



# SEESGEN-ICT

## 4° GENERAL WORKSHOP

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**Evangelos Rikos (CRES), Matthias Stifter (AIT):**  
***Analysis of EU Test Facilities Capacity - Directory of EU  
Test Facilities***





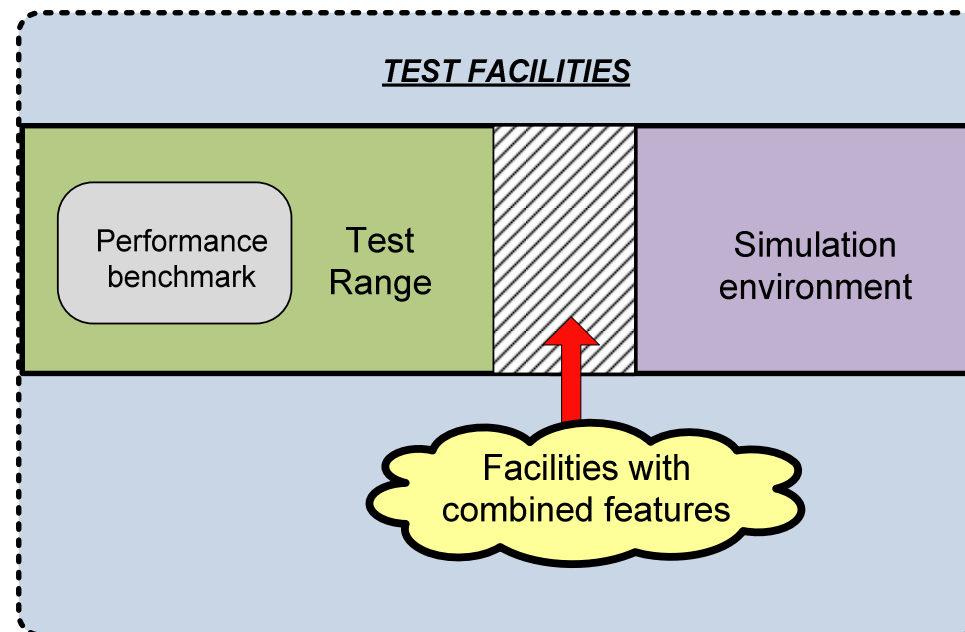
# Task Objectives

- Focus on **assets** and **capabilities** of TF
  - prove the effectiveness and functionality of ICT solutions
  - addressing the overcoming of technical and non-technical barriers to their entry in the market
  - support standardization
- TFs **classification methodology**
- TFs **directory compilation**
- **Compliance** of the TFs to the **requirements** for testing ICT (identified in D7-2)



# Test Facilities classification

- Simulation Environment (SE)
- Test Range (TR)
- Performance Benchmark (PB)





# Description Template of a TF

ITEM	CONTENT
<b>Identification of the Test Facility</b>	<b>Name, Addresses (legal and web), Contacts</b>
<b>Area</b>	<b>Description (Comments)</b>
<b>Main Focus</b>	<i>Testing of Components (e.g. Generators, Protection Devices), Systems (e.g. Demand Side Integration, Microgrids, Virtual Power Plants), Market, Certificated testing</i>
Physical Network	<i>e.g. interface to numerical simulation, HIL</i>
External World	<i>e.g demand forecast</i>
Players	<i>e.g. market simulation, customer participation,</i>
Data logging and results	<i>e.g. analysis and evaluation of results</i>
Power level	<i>e.g. Test of protection equipment, high voltage partial discharge, performance of DER, certification,</i>
Communication level	<i>e.g. certification of protocols, control of DER</i>
Workload controller	<i>e.g. benchmarking, evaluation</i>
Power/environmental measurements	<i>e.g. emissions, power efficiency of generators</i>



# TF requirements: fact sheets

## OBJECTIVES

- TFs should include sufficient number of components, especially concerning the electrical parts
  - wide range of tests and technology validations
- The proposed methodology could be used
  - Guide for **extending** existing facility by filling possible technology gaps in order to be able to offer more capabilities in the field of ICT testing –
  - or to **identify complementarities** and **synergies** opportunities and therefore establish effective partnerships
  
