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

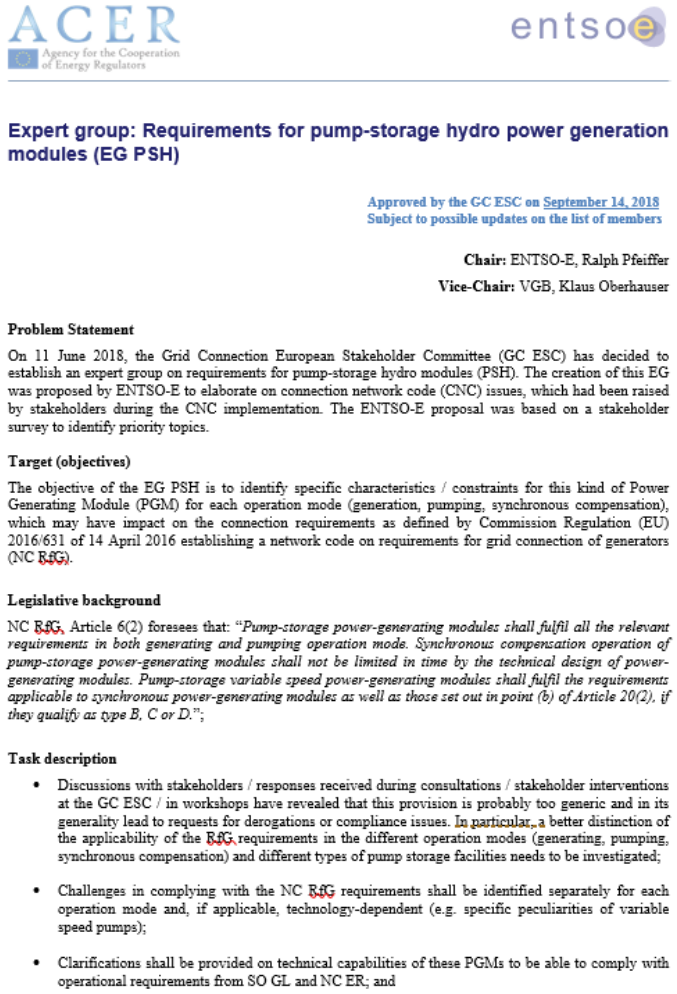
Ralph Pfeiffer, Chair of EG PSH

12th Grid Connection European Stakeholder Committee Meeting

13 December 2018, Brussels

EG PSH structure

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



ACER Agency for the Cooperation of Energy Regulators

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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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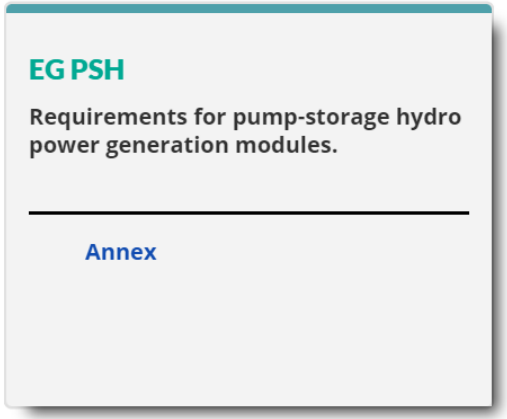
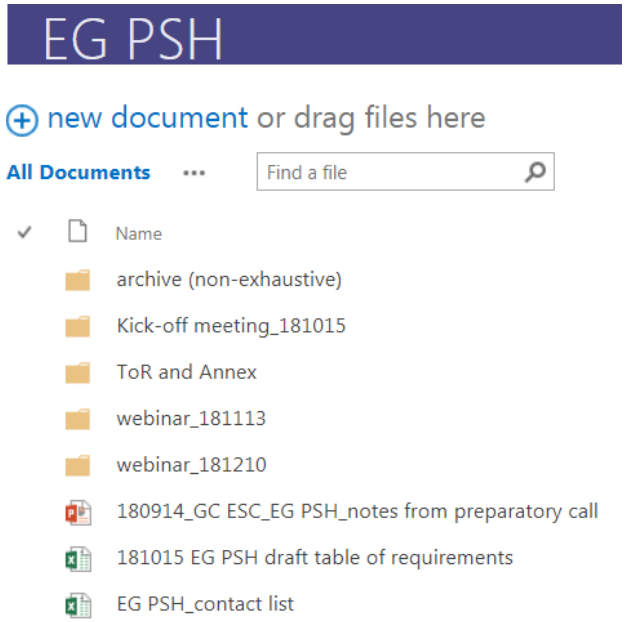
Public space



