IMPACT OF THE NEW EUROPEAN GRID CODE - RFG - ON EXISTING CONVENTIONAL POWER PLANTS

Focus on HV Equipment

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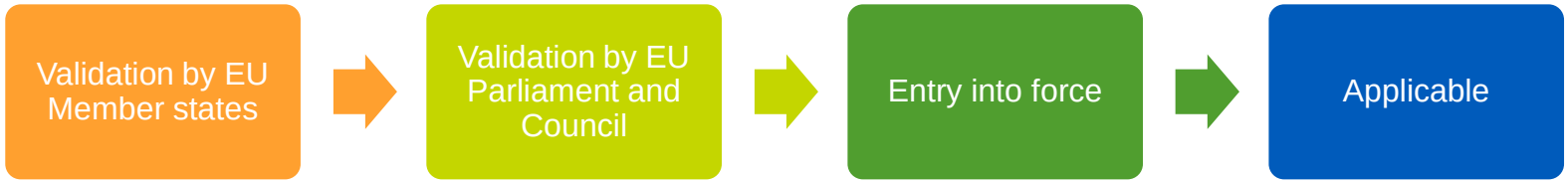
OVERVIEW OF THE ENTSO-E GRID CODES AND GUIDELINES



Connection to the grid	
Requirements for generators	Entered into force
Demand connection	Awaiting validation by EU P&C
HVDC	Awaiting validation by EU P&C

System Operation	
System Operation Guidelines	Awaiting validation by EU P&C
Emergency and restoration	Awaiting validation by EU P&C

Market and Trading	
Capacity Allocation and Congestion Management Guideline	Entered into force
Forward Capacity Allocation	Awaiting validation by EU P&C
Balancing	Awaiting validation by EU Member States

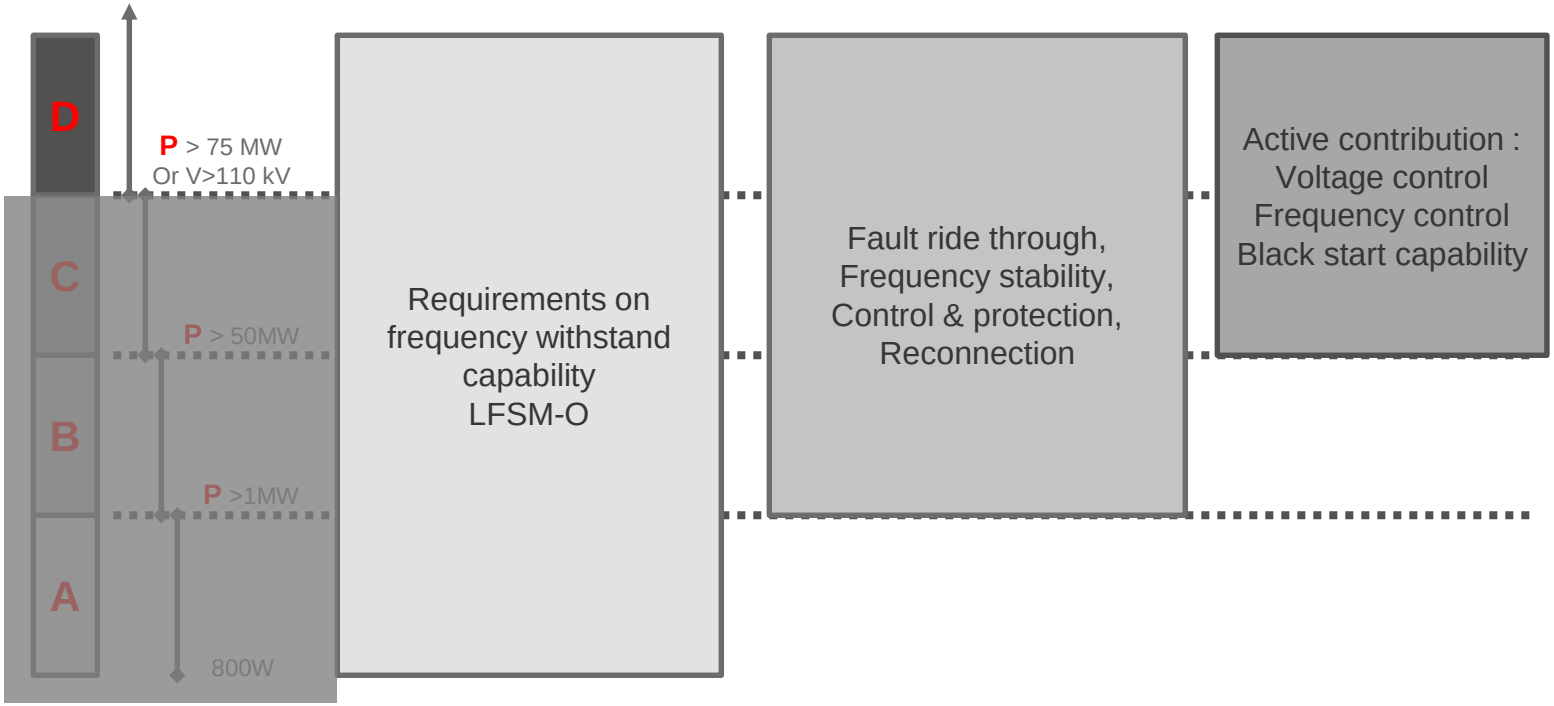
N.B : Sometimes the regulations are adopted as 'guidelines' rather than 'network codes.' These are adopted under a different provision of the Electricity Regulation but they have the same status – they are both legally binding regulations

