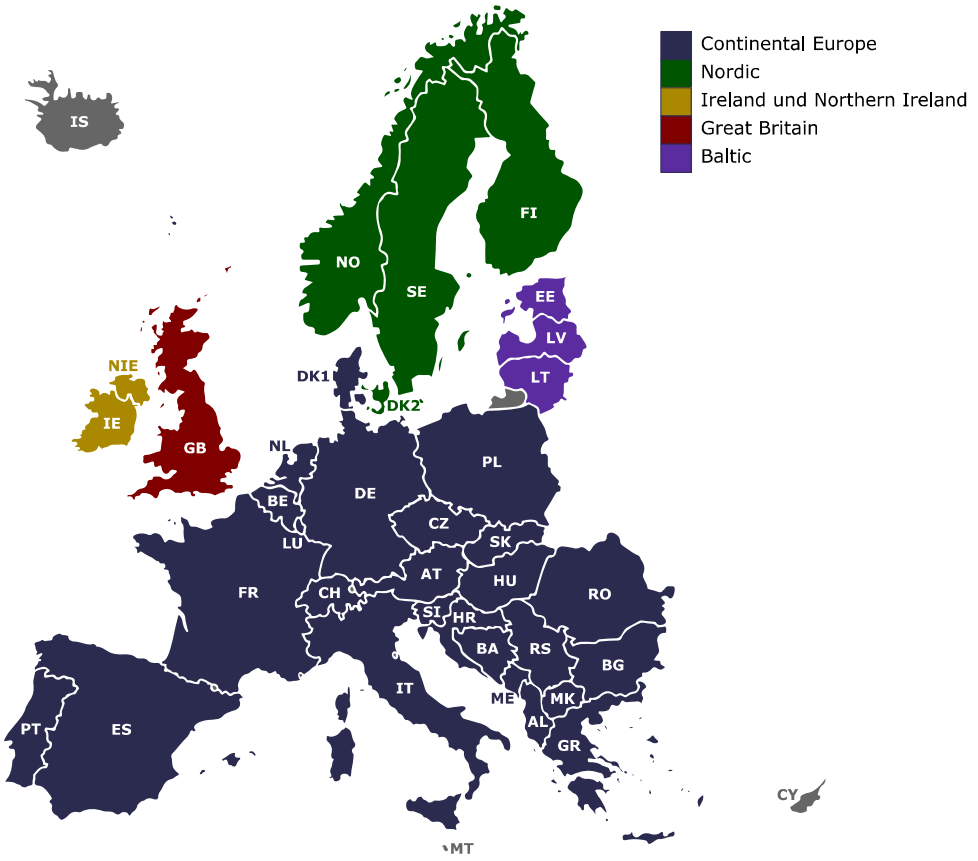
Implementation of the Network Code on Requirements for Grid Connection of Generators

Results from a survey commissioned by the European Commission, 2020



Team International Grid Code Compliance @ FGH

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Aachen, 09.03.2021

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Agenda

- Methodology of the analysis
- Actors in the national implementation process
- Capacity Thresholds for Type Definitions
- Type A Requirements
- Type A Additional Requirements
- Type B, C and D Requirements
- Compliance Assessment of the Technical Requirements
- Recommendations

Countries with available RfG implementation documents – defining the population basis

- National implementations of technical requirements has been completed in **26 MS** (excluding MT)
- **Additional 9 entities have been considered:** BA, CH, ME, RS, MK, GB, NIE, IS NO
- **Six** countries with **no open** available implementation document in 2020: BG, BA, ME, MK, RS, CY
- A total of 29 ***MS+*** under analysis
- Implementations were expected to be **changed** and **updated** in some MS+

Study input cut-off date: **30.05.2020**

National implementation of the technical requirements of the RfG NC				
available / found?	YES		NO	
approved / completed?	YES	NO*	YES	NO*
MS+	AT, BE, CH*, CZ*, DE, DK, EE, FI, GB, HR*, HU, IE, IS, IT, LT, LU, LV, NIE, NL*, PL, PT, RO, SE, SI*, SK*	ES, FR, GR, NO	BG*	BA, ME, MK, RS, CY**
Number of MS+	25	4	1	5
Note	*Amendments expected	*Proposals already submitted for approval	*According to ENTSO-E, implementation has been completed [1]	*Proposals in elaboration **excluded

Convergences & Incidences for providing a measure of coherence in national grid code implementation

- **Convergence level for RfG NC requirements**
  - Missing implementation or exceeding RfG NC ranges are counted as divergences
  - Convergence level defined as # of non-diverging MS+ ./. basic population (i.e. 29)

- **Incidence level for non RfG NC requirements**
  - As no ranges are pre-defined for non RfG NC requirements no exceeding can be analysed
  - Instead, the definition of respective requirements are counted as incidences
  - Incidence level defined as # MS+ with incidence ./. basic population (i.e. 29)

- **Additional analyses**
  - on implemented compliance levels
  - on requirements for storages

Different actors leading the process

MS+	Leading the elaboration process / Proposal		Approval	
	Entity	Description	Entity	Description
MK	MEPSO	TSO	PKE	NRA
NIE	SONI NIE Networks	TSO DSO	UR	NRA
NL	Netbeheer Nederland	Association	ACM	NRA
NO	Statnett	TSO	NVE	NRA
PL	PSE	TSO	URE	NRA
PT	REN EDP Distribuição	TSO DSO	Ministério Ambiente e da Ação Climática (MAAC)	Ministry
RO	Transelectrica	TSO	ANRE	NRA
RS	EMC	TSO	AERS	NRA
SE	Svenska Kraftnät			
SI	ELES			
SK	SEPS			

MS+	Leading the elaboration process / Proposal		Approval	
	Entity	Description	Entity	Description
IE	EirGrid ESB Networks	TSO DSO	CRU	NRA
IS	Landsnet	TSO	Ministry of Industries and Innovation	Ministry
IT	Terna	TSO	ARERA	NRA
LT	Litgrid	TSO	VKEKK (VERT actually)	NRA
LU	Creos	TSO	ILR	NRA
LV	AST	TSO	SPRK	NRA
ME	CGES	TSO	REGAGEN	NRA