Internal EG space



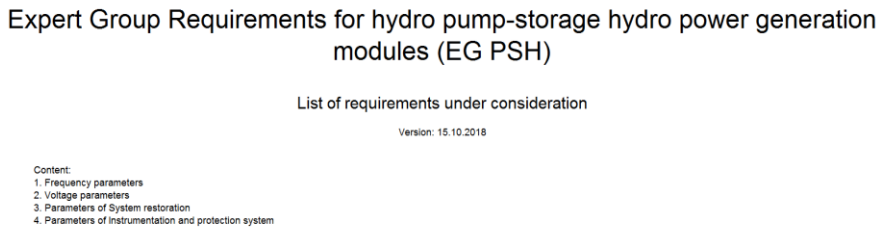
EG PSH meetings

- 15 October 2018 kick off meeting
- 13 November 2018, webinar
- 10 December 2018, webinar

- 16 listed members
- 5 different representative organizations + 1 invited expert
- 50% participation of members
- >80% participation of organizations

- Overall good collaboration among the members, with useful discussions
- Timely input in accordance with follow up actions
- Common space (SharePoint) and emails are used to provide inputs
- Workplan continues as agreed with no changes foreseen at the moment

Evaluation of RfG requirements for PSH modules



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

List of requirements under consideration

Version: 15.10.2018

Content:
1. Frequency parameters
2. Voltage parameters
3. Parameters of System restoration
4. Parameters of Instrumentation and protection system

- A template with RfG requirements has been created to assess better the different technologies

- PSH techs were differentiated into
  - Fixed speed:
    - Synchronous
    - Single shaft ternary (hydraulic short circuit)
  - Variable speed:
    - DFIG
    - Full converter
      - Converter can be bypassed (to switch between fixed and variable speed pump mode)
      - Converter cannot be bypassed

Snapshot from the template and ongoing work

Requirement	General (G) / Site specific (S)	Non-Mandatory Requirement	Article	Definition	Type	Type	Type	Type	Comment	Generation Technology: fixed speed pump turbine (generation mode)	fixed speed pump turbine (pumping mode)	fixed speed pump turbine (sync. compensation mode)	single shaft ternary (generation mode)	single shaft ternary (pumping mode)	single shaft ternary (sync. compensation mode)	variable speed pump turbine (dfig) (generation mode)	variable speed pump turbine (dfig) (pumping mode)
FREQUENCY RANGES	G		13.1.a.(I)	TSO	X	X	X	X	time period for operation in the frequency ranges	x	underfrequency limited by defence plan due to pump disconnection	time limited due to cooling of turbine blades, seal rings (only existing)	x	underfrequency limited by defence plan due to pump disconnection	time limited due to cooling of turbine blades, seal rings (only existing)	x	not at low frequ. in pump
RATE OF CHANGE OF FREQUENCY (ROCOF) WITHSTAND CAPABILITY	G		13.1.(b)	TSO	X	X	X	X	maximum ROCOF for which the Power Generating Module (PGM) shall stay connected	x	x	x	x	x	x	x	x
	G			RSO TSO	X	X	X	X	specify ROCOF of the loss of main protection								
Limited Frequency Sensitive Mode (LFSM)-O	G		13.2.(a)	TSO	X	X	X	X	frequency threshold and droop settings	x	N/A	N/A	x	x (N/A if only pump is in operation)	N/A	x	
	G	X	13.2(b)	TSO	X				use of automatic disconnection and reconnection								
ADMISSIBLE ACTIVE POWER REDUCTION FROM MAXIMUM OUTPUT WITH FALLING FREQUENCY	G		13.4	TSO	X	X	X	X	admissible active power reduction from maximum output with falling frequency	x	x		x	x		x	
	S		13.5	TSO	X	X	X	X	definition of the ambient conditions applicable when defining the admissible active power reduction								
LOGIC INTERFACE	S	X	13.6	RSO	X	X			requirements for the additional equipment necessary to allow active power output to be remotely operable	x	x	x	x	x	x	x	cease power input
AUTOMATIC CONNECTION TO THE NETWORK			13.7	TSO	X	X	X		conditions for automatic connection to the network, including:	x	N/A	N/A	x	N/A	N/A	x	x
	G								- frequency ranges and corresponding delay time								
	G								- Maximum admissible gradient of increase in active power output								
LOGIC INTERFACE	S	X	14.2.b	RSO		X			requirements for the equipment necessary to make the logic interface (to cease active power output) remotely operable	x	x	x	x	x	x	x	x
FREQUENCY STABILITY	G		15.2.(a)	TSO		X	X	X	time period for frequency stability to be reached	x	not possible	N/A	x	x (N/A if only pump is in operation)	N/A	x	
LFSM-U	G		15.2.c	TSO			X	X	definition of the frequency threshold and droop	x	not possible	N/A	x	x (N/A if only pump is in operation)	N/A	x	
	G			TSO			X	X	definition of Pref								
FREQUENCY SENSITIVE MODE	G		15.2.d.(I)	TSO			X	X	parameters of the Frequency Sensitive Mode (FSM):	x			x	x in hydraulic short circuit mode		x	
	S								- active Power range related to Maximum capacity								
	G								- frequency response insensitivity								
	S								- frequency response dead band								
	S								- droop								
	G		15.2.d.(III)	TSO			X	X	maximum admissible full activation time								
	G		15.2.d.(IV)	TSO			X	X	maximum admissible initial delay for power generating modules with inertia								
	G	X	15.2.d.(IV)	TSO			X	X	maximum admissible initial delay for power generating modules without inertia								
	G		15.2.d.(V)	TSO			X	X	time period for the provision of full active power frequency response								
FREQUENCY RESTORATION CONTROL	G		15.2.e	TSO			X	X	specifications of the Frequency Restoration Control	x			x	x in hydraulic short circuit mode		x	
REAL-TIME MONITORING OF FSM	G		15.2.g	RSO or TSO			X	X	list of the necessary data which will be sent in real time	x			x	x in hydraulic short circuit mode		x	
RATES OF CHANGE OF ACTIVE POWER OUTPUT	G		15.6.e	RSO TSO			X	X	definition of the minimum and maximum limits on rates of change of active power output (ramping limits) in both an up and down direction, taking into consideration the specific characteristics of the prime mover technology	x			x	x in hydraulic short circuit mode		x	
SYNTHETIC INERTIA CAPABILITY FOR POWER PARK MODULE (PPM)	G	X	21.2	TSO			X	X	definition of the operating principle of control systems to provide synthetic inertia and the related performance parameters	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	x	