WHAT IS THE RFG CODE ABOUT ?

Topics	Requirements
Frequency stability	Frequency range
	Frequency sensitive modes
	Limited Frequency sensitive modes
Voltage	Reactive Power Capability
	Voltage ranges
	Voltage control
Robustness	Fault ride through capability
System restoration	Reconnection after an incidental disconnection
	Black-start capability
	Island operation
General system management	Control & Protections
	Information exchange
	Simulation models
	Active power ramping limits
	Synchronization

WHAT ARE THE GENERATORS CONCERNED BY THE RFG CODE ?

Power generating units categories (Continental Europe figures)



New and existing generation units

As quoted in the RfG, existing generation units are not concerned by the RfG unless explicitly asked by the TSO and economically justified through a Cost-Benefit analysis.

Caution : This rule is actually applicable for local parameters only !

HARMONIZATION : A BIG CHALLENGE

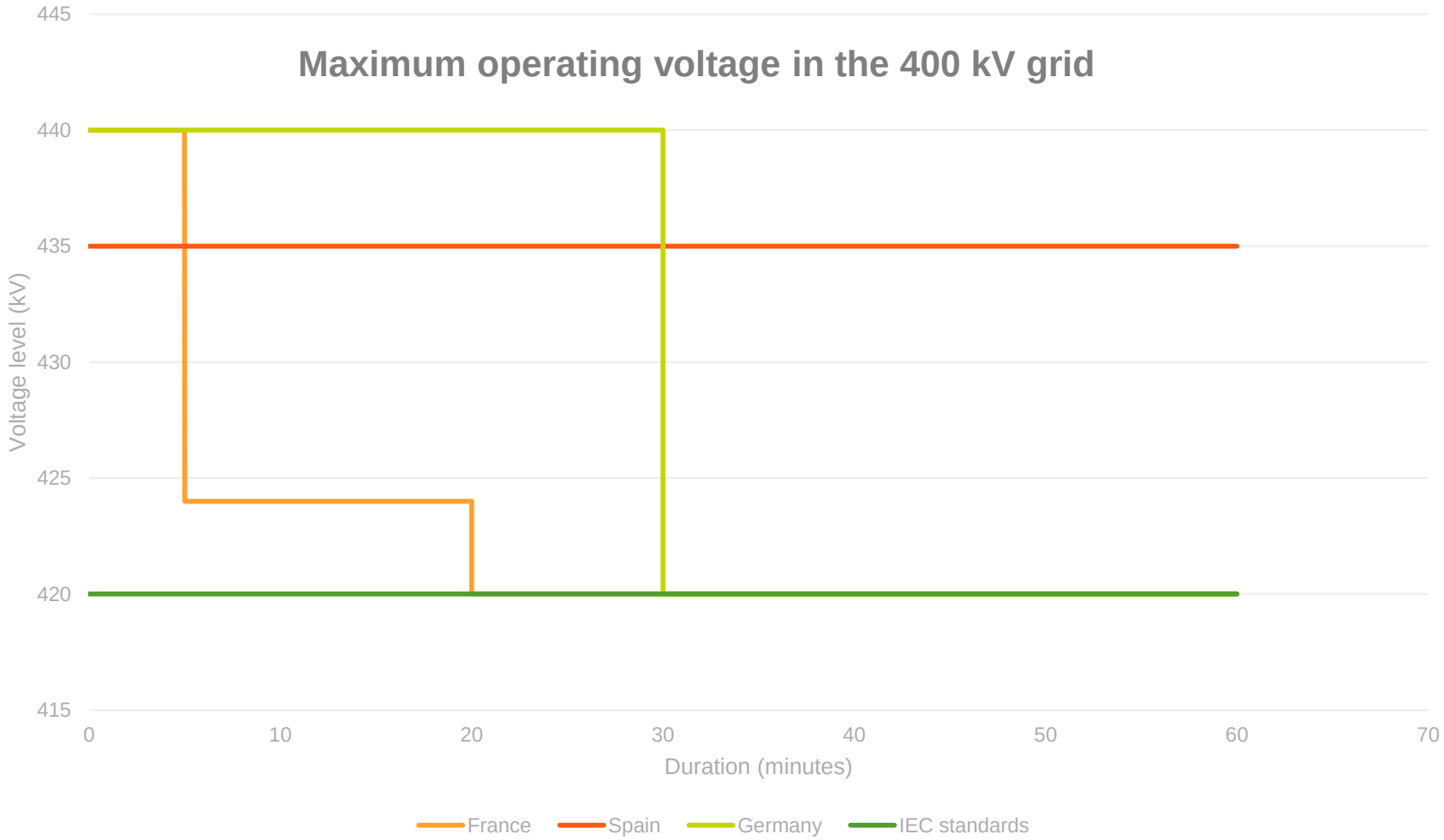
The aim of the RfG code is to harmonize the technical requirements that should be respected by generating units that are connected to the same synchronous area.

