Attachment 1 –RFP-2020-005 / Clarification 2

Grid Integration Training Programme

Training day	Topics covered	Description and Key Take-aways
DAY ONE		
	Introduction to the training session • Presentation of the trainees and the trainers • Discussion about content and logistics of the training session and expectations • Exchanges around trainer and trainees expectations	Contact making between the trainer and the trainees allowing assessing the experience and level of familiarity of the participants with Variable Renewable Electricity Generators technologies, grid integration and system operation and planning. The level of knowledge will define the required introduction and recall for each of the treated subjects during the training session for all the participants to follow and benefit from the course. Expectations of the trainees will also be discussed in order to meet them during the week as far as possible. Logistics around the training session will be presented.
	Understanding the power system and the characteristics that affect VRE Integration • The changing world of electricity • Presentation of VREG technologies (PV and Wind) • Power system planning and operation • Impact of VREG on the grid	A first step when conducting technical studies to plan for the integration of VRE is to acquire a good understanding of the characteristics of the power system and, more generally, of the electricity sector. This is a necessary step to understand which technical challenges would have the highest impact in the context of the country and to determine the best approach for using the technical studies in the planning process. This session explains the basics of a power system and covers all basics of the topics that will be discussed in the following sections.
DAY TWO		
	Impact of uncertainty and variability of VREG on generation adequacy • Defining generation adequacy and system reliability • Reliability indicators LOLE and EENS • VREG statistical models, modelling VREG in planning tools • Impact of VREG on the system adequacy • Practical Exercises on VREG impact and system adequacy using MS EXCEL • Demo of impact of VREG and main generation units on system reliability using SCANNER software • Impact of interconnections on generation system adequacy	When planning VREG integration in the power system, it is important to check that the generation capabilities are adequate and in line with the load demand and its future evolution. To deal with the uncertainty of VREG generation, probabilistic approach and models are commonly used. This session focusses on generation adequacy in presence of VREG, and on the probabilistic models. It will be illustrated by practical exercises with EXCEL and demonstrations using SCANNER software.
DAY THREE		

	Improving Grid Operations to accommodate renewables
	• Introduction to Generation Dispatch – Production Cost Modelling
	  • Unit Commitment
	  • Economic Dispatch
	• Impact of VREG on generation dispatch
	  • Notion of net load
	  • Flexibility of generation system versus variability and partial unpredictability of VREG
	• Coordinating Flexibility
	  ○ Start-up
	  ○ Ramp-rates
	  ○ Load-following
	• Practical Exercises on VREG impact and system and net load using MS EXCEL
	• Demo of impact of variability of net load and main generation units on system stability using EUROSTAG software
		The session delves deeper into the impact of renewable energy generation on grid operations. This session focuses on the increased variability introduced into the system by the VREG and the corresponding flexibility required from the other generating units in order to maintain system stability.
		
		This session will include a practical exercise using EXCEL to illustrate net load variability and its impact on economic dispatch. A demonstration of dynamic simulations on EUROSTAG software will present the characteristics of different types of generating units regarding active power production flexibility and illustrate the frequency stability of different generation mixes. The demo will be based on the model of a simplified system in order to enable focusing on this particular topic.

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DAY FOUR	

Addressing grid issues related to renewables integration
• Managing the Steady-state security
  • Reminders: static security assessment principles and calculations
  • Impact of VRE resources and their location on flows, voltages and N-1 security
  • Contribution of non-synchronous generation to reactive power management
  • Flexible network management principles: curtailment, dynamic line rating
  • Illustration & guided exercises with SmartFlow: static security assessment based on the WAPP network 2020
• Ensuring System Stability
  • Reminders: stability definitions and classification
  • Impact of VRE variability and non-synchronous generation on frequency stability: inertia, RoCoF
  • Illustration & guided exercises with Eurostag: short-term frequency deviations and stability following load changes with different generation mixes, same reduced system as in Day 3
• Estimation of the VRE hosting capacity
  • Overview of the methodology
	This session is intended to answer some of the main questions with regards to integrating renewables:
	
	What are the main technical issues to be investigated, depending on the power system characteristics, and how to perform the relevant technical studies to find the maximum hosting capacity for VRE in a given system?
	
	What are the possible solutions to increase this hosting capacity in the near and long term up to a given VRE target share?
	
	This session will also demonstrate power system analysis software that will help in modelling the system and carry out the required technical studies.

DAY FIVE	

Benefits of Regional Coordination for VRE integration
• Benefits of interconnections on frequency stability
• Impact of VRE on long distance power transfers
• Reminders: operational reserves and balancing
• Benefits of Regional Coordination
  • Sharing reserves among balancing areas
  • Managing long distance power transfers and exchanges
	Renewable resources are often location-constrained. Interconnections between power grids results in multiple benefits including sharing of resources. Further, large interconnected areas help in reducing the variability of renewable resources. However, these benefits require overcoming coordination challenges.
	This session focuses on the benefits of regional coordination and pathways to improve the operation of the regional interconnection.