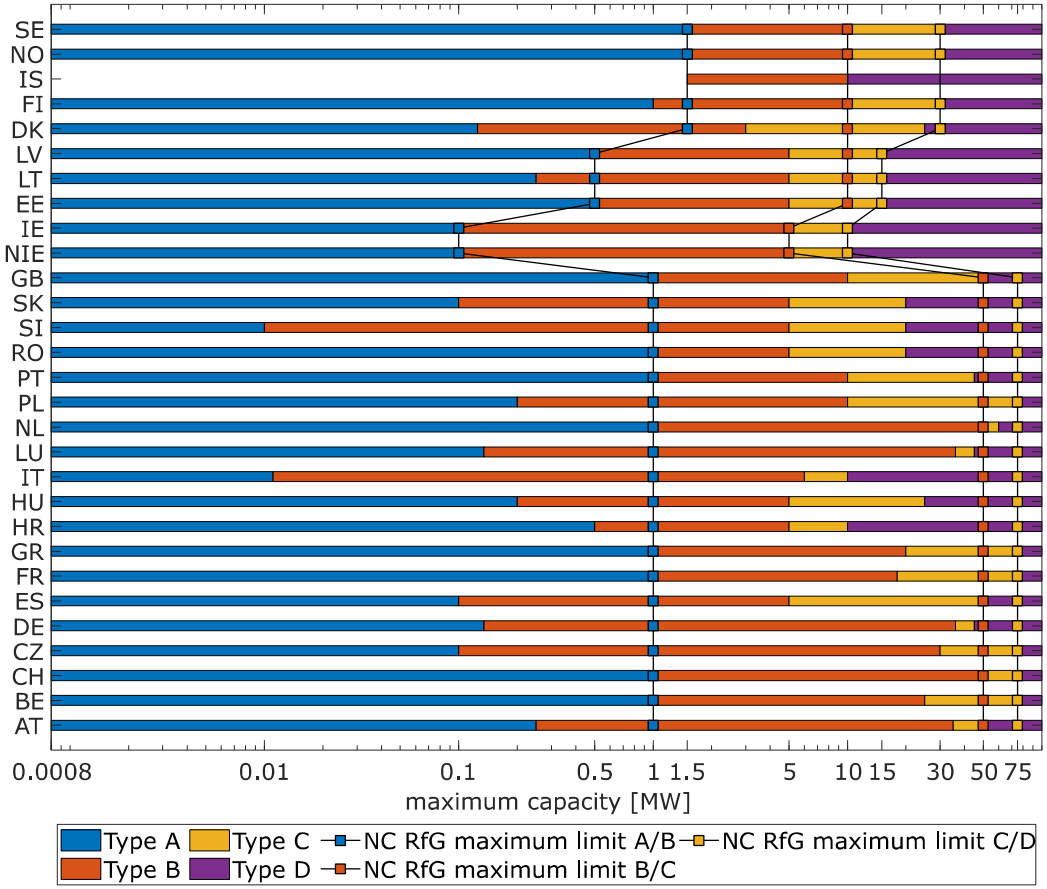
NC RfG

MS+	Leading the elaboration process / Proposal		Approval	
	Entity	Description	Entity	Description
AT	APG / VÜN	TSOs	E-Control	NRA
BA	NOS-BiH	TSO	DERK	NRA
BE	Elia	TSO	VREG (Flanders) Cwape (Wallonia) Brugel (Brussels)	regional regulators
BG	ESO	TSO	EWRC	NRA
CH	VSE	Association	VSE	Association
CZ	CEPS	TSO	ERU	NRA
DE	FNN (VDE)	Association	FNN (VDE)	Association
DK	Energinet Dansk Energi	TSO Association	Forsyningstilsynet	NRA

MS+	Leading the elaboration process / Proposal		Approval	
	Entity	Description	Entity	Description
EE	Elering	TSO	Konkurentsiamet	NRA
ES	REE AELEC	TSO Association	Ministerio para la Transición Ecológica	Ministry
FI	Fingrid	TSO	Energiavirasto	NRA
FR	RTE ADEeF	TSO Association	Ministère de la Transition écologique et solidaire	Ministry
GB	NationalGridESO	TSO	OFGEM	NRA
GR	IPTO	TSO	PAE	NRA
HR	HOPS	TSO	HERA	NRA
HU	MAVIR	TSO	MEKH	NRA

Variations in type definitions among MS

- Type definitions vary significantly among MS
  - Example: Type A PGU in France could possibly be recognized as Type B in 15 other MS
- No deviation to set thresholds in NC RfG framework
- Other identified distinctiveness:
  - Czech Republic provide subtypes A1/2 and B1/2
  - Iceland: Only type B and D are defined



Type A Requirements

Requirements from NC RFG Framework

- Frequency ranges and minimum periods for operation
- Resistance to frequency gradients (Rate of Change of Frequency - ROCOF)
- Permissible reduction in the maximum active power output with falling frequency
- Limited frequency sensitive mode – Over frequency (LFSM-O)
- Definition of Pref for PPMs
- Logic interface to cease active power
- Automatic connection

Type A

97% Convergence in Implementations

- In Switzerland, for type A,B,C PGMs, there is a deviation for the frequency range, where the minimum operation time is defined as 10 min for 47,5 - 48 Hz. For 48 - 48,5 Hz, this value is 20 min (Note: Grid code in Switzerland still not finalized)
- ➢ Convergence degree with respect to non-exhaustive parameters is 97% (28/29)
- No deviations observed for frequency ranges FB0, 3, 5

Frequency ranges according to NC RfG

Frequency range	FB0	FB1*	FB2*	FB3	FB4*	FB5
from [Hz]	47	47,5	48,5	49	51	51,5
to [Hz]	47,5	48,5	49	51	51,5	52

	Region	Frequency range					
		FB0	FB1	FB2	FB3	FB4	FB5
Minimum time period [min]	Continental Europe	n/a	≥30	$\geq t_{FB1}$	∞	30	n/a
	Great Britain	1/3	90	≥90	∞	90	15
	Ireland and Northern Ireland	n/a	90	≥90	∞	90	n/a
	Baltic	n/a	≥30	$\geq t_{FB1}$	∞	≥30	n/a
	Nordic	n/a	30	≥30	∞	30	n/a

* non-exhaustive parameters

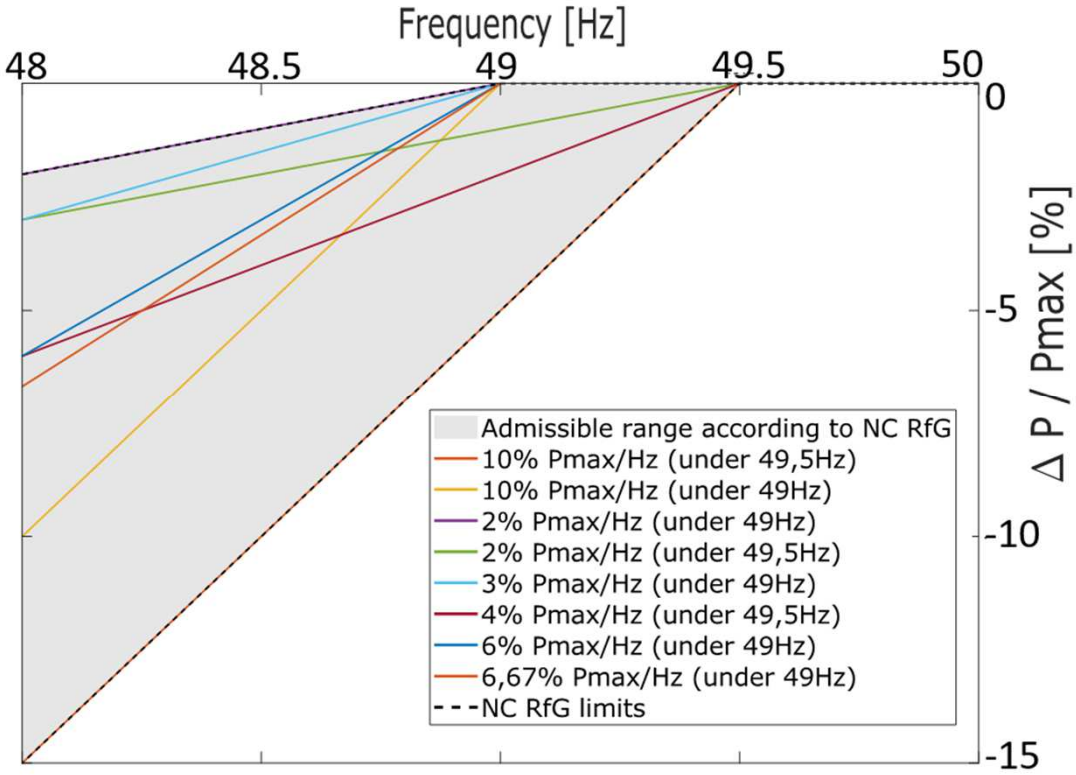
Currently 97% Convergence in Implementations

- 28 member states mention ROCOF requirements
- France set ROCOF requirement with no specific values
- Switzerland mention no requirement for ROCOF (Final grid code is pending)

