Reactive Power Management and Voltage Control

First experts group session

Brussels, 25/02/2016

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Agenda

1. Context and Related network codes
2. Requirements for Generators
3. Demand Connection Code
4. Agenda next Experts Group meeting

* Reactive Power Management and Voltage Control (RPM & VC)

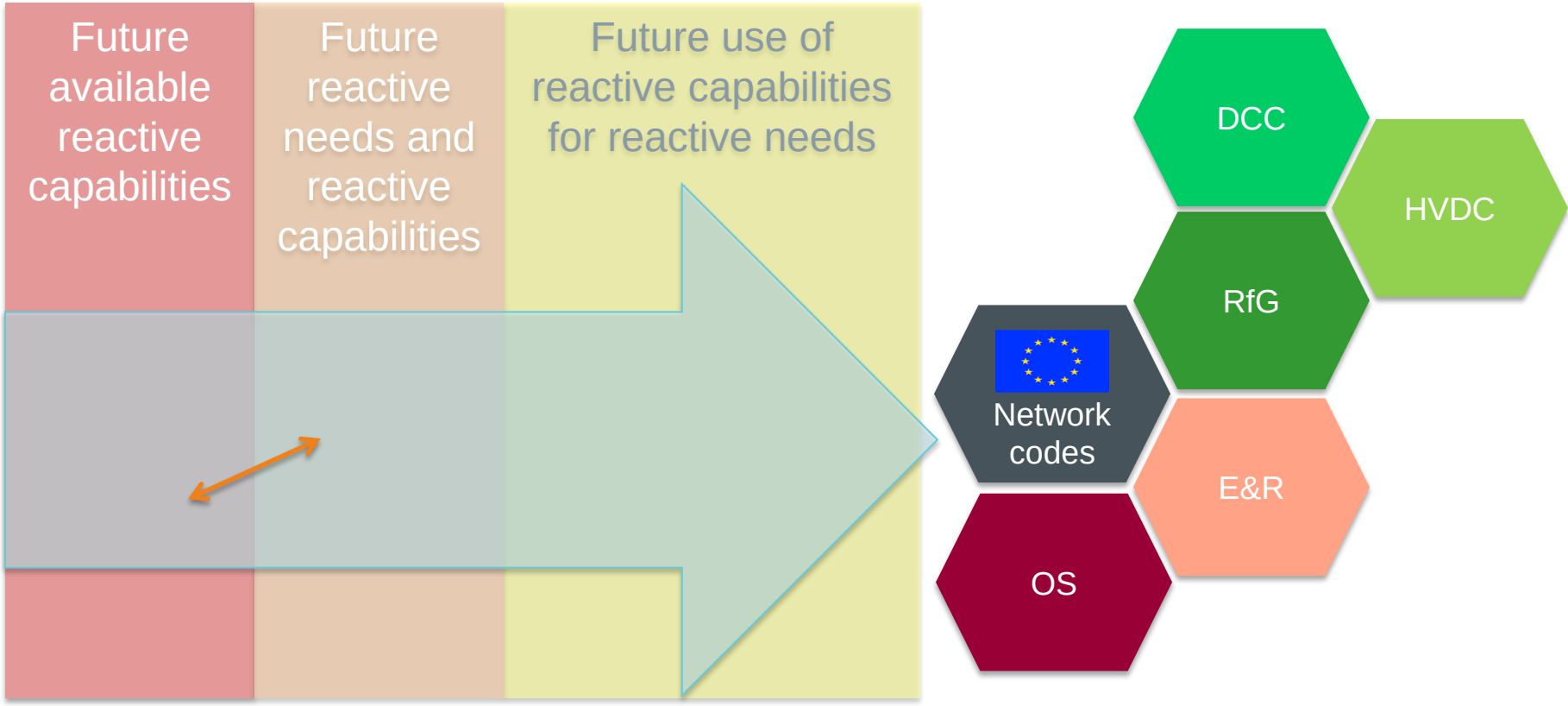
Context and Related network codes

Facing new challenges in RPM & VC

- Switch centralized production → decentralized production
  - moments with VERY LOW loading of TSO lines/cables AND almost NO centralized production (summer/interseason)
  - Reactive absorption needs ↑, while absorption capabilities ↓
- Higher interconnectivity with other TSO grids
  - Moments with VERY HIGH loading of lines/cables AND almost NO centralized production (winter/interseason)
  - Reactive injection needs ↑, while injection capabilities ↓

