EUTurbines
RoCoF amendment - SPGMs constraints

Online

16 March 2023

Topics

1. Sum-up of the discussions
2. ROCOF containment as common target in CNCs
3. Conclusion

Status of…

…since last GC ESC in 2022

- 2 x multilateral web conferences with Eurelectric, VGBE and ENTSOE
- Presentation of technology physical constraints for big units which cannot be overridden, mainly:
  - Risk of loss of synchronism when considering certain generator and grid conditions (SCP),
  - Risk of severe damages for high RoCoF value
- Presentation of result of simulation studies
- Definition of possible way forward… expected next follow up meeting with ENTSOE, VGBE, Eurelectric and ACER

Sum-up of discussions

EUTurbines presented the results of extensive studies:

- Studies are focused primarily of RoCoF values and use RoCoF values/profiles as stated by TSOs (focusing first on the 2Hz/s profiles included in the IGD and the values proposed by ENTSOE as an amendment proposal)
- Grid characteristics used for the studies are based on a very wide range of SCP (Short Circuit Powers) provided by various TSOs
- The studies based on this wide range of SCPs show that RoCoF values for generating units with big inertia could not exceed 1Hz/s during 500ms, if the machine is expected to remain connected to the Grid
- The findings are in line with the conclusion of the KEMA-DNV report “RoCoF - An independent analysis on the ability of Generators to ride through Rate of Change of Frequency values up to 2Hz/s”
- For big generating units the way RoCoF requirements need improvement
- RoCoF requirements also cannot be considered the same for high inertia generating unit/grid areas and low inertia generating unit/grid areas

Sum-up of discussions

Grid SCP and FRT

- Short Circuit Power (SCP) grid characteristic is being discussed:
  - Certain TSOs commented that assumptions considered for simulations were not realistic: “too low SCP values for which the units would not comply with requirements for Fault-Ride-Through (FRT)”
  - On the other hand, others commented that EUTurbines assumptions were realistic to them, and emphasized the very likely erosion of SCP in the grids in the future
  - SCPs considered by EUTurbines for the studies so far are based on real values provided by various TSOs in Europe (in ‘connection agreements’) during tendering and execution stages of real projects
  - Reference to German SCP requirements rule (SCP = 6 times the generating unit active rated power) does not seem to be achievable, as per EUTurbines simulation results shared during the last ENTSOE call.
  - EUTurbines is open to perform additional simulations based on SCP values provided by ENTSOE.
- The big inertia of the large turbogenerator units is the reason why ROCOF values beyond 1Hz/s cannot be handled without disconnection from the grid. Indeed, simulations show clearly that, due to the very high kinetic energy (MWs values) stored in these shaft-lines, more severe assumptions would result in pole slips in many operating conditions
- ROCOF containment is considered top-priority element for the power quality of the system. It is a must-have for frequency stability, therefore lower ROCOF value than 2Hz/s is highly desirable
- Big Generating units are key elements for the stability of the system. Indeed, it is their inertia that prevents higher RoCoF values!
- The physical features of these big turbogenerator units shall be considered when defining requirements applying to this type of units

Sum-up of discussions

AVR contribution

- It was commented that the AVR contribution has been neglected in EUTurbines simulations
- It was estimated that AVR parameters optimization would only provide very limited to no contribution in improving the RoCoF withstand capability
- The contribution of the AVR is discussed also in below IEEE report and KEMA report, which both are in line with EUTurbines approach

IEEE Power & Energy Society
Report on Coordination of Grid Codes and Generator Standards: Consequences of Diverse Grid Code Requirements on Synchronous Machine Design and Standards

DNV KEMA
RoCoF
An independent analysis on the ability of Generators to ride through Rate of Change of Frequency values up to 2Hz/S

Sum-up of discussions

EUTurbines requested that ENTSOE:

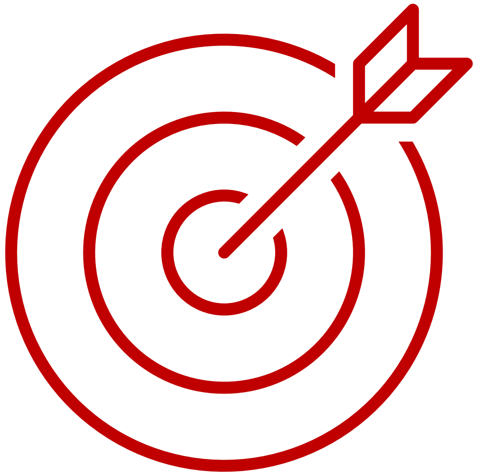
- Present the status of countermeasures for RoCoF containment (already requested in all previous requests)
- To study real RoCoF values associated with big generating units or in general for units with inertia, and not as a general average value for all technologies

As yet, ENTSOE has not presented any documentation in response to these requests

EUTurbines highlighted the very high cost of providing ‘synthetic inertia’ with Power Electronic converters, when compared to inertia provided with mechanical rotating masses (refer to paper “A1-102_The benefits of implementing Synchronous Compensators in grids with high penetration of Renewables”).

Next Steps

- Follow up on technical discussion (including ENTSOE expected actions)
- Presentation of possible way forward (text amendment proposals); derogation proposal is not desirable, but clear exception proposal could be considered as alternative
- EUTurbines considers that the text proposed and graphs cannot be acceptable (not only by big generating units) in the way they are expressed, among other comments:
  - The graph proposed is not consistent with a real RoCoF behaviour nor with the ROCOF requirement proposed
  - The frequency in the graph shown in ENTSOE amendment proposal exceeds the generating unit permitted values in European standard; therefore this is not technically acceptable



RoCoF containment as common target in CNCs

Requirement for Generators Regulation (2016/631), Recitals

(25) Synchronous power-generating modules have an inherent capability to resist or slow down frequency deviations, a characteristic which many RES technologies do not have. Therefore countermeasures should be adopted, to avoid a larger rate of change of frequency during high RES production. Synthetic inertia could facilitate further expansion of RES, which do not naturally contribute to inertia.