Frequency Values	MS	Number of MS	Comments
Maximum frequency gradient (+/-) [Hz/s] and Sliding Window (SW)			
0,5 (n/a for SW)	IS*	1	* Defined for type B and D
1 (for 0,5s)	GB, NIE, IE	3	
1,5 (for 1s)	NO	1	
2 (n/a for SW)	AT, DK	2	
2 (for 0,5s)	CZ, ES, HR, HU*, PL, SI, SK, FI, SE, PT	10	* Defined for type B, C and D
2,5 (n/a for SW)	EE	1	
2,5 (for 0,5s)	HU*, LT, LV	3	* Defined for type A
2,5 (for 0,1s until 1s)	IT	1	
1,25 (for 2s) or 1,5 (for 1s) or 2 (for 0,5s)	DE, LU, NL, RO	4	
Over - and underfrequency profile	BE, GR	2	
n/a	CY, BA, BG, CH, FR, ME, MK, RS	8	

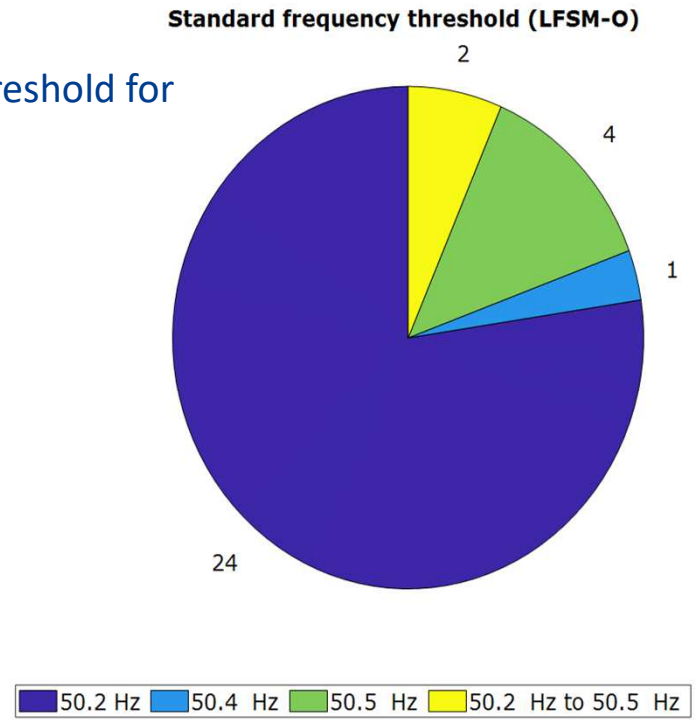
Implementations are with in the RfG NC Framework

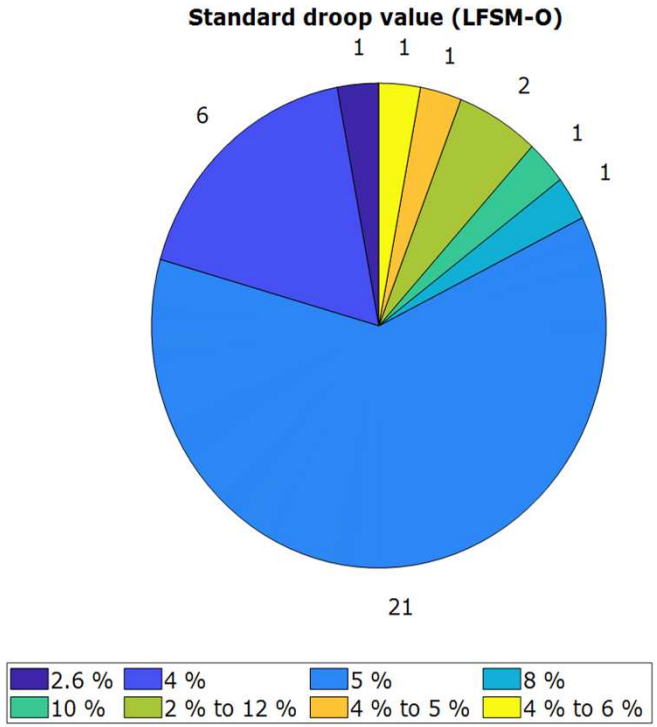
- Implementations among MS can be grouped with respect to $P_{reduction}$ percentages
- Grey region corresponds to admissible range from RfG NC
- The upper limit in plot corresponds to a reduction by 2% max. capacity per drop of 1 Hz starting from 49 Hz. The lower limit corresponds to a similar reduction by 10% max. capacity below a frequency of 49.5 Hz
- In some MS (e.g. Belgium, France, Greece, Romania, Slovenia, Northern Ireland and Ireland), maximum power reduction differs according to a so called stationary or transient mode



100% Convergence for LFSM-O Implementations

- Definition on two criteria
  - Droop values
  - Frequency threshold for LFSM mode





Mostly the definitions are set on mentioned criteria

- Possible definition of parameter
  - The Maximum Capacity of the generator (P_{max}) or
  - The actual active power at the moment of entering into LFSM or FSM operation (P_{mom}).

Value	MS	Number of MS
Reference active power (Pref) for LFSM and FSM for PPMs		
Maximum Power Capacity (Pmax)	ES, GR, HR, HU, PL, PT, RO, SI, GB, NIE, IE, EE, LT, DK, FI, IS, NO, SE	18
Actual active power output at the time of reaching the threshold value (Pmom)	AT, BE, CH, DE, FR, IT, LU, NL	8
Defined by the System Operator	CZ, SK, LV	3
n/a	CY, BA, BG, ME, MK, RS	6

Convergence of 66% (19/29) on implementation of requirement

- In **Lithuania** and **Poland**, a reference has been made to the corresponding article of RfG NC regarding the stoppage of active power. However, the 5 second criterion is not explicitly mentioned

Implementation	MS+	Number of MS+	Comments
Type A	AT, BE, CZ, DE, FR, GR, IT, NL, PL*, RO, SI, IE, NIE, LT*, DK, FI, NO**, GB, LU	19	* Cease within 5 sec not mentioned explicitly **In general required for units above 0.1 MW
n/a	CY, BA, BG, ME, MK, RS, **CH, EE, ES, HR, HU, IS, LV, PT, SE, SK**	16	

Type A Requirements – Overview

Overall convergence 91%

- Type A requirements among member states are mostly set with in the RfG NC framework
- Variation among MS with respect to implementations could still be challenging especially in terms of ROCOF requirement
- LFSM-O requirements although varying, but mostly set through parameterization in PGUs
- Implementations in active power reduction requirements are not largely varying

Requirement	Convergence level [%]
Frequency ranges and minimum periods for operation	97
Resistance to frequency gradients (Rate of Change of Frequency - ROCOF)	97
Permissible reduction in the maximum active power output with falling frequency	100
Limited Frequency Sensitive Mode - Overfrequency (LFSM-O)	100
Definition of Pref for PPMs	100
Logic interface for cease of active power	66
(Automatic) connection	79
Average convergence level	91%

Type A – Additional Requirements

Requirements above RfG NC framework

Type A with Additional Requirements

- Frequency ranges and minimum periods for operation
- Resistance to frequency gradients (Rate of Change of Frequency - ROCOF)
- Permissible reduction in the maximum active power output with falling frequency
- Limited Frequency Sensitive Mode - Overfrequency (LFSM-O)
- Definition of Pref for PPMs
- Logic interface for cease of active power
- (Automatic) connection

- Limited Frequency Sensitive Mode - Underfrequency (LFSM-U)
- Voltage related active power reduction (P(U))
- Frequency related protection
- Voltage ranges and minimum periods for operation
- Voltage related protection
- U-Q/Pmax for SPGMs
- U-Q/Pmax for PPMs
- P-Q/Pmax for SPGMs
- P-Q/Pmax for PPMs
- Reactive power control
- Power quality
- **LVRT for SPGM**
- **LVRT for PPM**
- Over Voltage Ride Through (OVRT)
- Vector shift
- Zero current mode for PPM technology
- Active power recovery after fault
- Reconnection/synchronization requirements after disconnection
- Unintentional/Intentional Islanding operation
- Uninterruptible Power Supply (UPS)
- Information exchange

