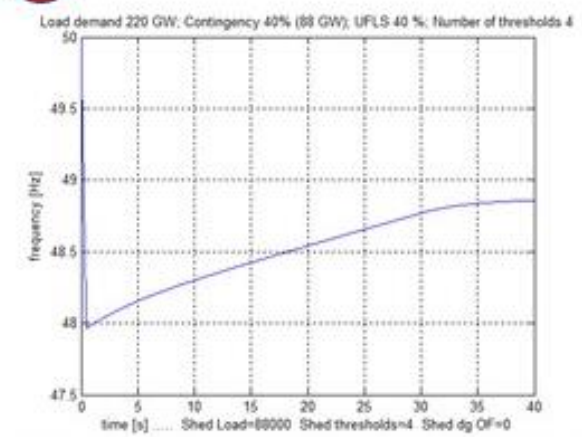


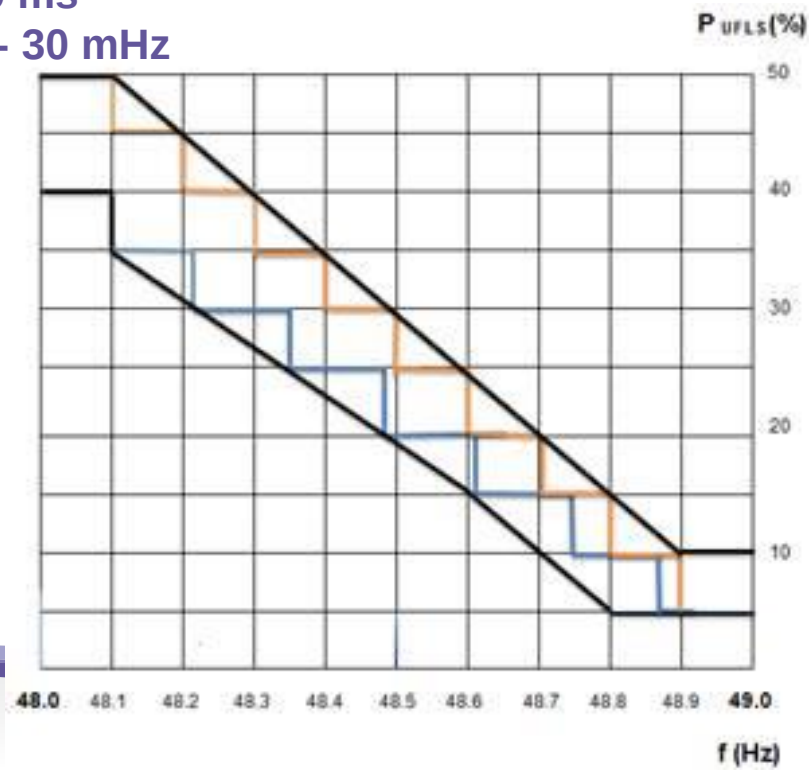
Figure 6: Too low end frequency

Lesson learned from simulations

1. The first step size has a limit; if increases, also risk to loss control in overfrequency increase
2. Increasing number of steps, the action is more accurate and stable
3. The number of steps cannot increased indefinitely, because efficiency decreases
4. The delays on LS trip devices is a constraint that can influence the plan
5. There is a min max range to ensure success to the plans

Study Results

- The **mandatory** operation range is **48-49 Hz**
- The **Maximum** value of total load that shall be shed per single TSO is **50%** of the reference load for the whole system
- The **minimum** value that shall be shed per single TSO is **40%** of the reference load
- The **amplitude** of each step shall be in the range of **5-10%**.
- The **minimum** mandatory **number of steps** for single TSO is **6**
- The **maximum total delay time** shall not exceed **150 ms**
- The required frequency **measurement accuracy** < **+/- 30 mHz**



entsoe

Network Code on Emergency and Restoration

New Market Interactions chapter

Fabian HEUS
Ritva HIRVONEN

entsoe
Reliable Sustainable Connected

New chapter on Market Interactions

Chapter 4

New structure:

1. Market Activities Suspension Triggers
2. Procedure for market activities suspension
3. Procedure for TSO processes suspension
4. Procedure for market activities and TSO processes restoration
5. Communication procedure
6. Settlement principles

