

Report from the Expert Group 'Requirements for Pump-Storage Hydro modules' (EG PSH)

Ralph Pfeiffer, Chair of EG PSH

14th Grid Connection European Stakeholder
Committee Meeting

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EG PSH structure



Expert group: Requirements for pump-storage hydro power generation modules (EG PSH)

Approved by the GC ESC on September 14, 2018
Subject to possible updates on the list of members

Chair: ENTSO-E, Ralph Pfeiffer
Vice-Chair: VGB, Klaus Oberhauser

Problem Statement

On 11 June 2018, the Grid Connection European Stakeholder Committee (GC ESC) has decided to establish an expert group on requirements for pump-storage hydro modules (PSH). The creation of this EG was proposed by ENTSO-E to elaborate on connection network code (CNC) issues, which had been raised by stakeholders during the CNC implementation. The ENTSO-E proposal was based on a stakeholder survey to identify priority topics.

Target (objectives)

The objective of the EG PSH is to identify specific characteristics / constraints for this kind of Power Generating Module (PGM) for each operation mode (generation, pumping, synchronous compensation), which may have impact on the connection requirements as defined by Commission Regulation (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators (NC RfG).

Legislative background

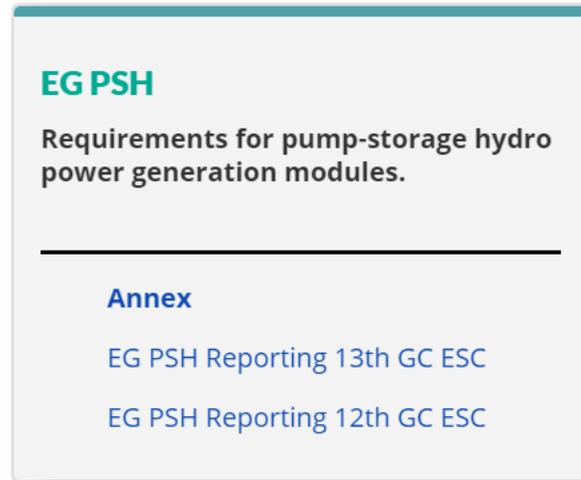
NC RfG, Article 6(2) foresees that: "Pump-storage power-generating modules shall fulfil all the relevant requirements in both generating and pumping operation mode. Synchronous compensation operation of pump-storage power-generating modules shall not be limited in time by the technical design of power-generating modules. Pump-storage variable speed power-generating modules shall fulfil the requirements applicable to synchronous power-generating modules as well as those set out in point (b) of Article 20(2), if they qualify as type B, C or D."

Task description

- Discussions with stakeholders / responses received during consultations / stakeholder interventions at the GC ESC / in workshops have revealed that this provision is probably too generic and in its generality lead to requests for derogations or compliance issues. In particular, a better distinction of the applicability of the RfG requirements in the different operation modes (generating, pumping, synchronous compensation) and different types of pump storage facilities needs to be investigated;
- Challenges in complying with the NC RfG requirements shall be identified separately for each operation mode and, if applicable, technology-dependent (e.g. specific peculiarities of variable speed pumps);
- Clarifications shall be provided on technical capabilities of these PGMs to be able to comply with operational requirements from SO GL and NC ER; and

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Public space



Final EG meetings since last GC ESC meeting

- 25 April 2019, webinar
- 24 May 2019, webinar

Internal EG space

EG PSH

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All Documents

Find a file

- archive (non-exhaustive)
- Kick-off meeting_181015
- meeting_190319_Brussels
- Report
- ToR and Annex
- webinar_181113
- webinar_181210
- webinar_190118
- webinar_190207
- webinar_190315
- 180914_GC ESC_EG PSH_notes from preparatory call
- 190118 EG PSH draft table of requirements
- EG PSH reporting_12th GC ESC
- EG PSH_contact list
- READ ME

Evaluation of RfG requirements for PSH modules

The Expert Group continued working on the template with RfG requirements that was created to assess better the capabilities of the different technologies. The table provides a useful overview but no explanations.