Varied additional requirements among MS+

Type A Additional Requirements

LVRT (SPGM/PPM)

Not needed for Type A according to NC-RfG, Recommended for Type A in EN 50549-1/2

SPGM

Implementation	MS	Number of MS	Comments
Type A	AT, CZ, DE, PT*, CH	5	* Above 15 kW
n/a	CY, BA, BE, BG, ME, MK, RS, HR, HU, LU, IS, ES, FR, GR, NL, PL, RO, SI, SK, NIE, IE, EE, LT, LV, NO, SE, IT, GB, DK, FI	31	

PPM

Implementation	MS	Number of MS	Comments
Type A	AT, CZ, DE, PT*, CH	5	* Above 15 kW
n/a	CY, BA, BE, BG, ME, MK, RS, HR, HU, LU, IS, ES, FR, GR, NL, PL, RO, SI, SK, NIE, IE, EE, LT, LV, NO, SE, IT, GB, DK, FI	31	

Degree of Variance is equal to 17% (5/29) (for SPGM & PPM)

Type A Additional Requirements

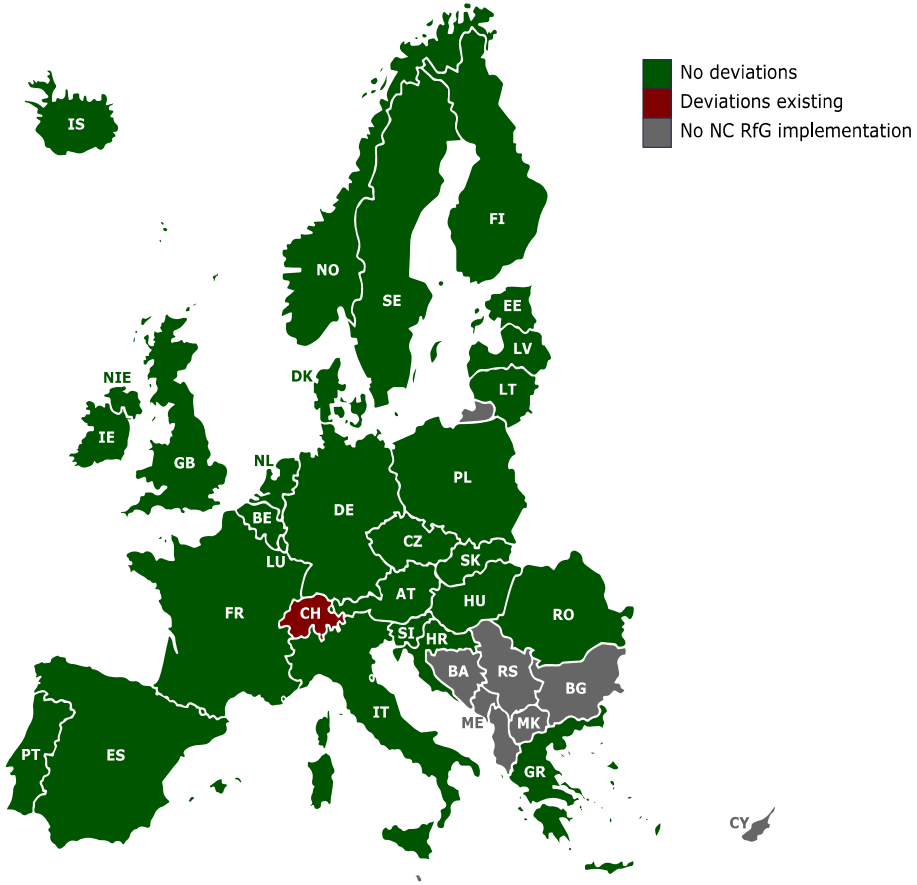
Overview

Requirement	Incidence level [%]
Limited Frequency Sensitive Mode - Underfrequency (LFSM-U)	7
Voltage related active power reduction (P(U))	14
Frequency related protection	24
Voltage ranges and minimum periods for operation	31
Voltage related protection	24
U-Q/Pmax for SPGMs	21
U-Q/Pmax for PPMs	17
P-Q/Pmax for SPGMs	17
P-Q/Pmax for PPMs	21
Reactive power control	21
Power quality	31
LVRT for SPGM	17
LVRT for PPM	17
Over Voltage Ride Through (OVRT)	10
Vector shift	14
Zero current mode for PPM technology	3
Active power recovery after fault	7
Reconnection/synchronization after disconnection	21
Unintentional/Intentional Islanding operation	3
Uninterruptible Power Supply (UPS)	7
Information exchange	21
Average incidence level	17

→ Low incidence corresponds to less number of countries have implemented the requirement at national level

Need for an extended framework

- Challenge for type A units in order to cover also type B requirements due to varying capacity threshold definitions among MS
- RfG NC framework has lead to a high degree of convergence among MS in their national implementation with respect to Type A requirements
- Incidence among MS with respect to additional requirements undermines the positive result achieved on type A requirements through RfG NC
- Collectively due to incidence of additional requirements the single market concept at EU level for type A PGU is effected ➡ No set of countries with similar additional requirements



Type B, C and D – Requirements

Requirements from RfG NC framework

Type B, C and D Mandatory requirements

- Frequency ranges and minimum periods for operation
- Resistance to frequency gradients (Rate of Change of Frequency - ROCOF)
- Permissible reduction in the maximum active power output with falling frequency
- Limited Frequency Sensitive Mode - Overfrequency (LFSM-O)
- Definition of Pref for PPMs
- Logic interface for cease of active power
- (Automatic) connection

Type A

- Limited frequency dependent mode - underfrequency (LFSM-U)
- Frequency dependent mode (FSM)
- Full active power frequency response in FSM
- Reactive power capacity at maximum capacity for SPGMs (type C and D)
- Reactive power capacity at maximum capacity for PPMs (type C and D)
- Reactive power capacity below the maximum capacity for PPMs (type C and D)
- Power System Stabilizer (type D)
- Voltage ranges and operating periods
- FRT capability with symmetrical faults for the SPGMs of type B, C and D connected to the network below the 110 kV level
- FRT capability for symmetrical faults for the SPGMs of type D connected to the network at or above the 110 kV level
- FRT capability for symmetrical faults for the PPMs of type B, C and D connected to the network below the 110 kV level
- FRT capability for symmetrical faults for the type D PPMs connected to the network at or above the 110 kV level
- FRT capability for asymmetrical faults
- Information exchange
- Voltage related protection
- Loss of angular stability protection
- Reconnection/synchronization after disconnection
- Simulation requirements
- Reactive power control modes
- Active power recovery after fault
- Active power setpoint control
- Active power ramp rate
- Prioritization of the active power contribution or the reactive power contribution on PPMs during faults
- Frequency related protection
- Operation after Tripping to Houseload

Requirements from RfG NC framework

Type B, C and D Non-mandatory requirements

- Synthetic inertia provision by PPMs
- Fast Fault Current Injection by PPMs
- Black Start capability
- Island Operation

Type B, C and D Mandatory requirements

- Limited frequency dependent mode - underfrequency (LFSM-U)
- FRT capability with symmetrical faults for the SPGMs of type B, C and D connected to the network below the 110 kV level
- FRT capability for symmetrical faults for the SPGMs of type D connected to the network at or above the 110 kV level
- FRT capability for symmetrical faults for the PPMs of type B, C and D connected to the network below the 110 kV level
- FRT capability for symmetrical faults for the type D PPMs connected to the network at or above the 110 kV level
- …