HOWEVER

- Around 75% of the technical requirements are non-exhaustive, some flexibility to fix theses requirements is given to each TSO;
- Some important details are missing to have clear requirements. These details will hence have to be addressed by each TSO for its perimeter;
- Some technical requirements fixed by the RfG are not in line with the IEC standards.

Some important elements must be addressed to prepare the application of the code

SO THE RFG WILL HARMONIZE THE VOLTAGE RANGE REQUIREMENTS IN EUROPEAN COUNTRIES, BUT WHAT DOES IT LOOK LIKE TODAY ?



THE VOLTAGE LEVEL HARMONIZATION IS AN INTERESTING IDEA, BUT SOMETHING IS MISSING …

- In France, 440 kV is an operating voltage that could already be reachable in the 400 kV grid following the TSO documentation.
- However, an additional and crucial information is given in the present rules compared to the RfG code :

The frequency of occurrence

Voltage level (kV)	Maximum Duration	Frequency of occurence
420 < V < 424	20 minutes	Several times a year
424 < V < 428	5 minutes	Few times a year
428 < V < 440	5 minutes	Once in 10 years

Transient margins fixed by the French TSO for the 400 kV grid

Voltage level (kV)	Maximum Duration
420 < V < 440	> 20 minutes < 60 minutes

Transient margins fixed by the RfG in Continental Europe

What could be the frequency of occurrence after the application of the RfG ?

Several times a day ? a month ? a year ?

WHAT COULD BE THE IMPACT ON HV OUTPUT SUBSTATIONS EQUIPMENT ?

Following the IEC standards, 420 kV high voltage equipment are dielectric-tested at voltage higher than 440 kV

- Phase-to-earth dielectric withstand tested at 520 kV (AIS) and 650 kV (GIS)
- Phase-to-phase dielectric withstand depends on the clearance distance in AIS, in 400 kV GIS the phases are separated through insulated compartments.