Reactive power management becomes 2 times more complex

Network Codes related to RPM & VC



RPM & VC is a shared responsibility

1. Comparison between FTR-C10/11 and NC RfG + first interpretation + detection of possible quick wins
   (Today's discussion)

2. See what additional possibilities this gives @ TSO-DSO level on short term and on long term
   (Synergrid study/Expert View)

3. Discussion of first results and on extra requirements for
   1. PGM owners (with FB on quick-wins)
   2. Demand facilities
   3. Distribution System Operators (DSOs + CDSOs)
   4. Transmission System Operators

   (Next Experts Groups)

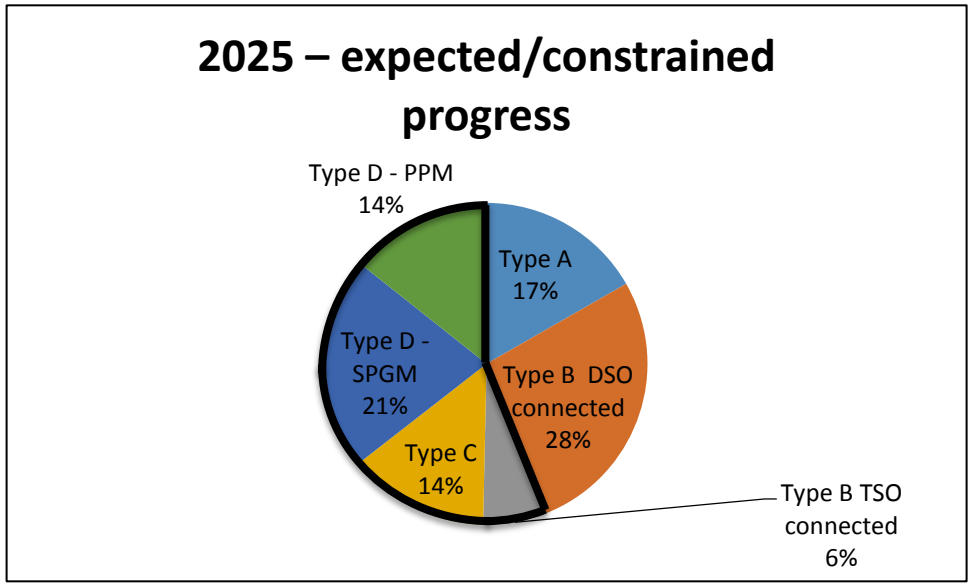
4. How to use the available reactive capabilities to ensure secure operation
   (Next Experts Groups)

Requirements for Generators

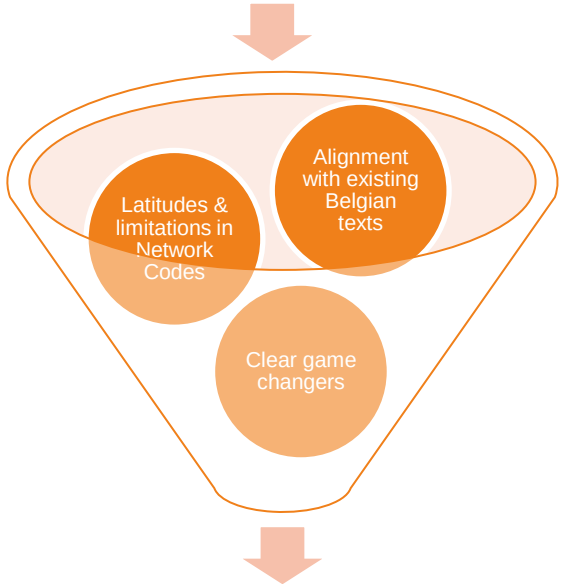
1. Hypotheses
2. “As Is” (FTR/RTF and C10/11)
3. “To Be” (NC RfG)
4. Interpretation & Implementation Goal

Approach

- **Hypothesis:** A/B/C/D classification start point as discussed in previous Experts Groups
- **FTR/RTF vs NC RfG**
- **Interpretation/Goal**
- **Action points**