Type A

- Frequency ranges and minimum periods for operation
- Resistance to frequency gradients (Rate of Change of Frequency - ROCOF)
- Permissible reduction in the maximum active power output with falling frequency
- Limited Frequency Sensitive Mode - Overfrequency (LFSM-O)
- Definition of Pref for PPMs
- Logic interface for cease of active power
- (Automatic) connection

Requirements from RfG NC framework

Type B, C and D Non-mandatory requirements

- Synthetic inertia provision by PPMs
- Fast Fault Current Injection by PPMs
- Black Start capability
- Island Operation

Type B, C and D Mandatory requirements

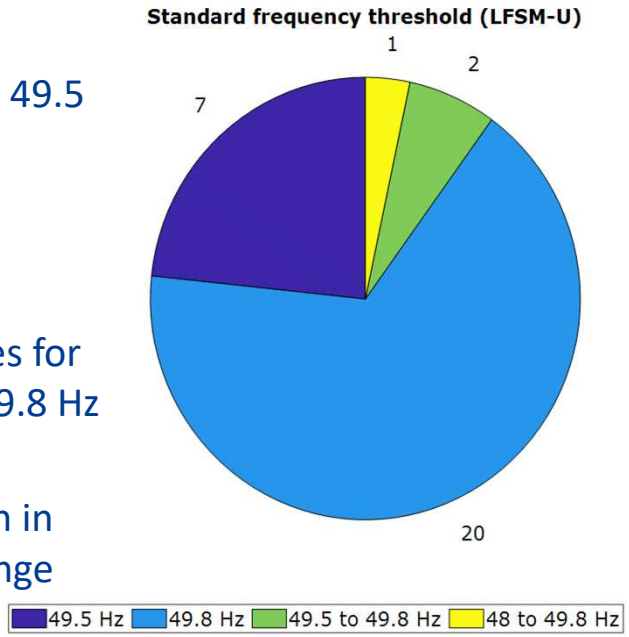
- **Limited frequency dependent mode - underfrequency (LFSM-U)**
- **FRT capability with symmetrical faults for the SPGMs of type B, C and D connected to the network below the 110 kV level**
- **FRT capability for symmetrical faults for the SPGMs of type D connected to the network at or above the 110 kV level**
- **FRT capability for symmetrical faults for the PPMs of type B, C and D connected to the network below the 110 kV level**
- **FRT capability for symmetrical faults for the type D PPMs connected to the network at or above the 110 kV level**

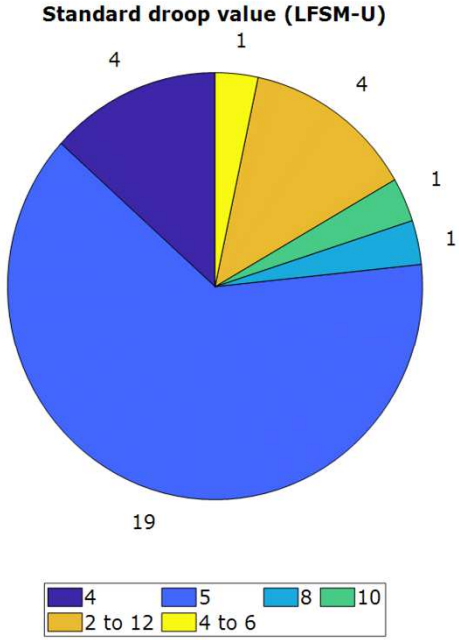
Type A

- Frequency ranges and minimum periods for operation
- Resistance to frequency gradients (Rate of Change of Frequency - ROCOF)
- Permissible reduction in the maximum active power output with falling frequency
- Limited Frequency Sensitive Mode - Overfrequency (LFSM-O)
- Definition of Pref for PPMs
- Logic interface for cease of active power
- (Automatic) connection

LFSM-U (Types C and D)

- Parameters to be set for droop and frequency threshold
  - Activation threshold b/w 49.8 Hz and 49.5 Hz
  - Droop between 2% and 12%
- Key findings
  - Most commonly chosen default values for frequency threshold and droop are 49.8 Hz and 5%
  - Frequency threshold, implementation in Iceland deviates from the NC-RfG (range between 48 Hz and 49.8 Hz)
  - Switzerland does not currently specify LFSM-U

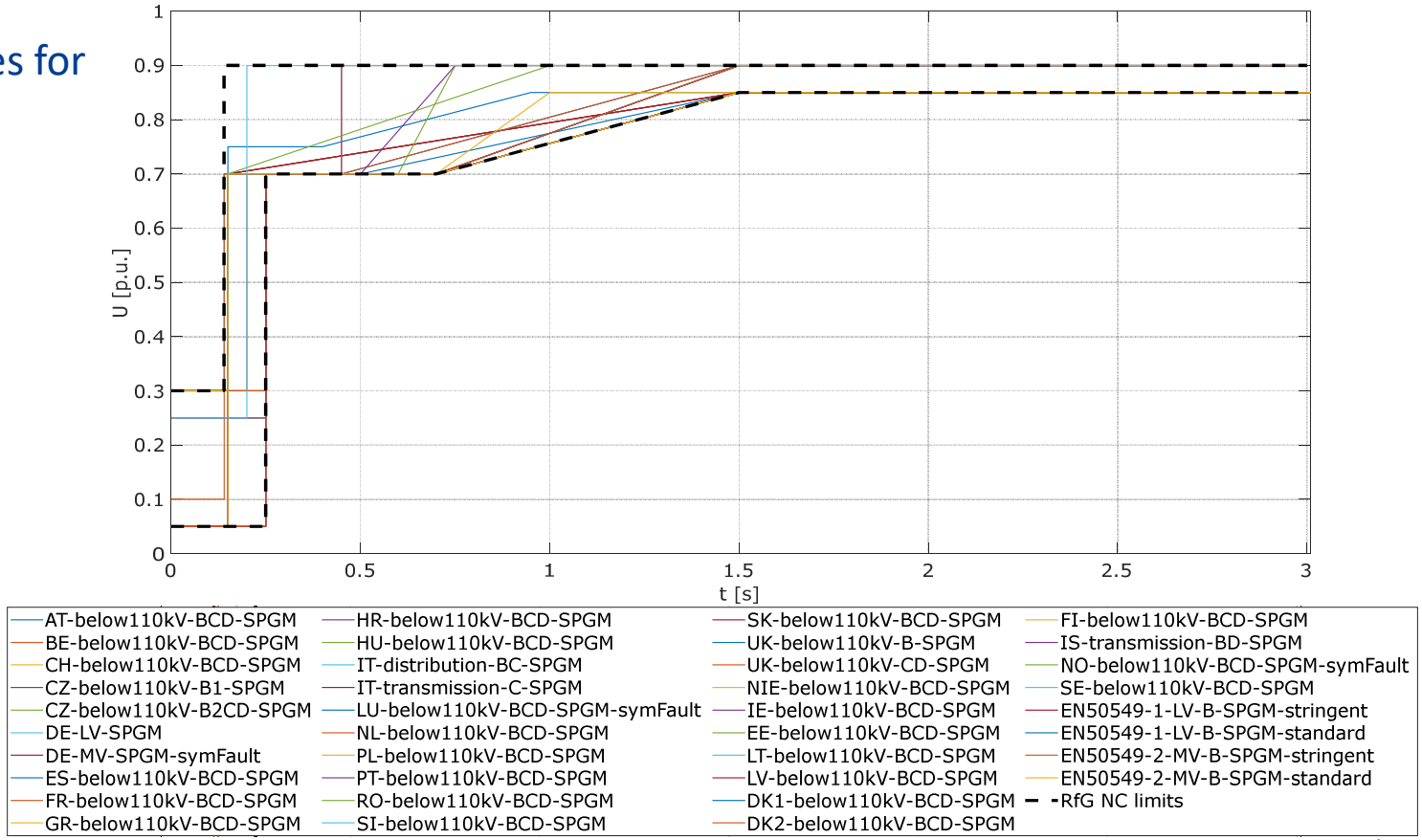




➢ Degree of convergence is 93% (27/29)

