

# Session 2

Mitigation possibilities for power quality and operational issues in relation to RE integration in distribution networks



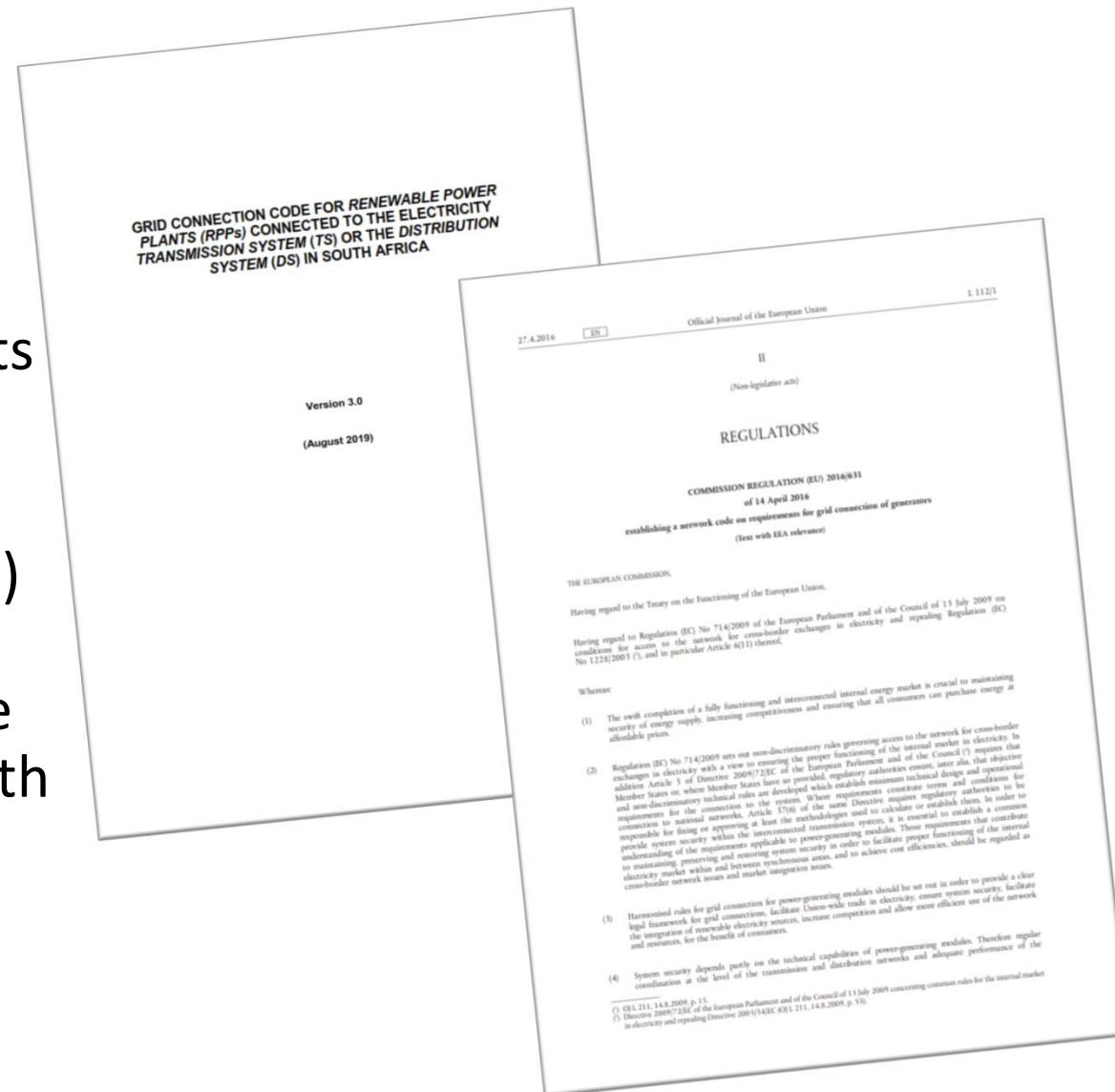
# Agenda for Session 2

- Grid codes
- Examples of operational issues faced by ESKOM
- Solutions
- Grid code requirement in relation to operational issues



# Grid code

- Network Code on Requirements for Generators (RfG)
- Grid connection code for Renewable power plants (RPPs) connected to the electricity transmission system (TS) or the distribution system (DS) in South Africa



# Grid code - RfG and national implementations



Figure 1 Categorization of requirements in RfG

Fully defined

Requiring further  
specifications at  
national level

# Grid code – Threshold values

Synchronous Area	Upper threshold limit [MW] (South Africa [MVA])		
	A B	B C	C D
Continental Europe	1 MW	50 MW	75 MW
Great Britain	1 MW	50 MW	75 MW
Nordic	1.5 MW	10 MW	30 MW
Ireland and Northern Ireland	0.1 MW	5 MW	10 MW
Baltic	0.5 MW	10 MW	15 MW
South Africa	1 MVA	20 MVA	-
Category A	Upper threshold limit [kVA]		
	A1 A2	A2 A3	
South Africa	13.8 kVA	100 kVA	