Most of the substation's equipment should not be impacted by a 440 kV operating voltage

However, some equipment could still be impacted by operating voltage higher than the maximum value specified by the standards (420 kV) :

- **Transformers**
- **Circuit breakers**

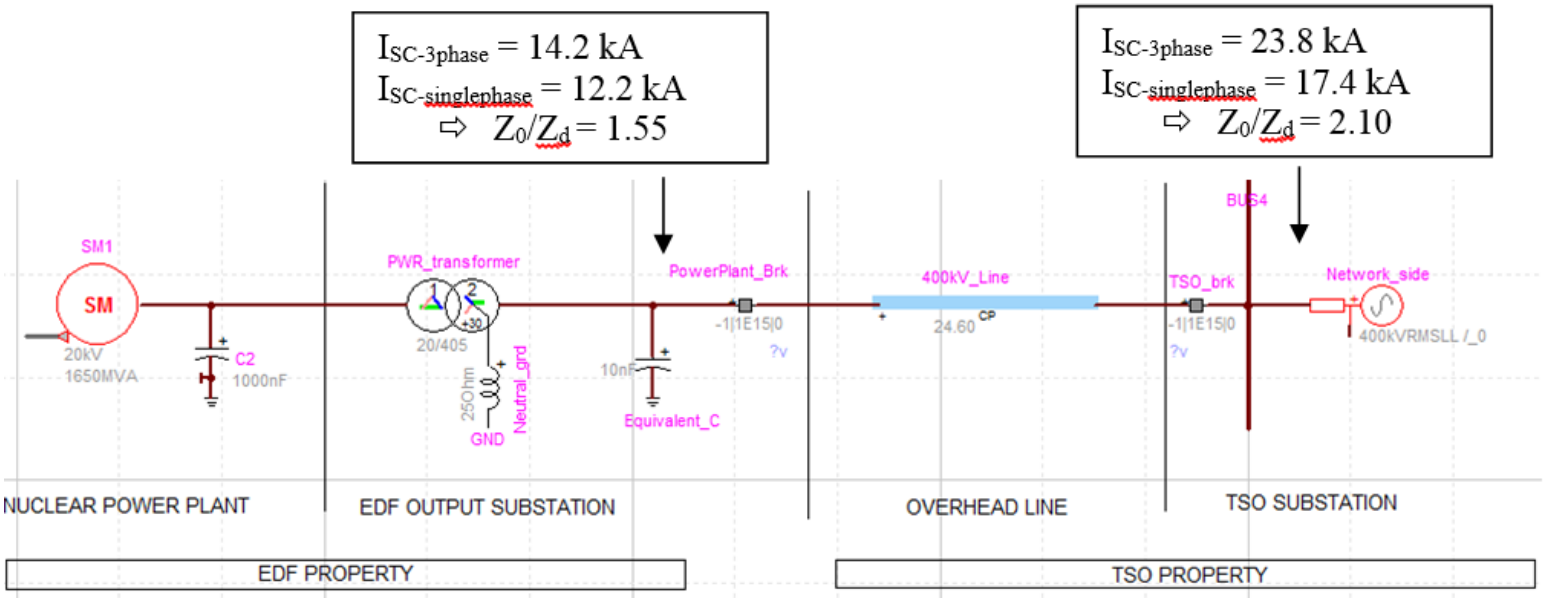
Let's focus on the circuit breakers

HOW WOULD THE CIRCUIT BREAKERS BE IMPACTED ?