Iterative process (expected end 2016)



Draft thresholds for BE-implementation of Network Codes

Topics for BE-implementation of Network Codes (Frequency, **Voltage**, Information Exchanges, …)

Type A

Hypothesis $P_{installed}$		FTR/RTF	C10/11	NC RfG		Interpretation/Goal	
				SPGM	PPM	SPGM	PPM
800W - 250kW	Voltage stability	Defined by ΔV-frequency profile (-7.5% to +7.5% @ generator terminal)	Must be capable to permanently operate at U+/- 10% (at connection point)	Nothing specified		general Synergrid requirements (reference: standards)	
	Reactive power capabilities	Nothing specified → to be discussed with SO	Cos φ >0,95	Nothing specified		general Synergrid requirements, based on realistic capabilities (reference: standards)	
	Voltage/reactive power control	• At least 2 set points (agreement between owner and SO) • Specific requirements on Qref control (fast-slow)	Nothing specified	Nothing specified		general Synergrid requirements (reference: standards)	

Action points:

Shall be included in next Synergrid C10/11
Goal: enlarge RPM & VC possibilities in DS

Type B

Hypothesis $P_{installed}$		FTR/RTF	C10/11	NC RfG		Interpretation/Goal	
				SPGM	PPM	SPGM	PPM
250kW – 25MW	Voltage stability	As in type A	Must be capable to permanently operate at U+/- 10% (at connection point)	Nothing specified		• TSO grid user: specified by TSO • DSO grid user: general Synergrid requirements (reference: standards)	
	Reactive power capabilities	→ to be discussed with SO	> 1MVA: Q-capability range -0,1 Pnom … 0,33 Pnom	To be specified by the relevant SO		• TSO grid user: specified by TSO • DSO grid user: general Synergrid requirements (reference: standards)	
	Voltage/ reactive power control	• At least 2 set points (agreement between owner and SO) • Specific requirements on Q_{ref} control (fast-slow)	> 1MVA: multiple setpoints (Q or cos phi) possible > 2,5 MVA: Real time tele-operation possible, for more dynamic voltage control	Constant V (alternator terminal) @ a selectable set point over the entire operation range	Nothing specified	TSO grid user: Constant V (alternator terminal) @ a selectable set point over the entire operation range DSO grid user: Dynamic Q- or cosphi setpoint (remote control above given kVA threshold)	

Action points:

Shall be included in next Synergrid C10/11
Goal: enlarge RPM & VC possibilities in DS

Type C

Hypothesis $P_{installed}$		FTR/RTF	NC RfG		Interpretation/Goal	
			SPGM	PPM	SPGM	PPM
25MW – 75MW	Voltage stability	As in type B	• Auto disconnection for V-levels (SO specified) • Terms and settings (SO/TSO specified)		• Auto disconnection for V-levels (SO specified) • Terms and settings (SO/TSO specified)	

	Reactive power capabilities	-10% and +45% of P_{nom} (for each voltage between 0.9 and 1.05 $V_{expl.}$)	• SO specifies compensation for HV lines or cables
			• @ max. capacity:
			  • SO/TSO specifies U-Q/Pmax-profile (SO/TSO specified)
			  • Within specific boundaries (Q/Pmax=0.95)
			  • @ connection point
			  • Capable of moving to any point in U-Q/Pmax
			• Below max. capacity: capable of operating @ every point in PQ-diagram of the alternator
				• SO specifies compensation for HV lines or cables
				• @ max. capacity:
				  • SO/TSO specifies U-Q/Pmax-profile (SO/TSO specified)
				  • Within specific boundaries (Q/Pmax=0.75)
				  • @ connection point
				  • Capable of moving to any point in U-Q/Pmax
				• Below max. capacity:
				  • SO/TSO specifies P-Q/Pmax profile
				  • Within specific boundaries
				  • Capable of moving to any point in P-Q/Pmax
					• Compensation of the no-load-losses
					• Make the U-Q/Pmax-profile more symmetric:
					  • To solve future problems for RPM & VC
					  • To align more with the available technology (e.g. rotated frame)
						• Compensation of the no-load-losses
						• Make the U-Q/Pmax-profile more symmetric:
						  • To solve future problems for RPM & VC
						  • To align more with the available technology