- Synthesis of a reference list



# TF requirements: fact sheets (cond.)

## ASSUMPTIONS-CONSIDERATIONS

- Separate list of requirements for PB
- **Comprehensive examination** of existing facilities in order to clarify and validate the reference lists especially regarding the electrical components
- **Specific requirements** are analysed in sub-components (e.g. SCADA systems analysed in PLCs, RTUs, sensors, communication protocols, and HMIs)
- Components of a test facility could represent, in practice, the System Under Test itself



# Reference Requirements List for SE

ASPECT	ID	ASSET
Physical network	SE_1	Software Simulation of electrical power system-
	SE_2	Real time Emulation of parts of the electrical power system including: Electrical sources, Loads, Transmission lines, Substations, Combination of the above
	SE_3	Configurable simulation/emulation topologies
	SE_4	Interface power simulators
	SE_5	Controllable load, generators, and storage systems
Players	SE_6	Simulation of prosumers as single entities
	SE_7	Simulation of prosumers as aggregated entities
	SE_8	Metering services
	SE_9	Business logic (profile clustering, algorithms, SLAs, etc.)
	SE_10	SCADA: Sensors and Actuators, Data Acquisition Systems, PLCs, RTUs, HMIs, Communication protocols



# Reference Requirements List for SE

Physical network	SE_11	EMS - Energy Management Systems
	SE_12	State Estimator
	SE_13	Business Management Systems
	SE_14	Human Machine Interface
	SE_15	Communication infrastructure protocols
	SE_16	Administrative data (as for billing)
External world	SE_17	Energy market module
	SE_18	Real Energy market data for simulation
	SE_19	Weather module
	SE_20	Real weather data for simulation
Data Logging and results	SE_21	Logging feature of performance and results
	SE_22	Logging interface between physical and market layer
	SE_23	Logging of messages and numerical simulation data
	SE_24	Metrics extraction from (database stored) logging data



# Reference Requirements List for TR

ASPECT	ID	ASSET
Power level	TR_1	Real electrical power system / network
	TR_2	Generators (renewables, conventional) / power plants
	TR_3	Electrical energy storage systems
	TR_4	Flexible connection and configuration
	TR_5	Transmission substations (including measurements and safety switchgear)
	TR_6	Distribution network/Medium Voltage (Meshed or radial)
	TR_7	Transmission network / High voltage
	TR_8	Double switches for isolation of feeders / networks
	TR_9	Independent power supply from external / high voltage generators
	TR_10	Primary distribution substation / medium voltage
	TR_11	Secondary distribution substation / low voltage
	TR_12	Controllable power loads (High Voltage)
	TR_13	Distributed Energy Resources
	TR_14	Full configurability of grid topology / medium voltage
	TR_15	Full configurability of grid topology / low voltage
Communication/monitoring level	TR_16	Electrical measurement equipments and SCADA
	TR_17	Data archiving
	TR_18	Communication system technologies (LAN Ethernet, WiFi, Power Line Communication)



# Reference Requirements List for PB

ASPECT	ID	ASSET
Workload controller	PB_1	External or internal performance driver
	PB_2	Start and stop sequence / phase of PB
	PB_3	Control workload demands of PB
	PB_4	Synchronization of power and performance data
	PB_5	Log files / data storage
	PB_6	Data conversion and validation logic
	PB_7	Environmental data and throughput performance information
	PB_8	Regulated workload rate
	PB_9	Benchmark intermediate workload curves
	PB_10	Minimum (idle) and maximum (100%) workload points
Power/Environmental measurements	PB_11	External power measurement equipment
	PB_12	Specification of power analyser requirements
	PB_13	Automatically upload power measurements results
	PB_14	Power analyzer characteristics: -Power (W), volts, amps and power factor -Reading/reporting rate $\geq 1/\text{sec}$ , averaging rate 1-2 times the reading interval -Accuracy better than 1% -Calibration: within past year by standards -Crest factor: at least 3 times the maximum amperage
	PB_15	Average power characteristics (once per second)
	PB_16	Temperature / environment measurement device