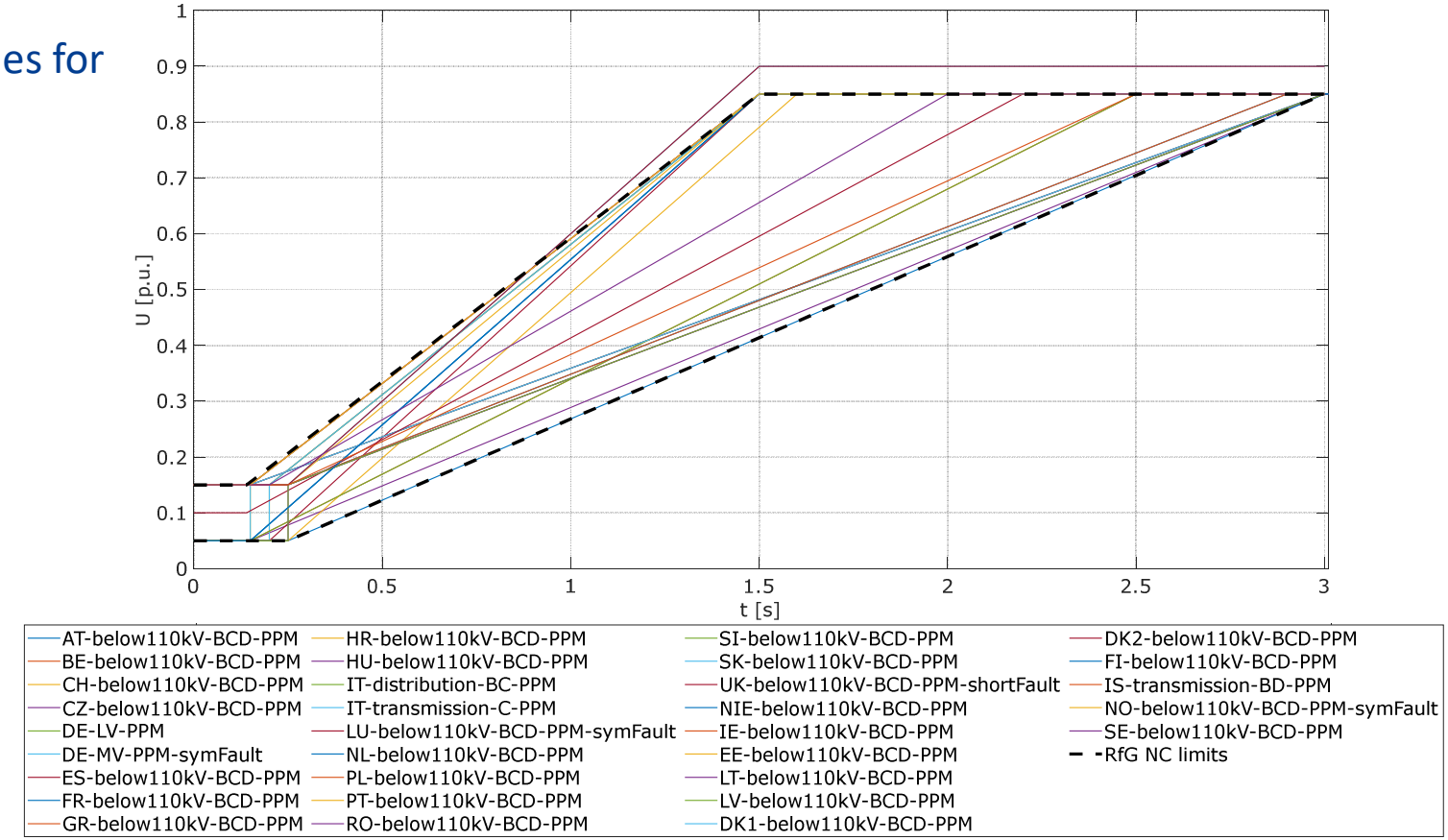
FRT capability within symmetrical faults below 110kV level (Type B, C and D)

- RfG NC defines FRT profiles for **SPGMs** of Type B, C and D
  - Degree of convergence is 100% (29/29)
  - EN 50549-1/2: 38% (11/29)



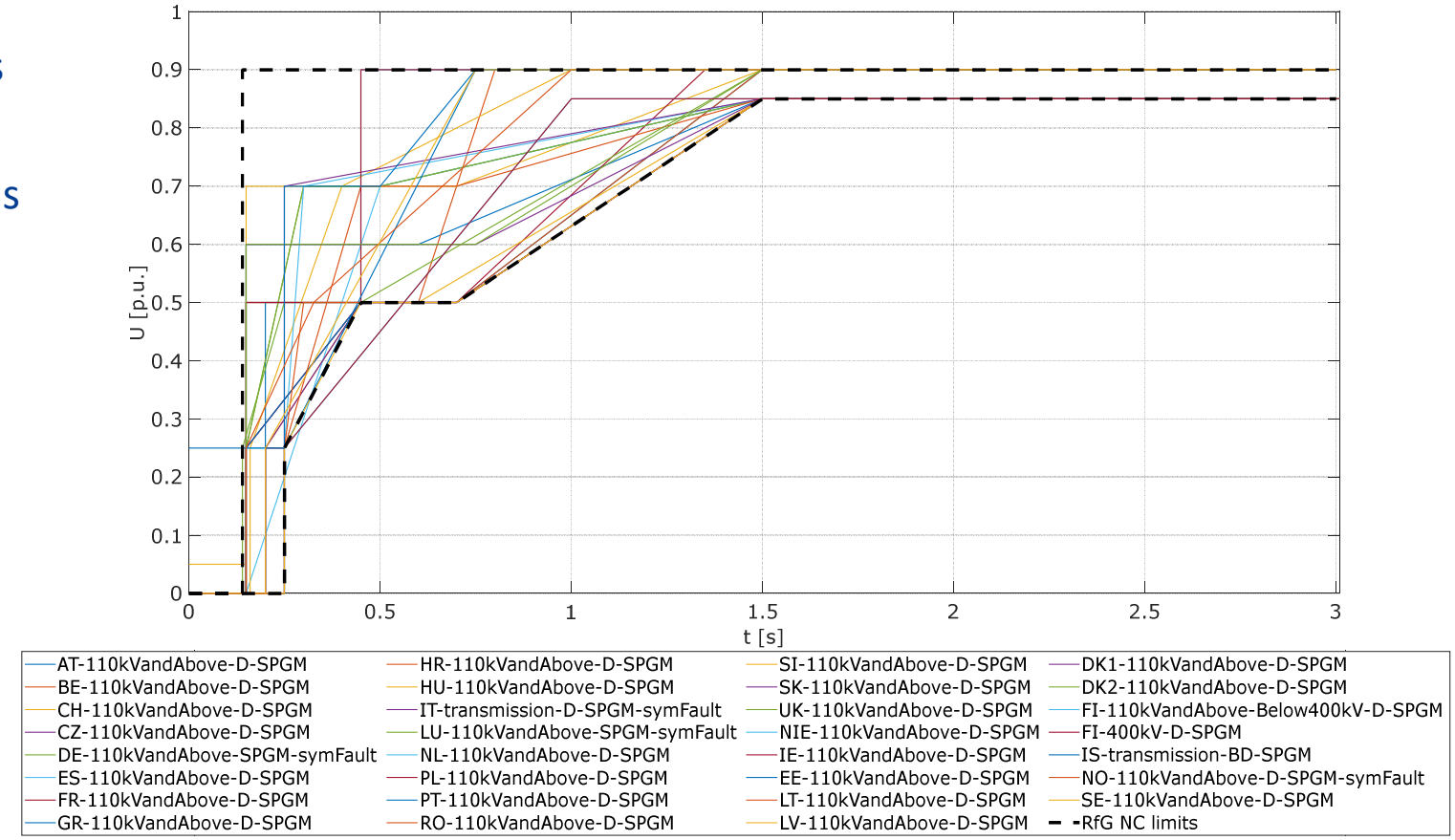
FRT capability within symmetrical faults below 110kV level (Type B, C and D)