Goal: symmetrize reactive power capabilities by win-win

Type C

Hypothesis $P_{installed}$		FTR/RTF	NC RfG		Interpretation/Goal	
			SPGM	PPM	SPGM	PPM
25MW – 75MW	Voltage/ reactive power control	• Capability to adapt Q on demand of SO (AVR - voltage @ connection point with selectable constant droop) • Equipped with OEL, UEL and PSS • Auto Q_{net} adaptation so that relative sensitivity coefficient is within 18 and 25	As in type B	Specific requirements on reactive power control modes: • V-control • Q-control • cos phi control	automatic voltage regulation within U-Q/Pmax profile (i.e AVR + OEL, UEL, PSS) → voltage @ connection point with selectable constant droop	No position yet
	Priority between active or reactive power	Nothing specified	Nothing specified	Specified by the relevant TSO	Nothing specified	Specified by the relevant TSO

Keep control possibilities

Action points?

To be discussed

Type D

Hypothesis $P_{installed}$		FTR/RTF	NC RfG		Interpretation/Goal	
			SPGM	PPM	SPGM	PPM
≥ 75MW	Voltage stability	As in type C	As in type C	As in type C	As in type C	As in type C
	Reactive power capabilities	As in type C	As in type C	As in type C	As in type C	As in type C
	Voltage/reactive power control	As in type C	• As in type C • Parameters and settings of V-control system (AVR) agreed between SO and owner in coordination by TSO, containing BW limitation, UEL, OEL, PSS and stator current limiter	As in type C	automatic voltage regulation within U-Q/Pmax profile (i.e AVR + OEL, UEL, PSS) → voltage @ connection point with selectable constant droop	No position yet
	Priority between active or reactive power	-	As in type C	As in type C	As in type C	As in type C

To be discussed

Belgian completion

- NC RfG: art. 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24 & 25
- NC RfG specifies only the requirements, doesn't indicate how this requirements should be used operationally and doesn't specify how ancillary services should be rewarded
- FTR/RTF & C10/11 requirements are a minimum on top of the minimal requirements set by the NC RfG.
- **Goal**:
  - **Symmetrize the reactive power capabilities** if technical possibilities allow to and without expensive additional cost
  - **Enlarge reactive power control possibilities** if technical possibilities allow to especially on distribution system connected PGMs