# Directory of EU Test Facilities

- Inputs from past and ongoing projects, like **Microgrids, DERlab** and **DERri**
- Examples with a variety of features and capabilities
- How the **proposed methodology** can be applied?
- Since the implementation of ICT in the Electric Power Systems (EPS) is still growing, it is expected that most facilities **will encounter some gaps**



# List of EU Test Facilities

Nr.	Name of the Test Facility	Ref. <a href="#">Organization</a>
1	DeMoTech	IWES – Kassel (D)
2	DER Test Facility	RSE – Milan (I)
3	LABEIN's $\mu$ Grid	TECNALIA – Deri (E)
4	Testing laboratory for system components for Photovoltaic and other DG applications	AIT - Wien (A)
5	Hybrid system/Microgrid test site and PV systems Laboratory	CRES - Pikermi (Gr)
6	Pilot Microgrid	CRES -Gaidouromantra-Kythnos (Gr)
7	Electric Energy Systems Lab	NTUA – Athens (Gr)
8	DTU SySlab	RISOE-DTU – Roskilde (DK)
9	INES/L2S	CEA - Le Bourget du Lac (F)
10	Digital	EDF-SA – Clamart (F)
11	Flexible Power Grid Lab (FPGL)	KEMA - Arnhem (NL)
12	Test Facilities	TUS RDS – Sofia (BG)
13	D-NAP (Distributed Network and Protection Laboratory)	USTRAT – Glasgow (UK)
14	Multipower	VTT – Espoo (FI)
15	CEP Microgrid	ARMINES – MINES PARISTECH – Paris (F)
16	Laboratory of Distributed Energy Resources	TULodz – LODZ (PL)



# General remarks

- The facilities cover aspects regarding **distribution grid, DER and RES, storage applications and microgrids**
- Either viewed as SE or as TR, there are some **gaps** regarding the **high voltage grid**.
- Regarding the ICT level, all facilities **meet a large number of requirements** for ICT since they incorporate communication infrastructures and protocols, SCADA systems, Energy Management Systems etc.
- **Existing gaps** regard mainly aspects like **Business Management Systems, Market Models and Communications** etc.



# Reference Requirements List for SE

Reference Requirements List for Simulation Environment-SE														
ASPECT	ID	ASSET	TEST FACILITY											
			Demotec	DER-TF	LABELIN'S	SimTech	CRES TF	Pilot microgrid	NTUA	INES	Digital	FPGL	TUS RDS	D-NAP
Physical network	SE_1	Software Simulation of electrical power system-Commercial software is recommended				X			X		X		X	
	SE_2	Real time Emulation of parts of the electrical power system including: -Electrical sources -Loads -Transmission lines -Substations -Combination of the above	X	X	X	X	X		X		X	X	X	X
	SE_3	Configurable simulation/emulation topologies	X	X	X	X					X	X		X
	SE_4	Interface power simulators				X	X				X	X		X
	SE_5	Controllable load, generators, and storage systems	X	X	X	X	X		X			X		X
Players	SE_6	Simulation of prosumers as single entities		X		X	X							
	SE_7	Simulation of prosumers as aggregated entities			X	X	X		X					
	SE_8	Metering services				X			X		X			
	SE_9	Business logic (profile clustering, algorithms, SLAs, etc.)												



# Reference Requirements List for SE

Reference Requirements List for Simulation Environment-SE															
ASPECT	ID	ASSET	TEST FACILITY												
			Demotec	DER-TF	LABELIN'S	SimTech	CRES TF	Pilot microgrid	NTUA	INES	Digital	FPGL	TUS RDS	D-NAP	Multipower
	SE_10	SCADA: -Sensors and Actuators -Data Acquisition Systems -PLCs -RTUs -HMIs -Communication protocols	X	X	X	X	X		X				X	X	
	SE_11	EMS - Energy Management Systems	X	X	X				X						
	SE_12	State Estimator							X						
	SE_13	Business Management Systems													
	SE_14	Human Machine Interface	X	X	X	X	X		X					X	
	SE_15	Communication infrastructure protocols	X	X	X	X	X		X		X				
	SE_16	Administrative data (as for billing)													
External world	SE_17	Energy market module													
	SE_18	Real Energy market data for simulation							X						
	SE_19	Weather module				X			X				X		
	SE_20	Real weather data for simulation				X			X	X		X			
Data Logging and results	SE_21	Logging feature of performance and results	X	X	X	X	X		X		X		X		
	SE_22	Logging interface between physical and market layer							X						
	SE_23	Logging of messages and numerical simulation data	X	X		X	X		X					X	
	SE_24	Metrics extraction from (database stored) logging data	X	X					X						