- RfG NC defines FRT profiles for **PPMs** of Type B, C and D
  - Degree of convergence is 97% (28/29)
  - EN 50549-1/2: 86% (25/29)



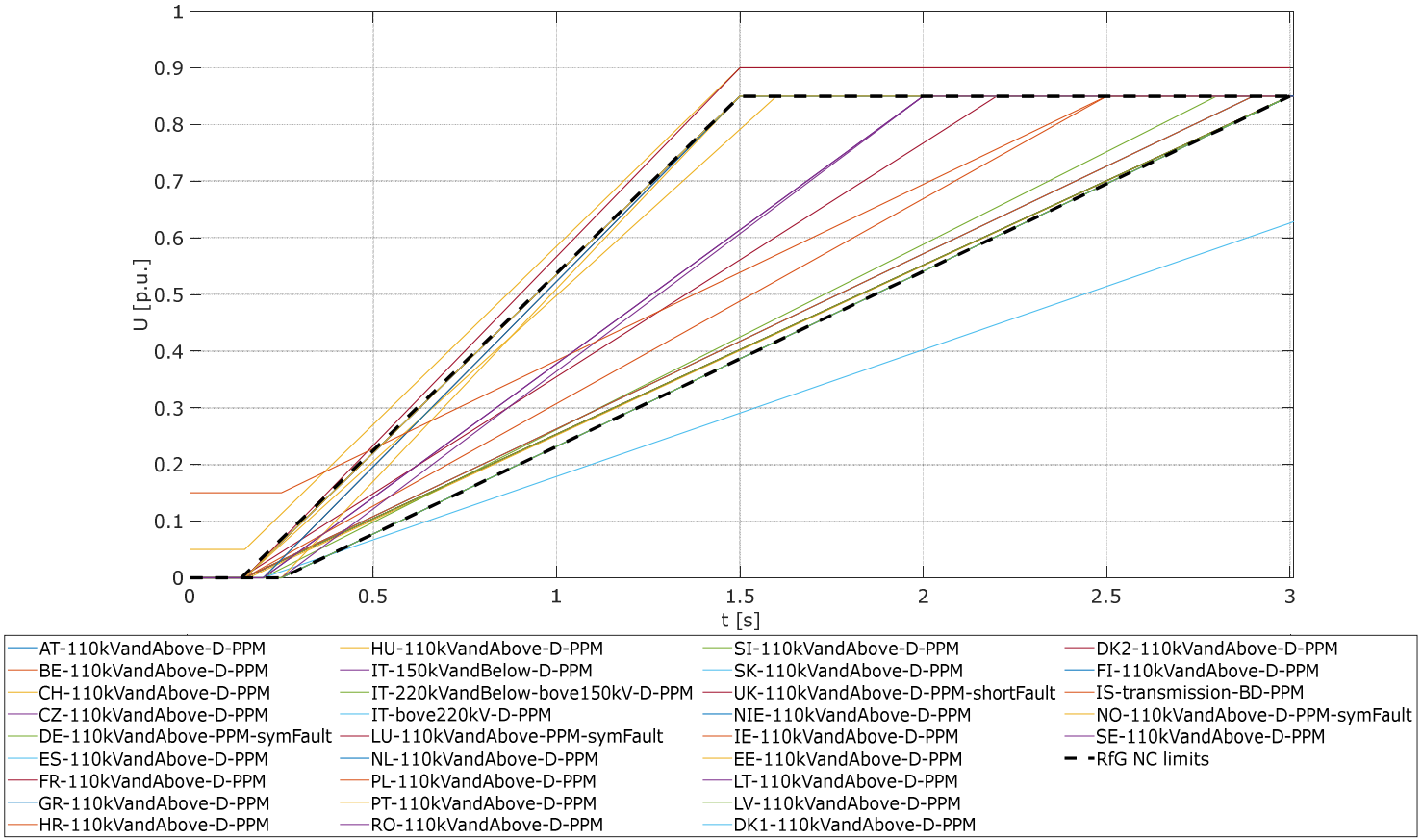
FRT capability within symmetrical faults at or above 110kV level (Type D only)

- RfG NC defines FRT profiles for SPGMs
  - Degree of convergence is 69% (20/29)



FRT capability within symmetrical faults at or above 110kV level (Type D only)

- RfG NC defines FRT profiles for PPMs
  - Degree of convergence is 86% (25/29)



Summary

Evaluated aspect (NC- RfG requirement)	Convergence [%]
Capacity threshold values for type B, C and D systems (<110 kV)	100
Resistance to frequency gradients (Rate of Change of Frequency – ROCOF; also considered for type A)	97
Frequency ranges and minimum periods of operation	97
Permissible reduction in the maximum active power output with decreasing frequency	100
Limited frequency dependent mode - overfrequency (LFSM-O) (Also considered for Type A)	72
Limited frequency dependent mode - underfrequency (LFSM-U)	93
Frequency dependent mode (FSM)	86
Full active power frequency response in FSM	90
Reactive power capacity at maximum capacity for SPGMs (type C and D)	79
Reactive power capacity at maximum capacity for PPMs (type C and D)	83

Evaluated aspect (NC- RfG requirement)	Convergence [%]
Reactive power capacity below the maximum capacity for PPMs (type C and D)	100
Power System Stabilizer (type D)	93
Voltage ranges and operating periods	95
FRT capability with symmetrical faults for the SPGMs of type B, C and D connected to the network below the 110 kV level	100
FRT capability for symmetrical faults for the SPGMs of type D connected to the network at or above the 110 kV level	69
FRT capability for symmetrical faults for the PPMs of type B, C and D connected to the network below the 110 kV level	97
FRT capability for symmetrical faults for the type D PPMs connected to the network at or above the 110 kV level	86
Information Exchange	83
Voltage related protection	41
Loss of angular stability protection	41
Reconnection/synchronization after disconnection	90

Summary - continued

Evaluated aspect (NC- RfG requirement)	Convergence [%]
Simulation requirements	79
Reactive Power Control Modes	100
Active Power Recovery after fault	97
Active power setpoint control	90
Active power ramp rate	97
Prioritization of the active power contribution or the reactive power contribution during fault events	55
Frequency Related Protection	34
Operation after Tripping to Houseload	100
Total number of requirements: 29	Average convergence level: 84

Type B, C and D Requirements (Non-mandatory)