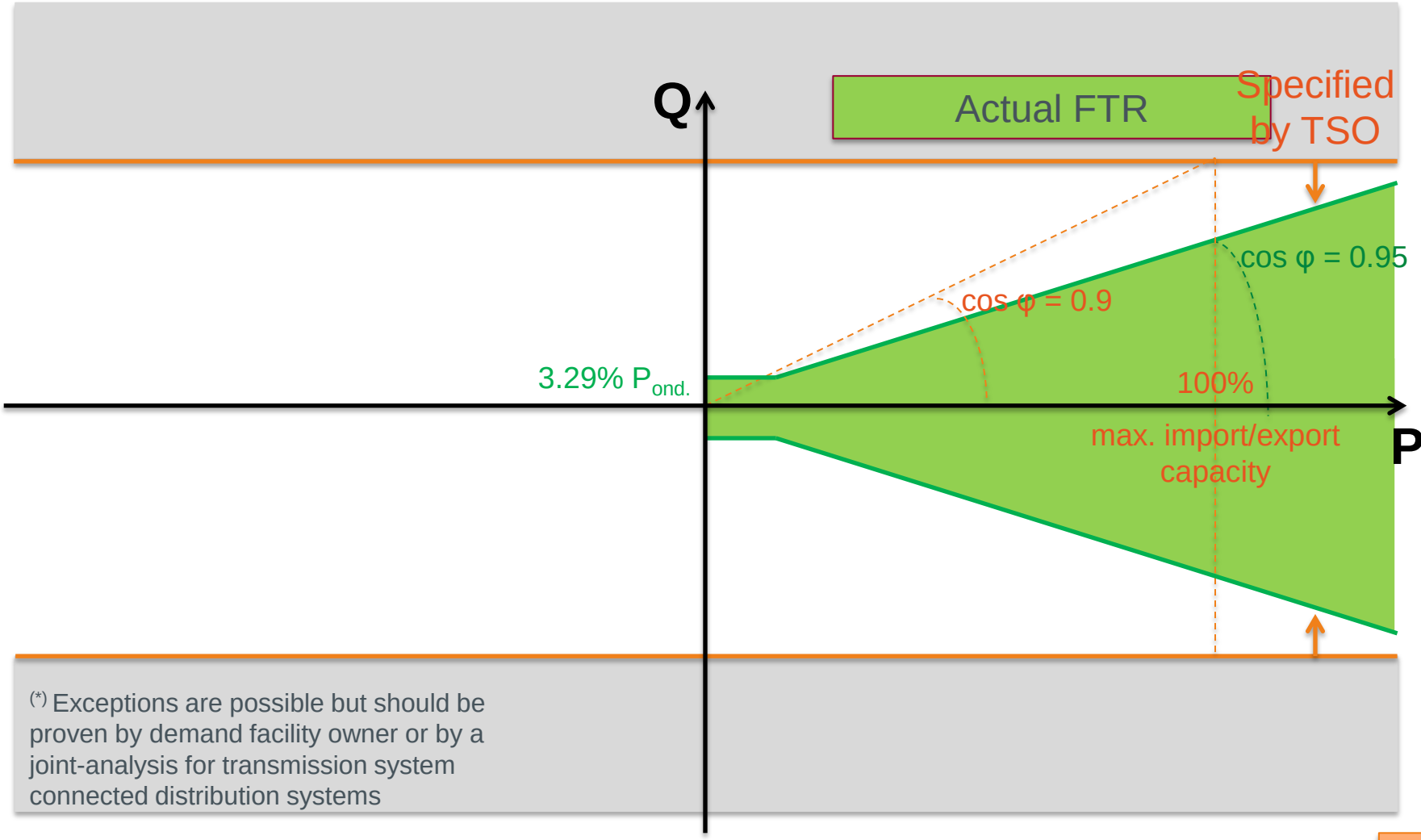
Demand Connection Code

1. Hypotheses
2. “As Is” (FTR/RTF)
3. “To Be” (NC DCC)
4. Interpretation & Implementation Goal

NC DCC

	Hypothesis	FTR/RTF	NC DCC	Interpretation /Goal
Transmission grid connected demand facilities		• No specific requirements • The demand facility owner has the right to have a reactive load (cap. or ind.) of 32.90% Pload for each time interval (min. 3.29% $P_{onderschreven}$) → cos φ 0.95	• Reactive power range specified by TSO is not larger than 48% of the larger of the maximum import/export capacity → cos φ 0.9 exception: techno-economical optimization to be proven by **demand facility owner** • @ connection point	No position yet
Transmission grid connected distribution systems	Possibilities on generators as determined by RfG	• No specific requirements • The demand facility owner has the right to have a reactive load (cap. or ind.) of 32.90% Pload for each time interval (min. 3.29% $P_{onderschreven}$) → cos φ 0.95	• Reactive power range specified by TSO is not larger than 48% of the larger of the maximum import/export capacity → cos φ 0.9 exception: techno-economical optimization to be proven by **joint analysis** • @ connection point • TSO may require the capability to not export Q when P ≤ 25% → should been justified by a **joint analysis** • TSO may require to actively control Q. Control method shall been agreed between TSO and DSO.	Joint analysis to be started with relevant Distribution System Operators (DSOs, CDSOs)

NC DCC – art 15.1



Belgian completion

- NC DCC: art. 15
- NC DCC specifies only the requirements, doesn't indicate how this requirements should be used operationally and doesn't specify how tariffs should be set.
- FTR/RTF requirements as a start point
- Joint analysis in Synergrid to determine requirements with DSOs
- Joint analysis with relevant CDS Operators to determine requirements for CDS
- Goal: reduce reactive power requirements by demand facilities and to enlarge reactive power control capabilities of distribution systems and demand facilities

Agenda Experts Group April 2016

Agenda Experts Group April 2016

- NC RfG
  - Follow-up action points
  - First proposal of NC RfG Belgian completion
- NC DCC
  - Follow-up action points
  - First results on high-level joint-analyses
- NC OS
  - Overview of NC OS articles related to RPM & VC

Thank you for your attention!

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