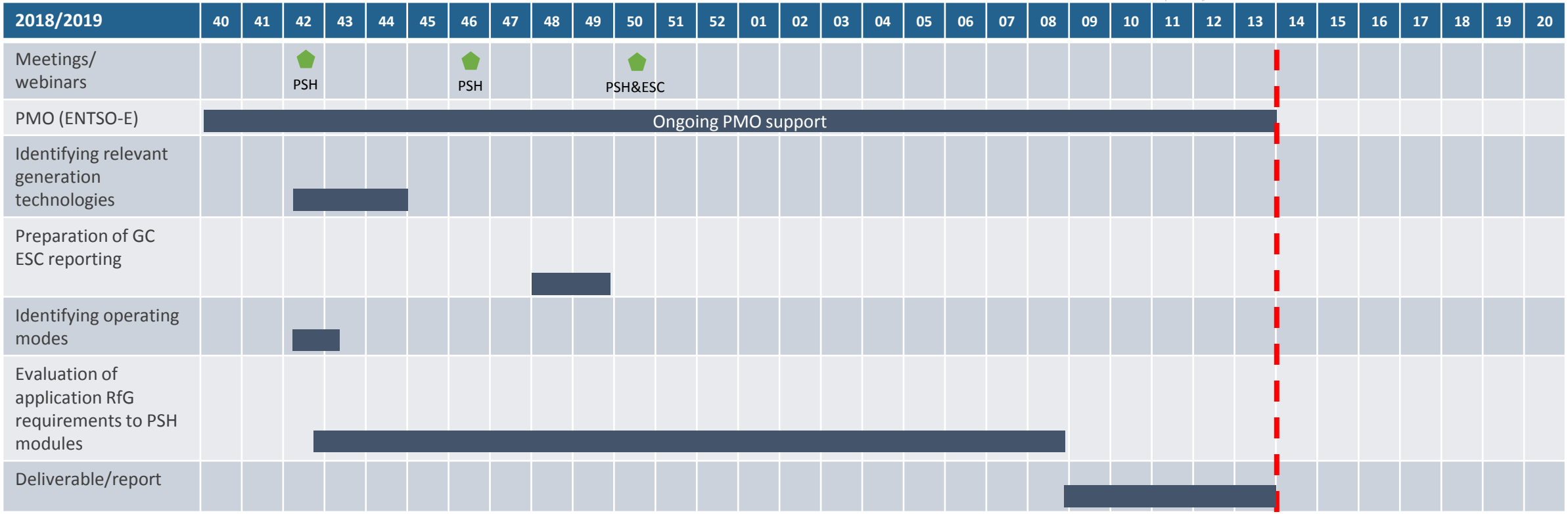
Cover | Freguency parameters | Voltage parameters | System Restoration | Instrumentation and Protection

Questions and remarks

- Open questions:
    - What do the differences in DFIG for wind and PSH mean in terms of requirements?
    - Should there be frequency-related requirements only for generation mode and not for pumping mode? (Operators are arguing, that according to NC ER pumps shall be disconnected at low frequencies, thus no requirements shall be imposed for pumps.)
    - Which way of defining the requirements is the best:
      Variable speed to be considered as PPM or as SPGM with exceptions?

- General:
    - The hydraulic part has to be considered in every requirement
    - Frequency response times for hydro can be very fast

Workplan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Meetings/ webinars
PSH
PSH
PSH&ESC
PMO (ENTSO-E)
Ongoing PMO support
Identifying relevant generation technologies
Preparation of GC ESC reporting
Identifying operating modes
Evaluation of application RfG requirements to PSH modules
Deliverable/report