Summary

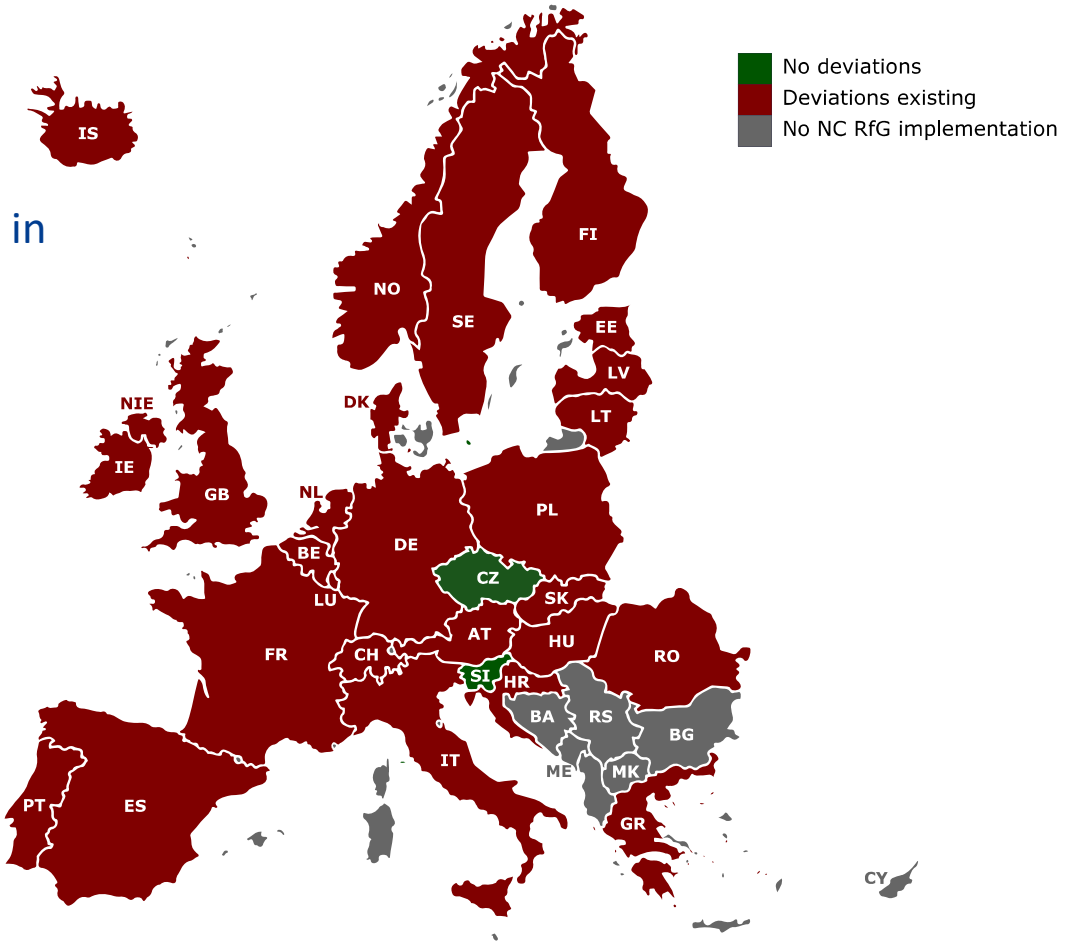
Evaluated aspect (NC- RfG requirement)	Incidence [%]
Synthetic Inertia provision by PPMs	59
Fast Fault Current Injection by PPMs	83
Black Start	62
Islanded Operation	66
Total number of requirements: 4	Average incidence level: 68

Summary

Evaluated aspect (NC- RfG requirement)	Incidence [%]
Voltages ranges and minimum operation periods (types B, C)	52
U-Q/Pmax for SPGMs on type B generators	59
U-Q/Pmax for PPMs on type B generators	66
P-Q/Pmax for SPGMs on type B generators	35
P-Q/Pmax for PPMs on type B generators	62
OVRT on types B,C,D	21
Additional reactive power control modes for type B, C, D PGMs	38
Total number of requirements: 7	Average incidence level: 48

Deviations in RfG NC implementations

- 27 countries in total have at least one deviation in their RfG NC implementation against the set framework for mandatory requirements
- Still high level of covergence among MS for mandatory requirements (84%)



Compliance verification by any of the 4 known methods!

Technical requirement	Compliance enforcement incidence level [%]	Comments
LFSM-O	62	
LFSM-U	59	
FSM	62	
Synthetic inertia	28	
Frequency restoration	45	
Reactive power capability	66	
P-setpoint	52	
ROCOF	14	Outside NC-RfG
Q(U)	45	
Q($\cos\varphi$)	35	
PSS	45	
Q setpoint	31	Outside NC-RfG
Constant U	14	Outside NC-RfG
Constant $\cos\varphi$	21	Outside NC-RfG
Q(P)	17	Outside NC-RfG
LVRT	69	
Fast fault current injection	48	
OVRT	10	Outside NC-RfG
Active power reduction during faults	14	Outside NC-RfG
Active power recovery	48	
Islanding operation	62	
Black start	45	
Tripping to house load	48	
Tests on interface protection system	24	Outside NC-RfG
Tests on power quality	31	Outside NC-RfG

Technical requirement	Compliance enforcement incidence level [%]	Comments
Connection and reconnection and P-gradient	28	Outside NC-RfG
Automatic reconnection	17	Outside NC-RfG
Quasi stationary operation of voltage and frequency	24	Outside NC-RfG
Active power reduction with falling frequency	14	Outside NC-RfG
Verification of the direct component of the output current	3	Outside NC-RfG
Generator parameters	10	Outside NC-RfG
Inertia constant	10	Outside NC-RfG
AVR response testing	21	Outside NC-RfG
Over/under excitation limiters	10	Outside NC-RfG
Turbine speed limiter / speed controller response	10	Outside NC-RfG
Information exchange with SCADA	17	Outside NC-RfG
Dynamic behavior of voltage regulation and stability in small movements	3	Outside NC-RfG
load stability	3	Outside NC-RfG
voltage withstand during frequency variation	10	Outside NC-RfG
protection system compatibility	3	Outside NC-RfG

- Convergence level for compliance on NC RfG requirements 51%
- Incidence level for compliance on additional requirements 15%

Convergences, incidences & missing links

1. High diversity for type definitions in terms of capacity thresholds –
   especially the threshold for type A/B varies with a factor of 150 (10 kW…1.5 MW)
2. High degree of convergence of in total 91% for type A specific RfG NC requirements;
   however: a lot of additional, national type A requirements are found, most of them originating from type B/C/D requirements. Here the convergene level drops down to 10%
   Note: a lot of these additional requirements are addressed by the EN 50549-1/2
3. A degree of convergence of in total 84% for mandatory type B/C/D requirements and 68% for the non-mandatory ones. A total of 27 MS+ show at least one deviation in the implementation of mandatory requirements. Again, many codes have included additional requirements for type B/C (mostly shifted down from type D, like Q provision), but also introduced new requirements like OVRT.
4. Compliance schemes are quite vague in most MS+. Only two MS+ have introduced comprehensive certification programmes.
5. Storage systems are addressed in two MS+ codes at all

A view on future Connection Codes

1. Capacity thresholds for type definitions A-D should be made more stringent to provide a more coherent scheme
2. National implementatios that exceed the ranges of RfG NC shall be catched in beforehand or clearly restricted to provide a coherent framework to all actors
3. Additional requirements introduced on national levels (like OVRT, Q-control etc) should be included within the framwork of RfG NC to increase the convergence among MS in future RfG NC implementations (especially with respect to type A PGM)
4. The EC may provide tenders for studies on the impact of additional requirements which can serve as basis for the future framework
5. Compliance requirements shall be extended in RfG NC to enhance single market concept -> Directly related to acceptance of a product in multilple MS
6. Battery storage systems should be made part of RfG NC

Thank you for your attention!

Implementation of the Network Code on Requirements for Grid Connection of Generators

Download study: https://op.europa.eu/en/publication-detail/-/publication/ee9ecda7-6788-11eb-aeb5-01aa75ed71a1/language-en?WT.mc_id=Searchresult&WT.ria_c=37085&WT.ria_f=3608&WT.ria_ev=search

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