Regardless of capacity, cat. D if  $\geq 110\text{kV}$

Must not exceed difference in installed capacity between phases of 4.6 kVA per phase

# Grid code – scope of the grid codes

Table 2. RfG requirements for PPM, per type. [1]

Requirement	Type			
	A	B	C	D
Frequency ranges	X	X	X	X
Limited frequency sensitive mode (overfrequency), LFSM-O	X	X	X	X
Rate of change of frequency withstand capability	X	X	X	X
Constant output at target active power	X	X	X	X
Maximum power reduction at underfrequency	X	X	X	X
Automatic connection	X	X	X	X
Remote switch on/off	X	X		
Active power reduction		X		
Active power controllability and control range			X	X
Disconnection of load due to underfrequency			X	X
Frequency restoration control			X	X
Frequency sensitive mode			X	X
Limited frequency sensitive mode (underfrequency), LFSM-U			X	X
Monitoring of frequency response			X	X
Synthetic inertia capability			X	X

General System Management	Control schemes and settings		X	X	X
	Information exchange		X	X	X
	Priority ranking of protection and control		X	X	X
	Transformer neutr-point treatment			X	X
	Electrical protection schemes and settings		X	X	X
	Installation of devices for system operation and/ or security			X	X
	Instrumentation for fault and dynamic behavior recording			X	X
	Loss of stability			X	X
	Rate of change of active power			X	X
	Simulation models			X	X
	Synchronisation			X	X

System Restoration	Auto reclosures			X	X
	Steady-state stability			X	X
	Reconnection after an incidental disconnection due to a network disturbance	X		X	X
	Black start			X	X
	Capability to take part in isolated network operation			X	X
	Quick re-synchronisation			X	X
Robustness	Post fault active power recovery		X	X	X
	Fault ride through capability of power park modules connected below 110 kV		X	X	
	Fault ride through capability of power park modules connected at 110 kV or above				X

Voltage Stability	Reactive current injection			X	X	X
	Reactive power capability (simple)			X		
	Priority to active or reactive power contribution				X	X
	Reactive power capability at maximum active power				X	X
	Reactive power capability below maximum active power				X	X
	Reactive power control modes				X	X
	Power oscillations damping control				X	X
	High/low voltage disconnection				X	
	Voltage ranges					X

# Grid code – scope of the grid codes

- a)** For Type A (with a maximum capacity between 0.8 kW and the A|B threshold, connected <110 kV) the main objective of the requirements is to ensure stable operation within certain frequency ranges, with only minimum requirements for automated system response or system operator control.
- b)** For Type B (ranging between the A|B and B|C thresholds, connected <110 kV) the requirements include extended resilience to external events and also some dynamic response and basic operation control.
- c)** For Type C (ranging between B|C and C|D threshold, connected <110 kV) most requirements of the RfG apply which, beyond the requirements for type A and type B, also include a higher level of controllability and dynamic response in order to provide ancillary services.
- d)** For Type D (ranging above C|D threshold or connected >110 kV) requirements are added or modified with respect to the higher voltage levels

# Proof of compliance

Table 3. Minimum requirements for compliance testing and simulations according to RfG (excluding features applicable to only synchronous PGMs). [7]

Features	Min. requirements for testing (T) and simulation (S)			
	B	C	D	Offshore
LFSM-O	T+S	T+S	T+S	T
LFSM-U		T+S	T+S	T
FSM		T+S	T+S	T
Reactive Power Capability		T+S	T+S	
Frequency Restoration		T	T	T
Voltage Control Mode		T	T	T
Reactive Power Control Mode		T	T	T
Power Factor Control Mode		T	T	T
Active Power Controllability		T	T	T
FRT	S	S	S	
Post-Fault Active Power Recovery	S	S	S	S
Fast Fault Current Injection	S	S	S	S
Island Operation		S	S	S
Power Oscillation Damping Control	S	S	S	S
Synthetic Inertia		S	S	S

## SA grid code for RPPs

- compliance to all applicable requirements
- conducting mandatory tests or studies
- continuously monitoring of the compliance
- submit a detailed test procedure
- keeping records



# Operational issues

- Issues faced by ESKOM
- Identification of the issues in the PF model
- Mitigation solutions
- Grid code
- Existing power plants

High voltages in a network due to un-normal switching status (N-1 situation) in combination with low load and weak grid and its impact on RE generation

Overload of a substation transformer due to unusually high generation from a RE

# Operational issues