Different types of switching

Capacitive
Inductive

Short circuit
Out-of-phase



Possible consequences

Switching performance alteration

Accelerated ageing process

TRV TESTS DUTY TODAY

$$U_c = fpcf * k_{amp} * U_r * \sqrt{\frac{2}{3}}$$

$$fpcf = \frac{3.k}{(1+2.k)}$$

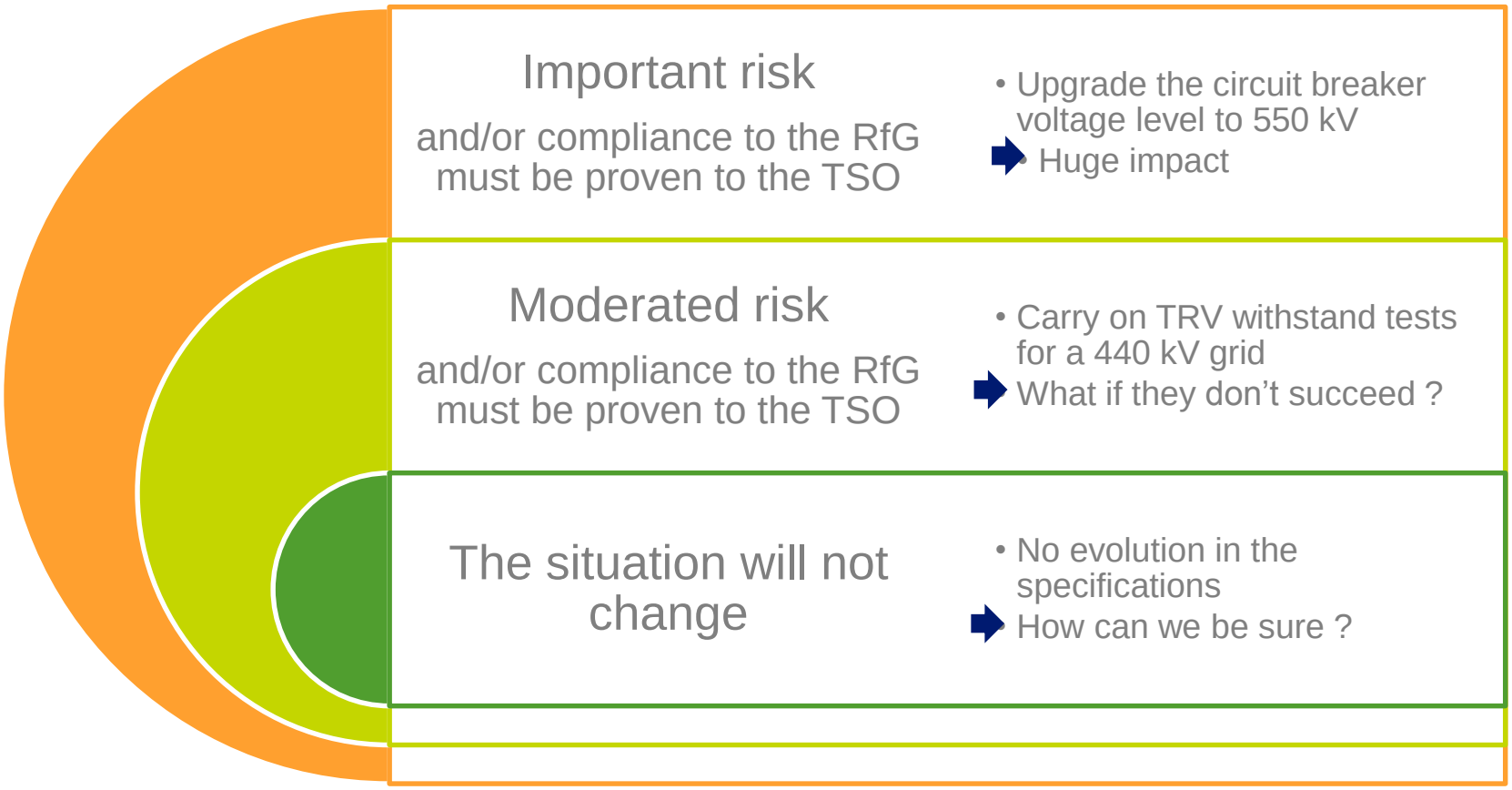
$$k = \frac{Z_0}{Z_d}$$

Some utilities report lower fcpf-factors and higher amplitude-factors, but mostly their Uc for the first clearing pole is equal to or less than the rated TRV given in IEC

First pole to clear factor = 1,3 or 1,5 depending on the short circuit level

Test duty	U_m = 420 kV	U_m = 440 kV
T100	624 kV	654 kV
T60	669 kV	701 kV
T30	687 kV	719 kV
T10	787 kV	824 kV
OP	857 kV	898 kV

POSSIBLE OPTIONS FOR CIRCUIT BREAKERS



The principal rule being not to over-specificy our equipment

THE RFG CODE WILL BE APPLICABLE IN LESS THAN THREE YEARS, ARE WE READY ?

- **The harmonization wanted through the RfG code is challenging**, further discussion is needed

- **Some crucial information are missing for the generation companies to prepare the application of this code**
  - Parameters/issues are missing in RfG to have clear requirements (frequency of occurrences for all events: FRT, F/V deviations…)

- **Several requirements from the RfG code are not compatible with international standards**
  - Some wider and longer voltage excursions can be met only in case of use of power transformers equipped with on-load tap changers. This is not the case in every power plants' step-up transformers.

- **The final consequence is that the responsibility to deal with the gap is on generators**

THANK YOU