Market Interactions Chapter – New Concept

- **Market suspension and restoration arrangements are based per TSO**
- **Suspension**
  - By using a Market Activities Suspension Trigger
  - in consultation with market parties
  - NRA approval foreseen
- **Restoration when reasons for maintaining suspension are not valid any more**
- **Information exchanges to be clarified via Communications procedure**
- **Settlement as per NC EB; for situations with market suspensions, other arrangements per TSO are possible.**

Market Interactions Chapter – Questions

- **Sufficient considerations for Market Activities Suspension Triggers, or is something missing?**

- **Is communication to all market parties ensured? E.g. not all BRPs/BSPs are member of a NEMO…?**

- **Any further questions?**

Network Code on Emergency and Restoration

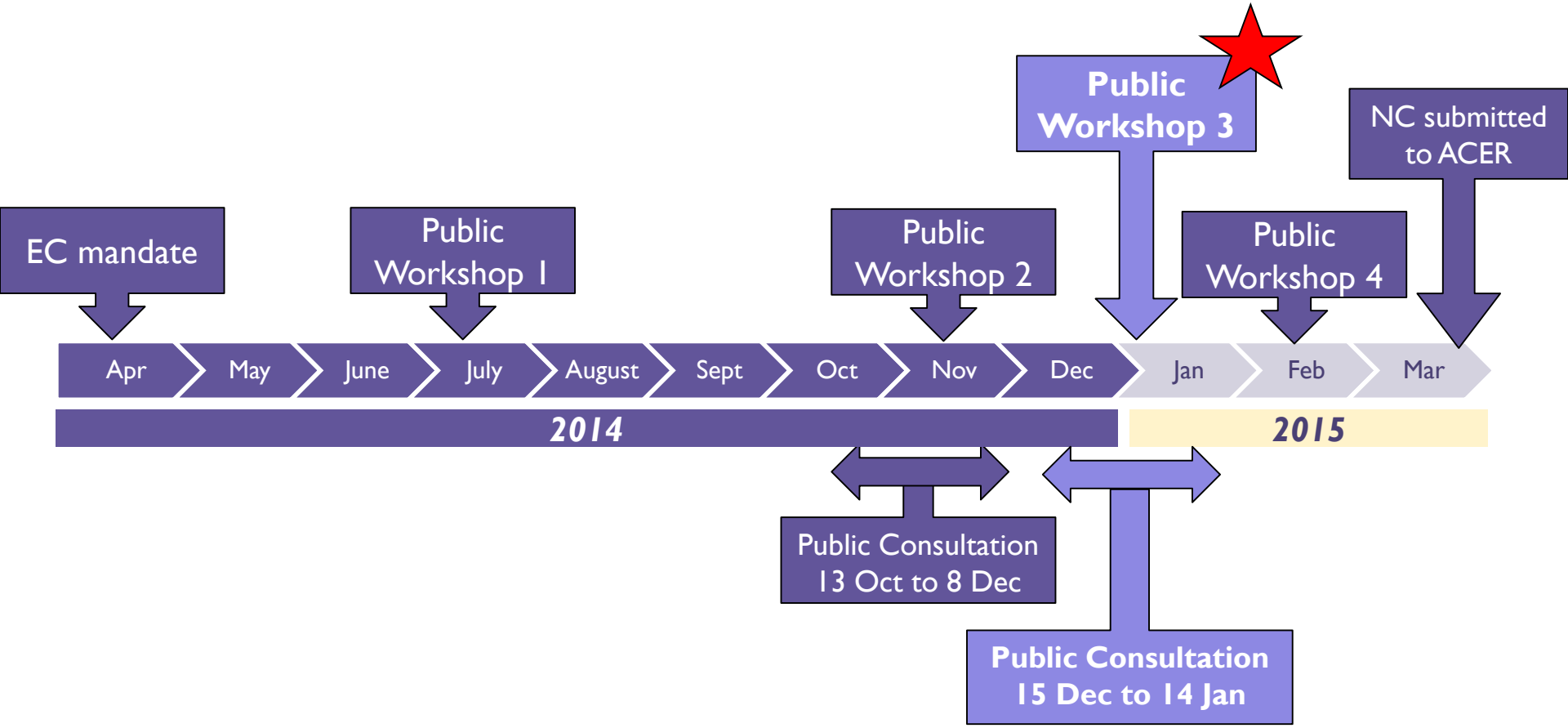
Conclusion

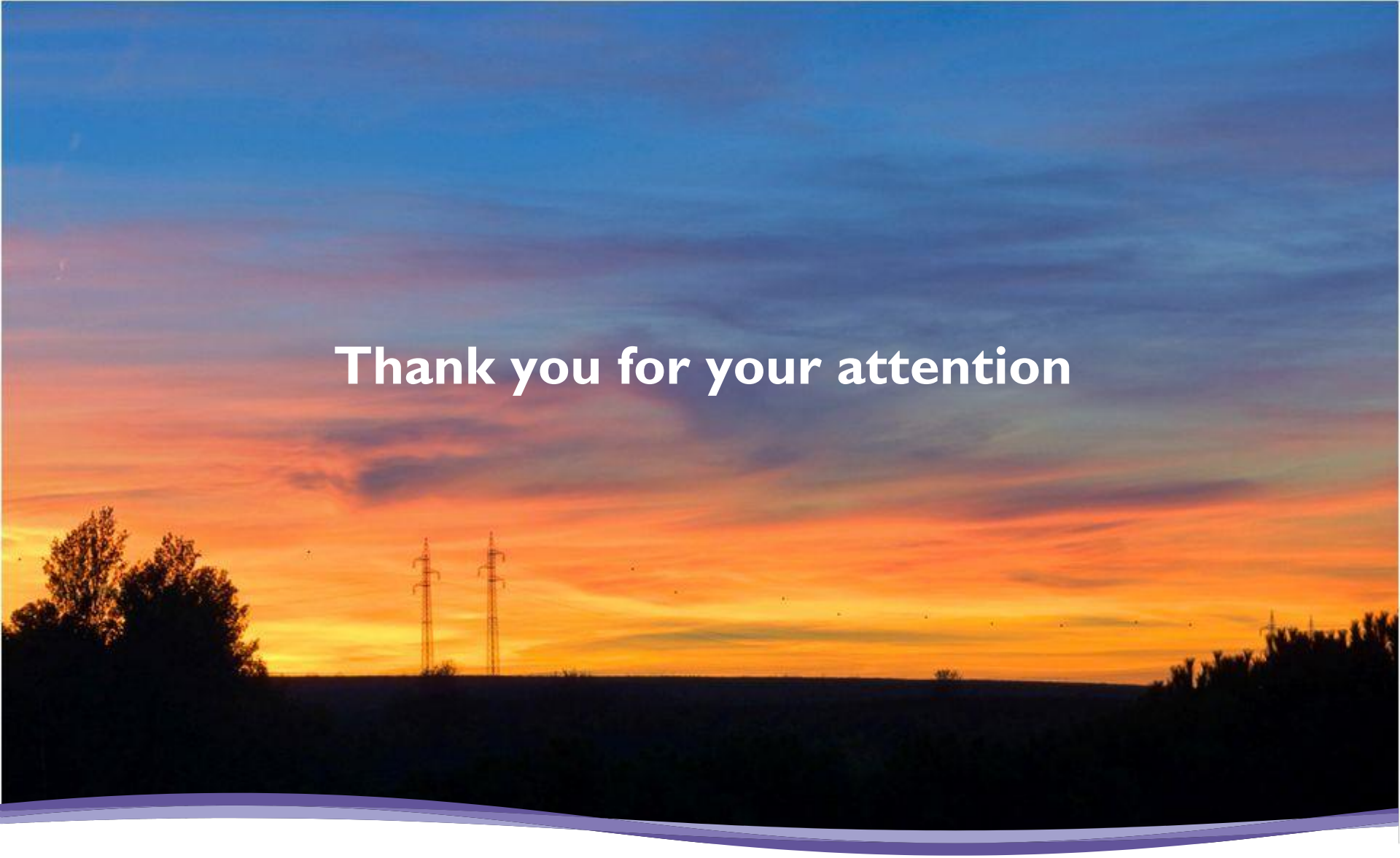
Laurent Lamy

entsoe

Reliable Sustainable Connected

Network Code Timetable





entsoe

Reliable Sustainable Connected