# Reference Requirements List for TR

Reference Requirements List for Test Range-TR																	
ASPECT	ID	ASSET	TEST FACILITY														
			Demotec	DER-TF	LABELIN'S	SimTech	CRES TF	Pilot microgrid	NTUA	SySlab	INES	Digital	FPGL	TUS RDS	D-NAP	Multipower	
Power level	TR_1	Real electrical power system / network	X	X	X	X	X	X	X	X	X	X		X			X
	TR_2	Generators (renewables, conventional) / power plants	X	X	X	X	X	X	X	X	X	X		X	X		X
	TR_3	Electrical energy storage systems	X	X	X	X	X	X	X	X	X	X			X		X
	TR_4	Flexible connection and configuration	X	X	X	X	X	X	X	X	X	X		X			X
	TR_5	Transmission substations (including measurements and safety switchgear)				X					X						
	TR_6	Distribution network/Medium Voltage (Meshed or radial	X	X	X									X			X
	TR_7	Transmission network / High voltage															
	TR_8	Double switches for isolation of feeders / networks															
	TR_9	Independent power supply from external / high voltage generators													X		
	TR_10	Primary distribution substation / medium voltage															
	TR_11	Secondary distribution substation / low voltage	X	X	X	X					X						X
	TR_12	Controllable power loads (High Voltage)				X			X					X			X
	TR_13	Distributed Energy Resources	X	X	X	X	X	X	X	X					X		X
	TR_14	Full configurability of grid topology / medium voltage	X											X			
	TR_15	Full configurability of grid topology / low voltage	X	X	X	X					X			X			X
Communication/monitoring level	TR_16	Electrical measurement equipments and SCADA	X	X	X	X	X	X	X					X			
	TR_17	Data archiving	X	X		X	X	X	X	X							
	TR_18	Communication system technologies (LAN Ethernet, WiFi, Power Line Communication)	X	X	X	X	X	X	X	X				X			



# Reference Requirements List for PB

Reference Requirements List for Performance Benchmark-PB														
ASPECT	ID	ASSET	TEST FACILITY											
			Demotec	DER-TF	LABELIN'S	SimTech	CRES TF	Pilot microgrid	NTUA	INES	Digital	FPGL	TUS RDS	D-NAP
Workload controller	PB_1	External or internal performance driver									X			
	PB_2	Start and stop sequence / phase of PB									X	X	X	
	PB_3	Control workload demands of PB									X	X	X	
	PB_4	Synchronization of power and performance data											X	
	PB_5	Log files / data storage									X	X	X	
	PB_6	Data conversion and validation logic											X	
	PB_7	Environmental data and throughput performance information									X	X	X	
	PB_8	Regulated workload rate									X	X	X	
	PB_9	Benchmark intermediate workload curves									X	X	X	
	PB_10	Minimum (idle) and maximum (100%) workload points											X	
	PB_11	External power measurement equipment									X	X	X	
	PB_12	Specification of power analyser requirements									X	X	X	
	PB_13	Automatically upload power measurements results										X	X	
	PB_14	Power analyzer characteristics: -Power (W), volts, amps and power factor -Reading/reporting rate $\geq$ 1/sec, averaging rate 1-2 times the reading interval -Accuracy better than 1% -Calibration: within past year by standards -Crest factor: at least 3 times the maximum amperage									X	X	X	
	PB_15	Average power characteristics (once per second)									X		X	
	PB_16	Temperature / environment measurement device									X		X	



# Summary and Conclusions

- **Vast number** of test capabilities especially regarding DER and RES sector
- **TF combine** characteristics of both SE and TR
- **Wide variety** of ICT requirements
- **Gaps** related to market modelling, high voltage system etc.



**Thank you for your attention**



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