- The different PSH technologies that were considered and analyzed are:
 - Fixed speed pump turbine
 - Single shaft ternary
 - Variable speed pump turbine (doubly-fed induction machine)
 - Variable speed pump turbine (full converter)
- All technologies have been assessed in three operating modes:
 - Generation mode
 - Pump mode
 - Synchronous compensation mode
- The requirements that all technologies in all operating modes were assessed against were:
 - Frequency requirements
 - Voltage requirements
 - System restoration & system robustness requirements
 - Instrumentation and protection

Final report of EG PSH

- The Expert Group, in line with the recommendation of the GC ESC, has drafted a report to be delivered together with the table of requirements
- The objective of the report is to document clearly the specific characteristics or constraints of PSH power generating modules for each operating mode and the consequences on connection requirements.
- The report enters into more details, clarifying the inputs in the table of the requirements – in general the ones that exclude the compliance with the requirements or meet the requirement conditionally
- The report concludes with recommendations and also highlights observations that are considered to be relevant for amending NC RfG or when it comes to capabilities and limitations of the PSH technologies when applying the current network code



Conclusions/Recommendations (I)

- PSH with fixed speed pumps and single shaft ternary machines shall be considered as synchronous power generating modules.
- PSH with variable speed pumps (DFIM or full converter) shall be considered as power park modules by principle, however limitations may apply to the FRT capability, where the application of the voltage-against-time profile for synchronous power generating modules shall be considered for mitigation.
- Pump Storage Hydro power generating modules can largely meet the RfG technical requirements in turbine operation mode irrespective of the generation technology.
- Larger restrictions apply in pumping operating mode, if active power output cannot be regulated
 - Fixed speed pumps cannot contribute to most requirements related to frequency stability
 - Ternary machines can partly contribute, but not, if only pumps are operated
 - Variable speed pumps can contribute, but typically only in a range of 70 – 100% active power capacity
- In synchronous compensation mode all generation technologies are largely able to meet the NC RfG requirements related to voltage stability. Most of the other requirements do not apply then.

Conclusions/Recommendations (II)

- NC RfG, Article 6(2) currently defines:
Pump-storage power-generating modules shall fulfil all the relevant requirements in both generating and pumping operation mode. Synchronous compensation operation of pump-storage power-generating modules shall not be limited in time by the technical design of power-generating modules. Pump-storage variable speed power-generating modules shall fulfil the requirements applicable to synchronous power-generating modules as well as those set out in point (b) of Article 20(2), if they qualify as type B, C or D.
- **The request for fulfilling all relevant requirements in both generating and pumping mode is not feasible in its generality.**
- It is recommended to distinguish better between the different operation modes and to state explicitly which requirements shall apply in each mode **emphasizing the limitations in pumping mode.**
- The principle classification of PSH with variable speed pumps (DFIM or full converter) shall be switched from synchronous power generating module to power park module with an exemption of the voltage-against-time profile to be considered for FRT capability

Issues for further consideration

Open questions:

- How to treat low inertia machines such as bulb turbines with regard to FRT?
- Can we utilize capabilities from some PSH technologies for instance “controlled load” to improve the management of low frequency events and give more options to the TSOs
- In a future evolved RfG, should we merge the PSH within the overall storage discussion?
- Should we treat pump mode as demand and therefore exclude them from RfG?

Remarks:

- Hydraulic specificities need to be considered whether they may constrain a requirement. This is considered to be a rather site-specific issue, which may be resolved by derogation, as the case may be.
- Particular attention needs to be paid on PSH with variable speed pumps (DFIM or full converter), which may not be classified unequivocally as power park modules or synchronous power generating modules. The current conclusion to classify them as power park modules except for the voltage-against-time profile to be considered for FRT capability needs to be scrutinized when reviewing/amending the connection requirements.