ROCOF containment as common target in CNCs

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System Operation Guideline

Article 38

Dynamic stability monitoring and assessment

1. Each TSO shall monitor the dynamic stability of the transmission system by studies conducted offline in accordance with paragraph 6. Each TSO shall exchange the relevant data for monitoring the dynamic stability of the transmission system with the other TSOs of its synchronous area.

2. Each TSO shall perform a dynamic stability assessment at least once a year to identify the stability limits and possible stability problems in its transmission system. All TSOs of each synchronous area shall coordinate the dynamic stability assessments, which shall cover all or parts of the synchronous area.

3. When performing coordinated dynamic stability assessments, concerned TSOs shall determine:

a) The scope of the coordinated dynamic stability assessment, at least in terms of a common grid model;
b) The set of data to be exchanged between concerned TSOs in order to perform the coordinated dynamic stability assessment;
c) A list of commonly agreed scenarios concerning the coordinated dynamic stability assessment; and
d) A list of commonly agreed contingencies or disturbances whose impact shall be assessed through the coordinated dynamic stability assessment.

4. In case of stability problems due to poorly damped inter-area oscillations affecting several TSOs within a synchronous area, each TSO shall participate in a coordinated dynamic stability assessment at the synchronous area level as soon as practicable and provide the data necessary for that assessment. Such assessment shall be initiated and conducted by the concerned TSOs or by ENTSO for Electricity.

ROCOF containment as common target in CNCs

System Operation Guideline

Article 41
Structural and forecast data exchange

1. To coordinate the dynamic stability assessments pursuant to Article 38(2) and (4), and to carry them out, each TSO shall exchange with the other TSOs of the same synchronous area or of its relevant part of the following data:

a) Data concerning SGUs which are the power generating modules relating to, but not limited to:
   i. Electrical parameters of the alternator suitable for the dynamic stability assessment, **including total inertia**;
   ii. Protection models;
   iii. Alternator and prime mover;

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ROCOF containment as common target in CNCs

System Operation Guideline

Article39

Dynamic stability management

1. Where the dynamic stability assessment indicates that there is a violation of stability limits, the TSOs in whose control area the violation has appeared shall design, prepare and activate remedial actions to keep the transmission system stable. Those remedial actions may involve SGUs.

2. Each TSO shall ensure that the fault clearing times for faults that may lead to wide area state transmission system instability are shorter than the critical fault clearing time calculated by the TSO in its dynamic stability assessment carried out in accordance with Article 38.

3. In relation to the requirements on minimum inertia which are relevant for frequency stability at the synchronous area level:

a) all TSOs of that synchronous area shall conduct, not later than 2 years after entry into force of this Regulation, a common study per synchronous area to identify whether the minimum required inertia needs to be established, taking into account the costs and benefits as well as potential alternatives. All TSOs shall notify their studies to their regulatory authorities. All TSOs shall conduct a periodic review and shall update those studies every 2 years;

b) where the studies referred to in point (a) demonstrate the need to define minimum required inertia, all TSOs from the concerned synchronous area shall jointly develop a methodology for the definition of minimum inertia required to maintain operational security and to prevent violation of stability limits. That methodology shall respect the principles of efficiency and proportionality, be developed within 6 months after the completion of the studies referred to in point (a) and shall be updated within 6 months after the studies are updated and become available; and

c) each TSO shall deploy in real-time operation the minimum inertia in its own control area, according to the methodology defined and the results obtained in accordance with paragraph (b)

ROCOF containment as common target in CNCs

System Operation Guideline

Article 139

Basic structure

1. All TSOs of each synchronous area shall specify the load-frequency-control structure for the synchronous area in the synchronous area operational agreement. Each TSO shall be responsible for implementing the load-frequency-control structure of its synchronous area and operating in accordance with it.

2. The load-frequency control structure of each synchronous area shall include:

a) a process activation structure in accordance with Article 140; and

b) a process responsibility structure in accordance with Article 141.

Article 141

Process responsibility structure

1. When specifying the process responsibility structure, all TSOs of each synchronous area shall take into account at least the following criteria:

a) the size and the **total inertia**, including synthetic inertia, of the synchronous area;

b) the grid structure and/or network topology; and

c) the load, generation and HVDC behaviour.

ROCOF containment as common target in CNCs

Emergency & Restoration Code Guideline

Article 15
Automatic under-frequency control scheme

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7. When implementing the scheme for the automatic low frequency demand disconnection pursuant to the notification under Article 12(2), each TSO or DSO shall:

a) avoid setting an intentional time delay in addition to the operating time of the relays and circuit breakers;
b) minimise the disconnection of power generating modules, especially those **providing inertia**; and
c) limit the risk that the scheme leads to power flow deviations and voltage deviations outside operational security limits.

Conclusion

RoCoF - a shared burden

EUTurbines expects a continuous involvement on the topic with who is defining requirements and countermeasures

EUTurbines expects that the team working in defining requirements is in more close contact and is coordinating activities with the team dealing with system operation and inertia countermeasure

EUTurbines is available and willing to cooperate in initiatives and studies on these critical technical topics by providing technical inputs and expertise as needed

Big Generating units are key elements to the stability of the system