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ISGAN Annex 3: Kosten-Nutzen-Analyse

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Für den Inhalt und die Schlussfolgerungen sind ausschliesslich die Autoren dieses Berichts verantwortlich.

Project Objectives

The scope of the Annex III is the development of methods and tools for the evaluation of the costs and benefits of smart grids projects, and for the preliminary assessment of the level of smartness of present electricity systems. Some requirements for the methods and tools developed by this Annex are:

- Results of application of these tools could be used to develop specific business cases, taking into account regulatory and market structures, as well as current system status, available generation assets and resources and demand profiles.
- Regulators, utilities and other electricity system stakeholders could use these toolkits to define and decide on system needs and priorities for smart grid system investment and regulatory changes
- Leverages existing knowledge and experience (e.g. in the DOE-EPRI methodology and computational tool, the EU KPI etc).

The objective of this Annex is to develop a global framework and related analyses that can identify, define, and quantify in a standardized way the benefits that can be realized from the demonstration and deployment of smart grids technologies and related practices in electricity systems. The Annex will leverage existing knowledge and experience gained in different participating countries (e.g. in the U.S. through the DOE-EPRI methodology and computational tool, the EU through its approach based on Key Performances Indicators, etc.), as well as in current international efforts underway and through cooperation among major smart grids stakeholders globally.

The program of work consists of the following three Tasks.

Task 1: Assess Current Network Maturity Models and Tools available

Subtask 1.1: Collecting and comparing maturity frameworks and tools

Subtask 1.2: Trial application of two network maturity analysis tool and results discussion

Subtask 1.3: Guidelines for the development of a new ISGAN simplified maturity analysis tool

Task 2: Assess Current Benefit-Cost Analytical Methodologies and Tools

Subtask 2.1: Collecting and comparing benefit-costs frameworks and tools

Subtask 2.2: Assessing policy and regulatory considerations for smart grid

Task 3: Develop Toolkits to Evaluate Benefit-Costs at the Technology or Sub-system Level

Subtask 3.1: Trial application of the DOE benefit-cost analysis computational tool and results discussion

Subtask 3.2: Guidelines for the development of a new ISGAN benefit-cost analysis tool

Work Performed and Achieved Results

The Tasks and Subtasks within the ISGAN Annex III are carried out on a task-sharing basis, as directed by the ISGAN ExCo. The following summary of activities includes contributions of all participating countries to the tasks.

Task 1: Assess Current Network Maturity Models and Tools available

More insights have been gathered on the two smartness methods proposed as a benchmark. The smartness KUL approach has been revised to take into consideration also the market features of the smart grids. Furthermore, The questionnaire for the assessment of the level of smartness of T&D networks has been updated and modified; it has been split into two parts:

- **Preface questionnaire**: general information on countries and their network structure
- **Smartness questionnaire**: specific information on smart grids technologies and functionalities implemented.

The main aim of the new version is to gather more quantitative data, collect data which do not depend on the size of the network, declare explicitly the influence due to the national/regional context, make a clear distinction between transmission/distribution grids, make sure that respondents refer to their BAU grid (not to demo projects). As also described above, the questionnaire is preceded by a first part called „Preface questionnaire" to get general information baut the network such as number of customers, network general data, etc.

The questionnaire is referred to *real life T&D grids*, and consists mainly of quantitative questions, that can be answered based on homogeneous information related to:

- a specific grid (minimum consistence: at least one HV/MV substation);
- a specific transmission grid;
- a whole distribution grid belonging to/operated by a single Company (DSO);
- a whole transmission grid belonging to/operated by a single Company (TSO);
- a set of distributions grids considered at a national/regional level;
- a set of transmission grids considered at a national/regional level.

The assessment of the maturity of the network is deemed necessary as a benchmark in view of better assessing the costs and benefits of smart grids projects. Figure 1, Figure 2 and Figure 3 show the results of the post–processing of the questionnaire for different networks.

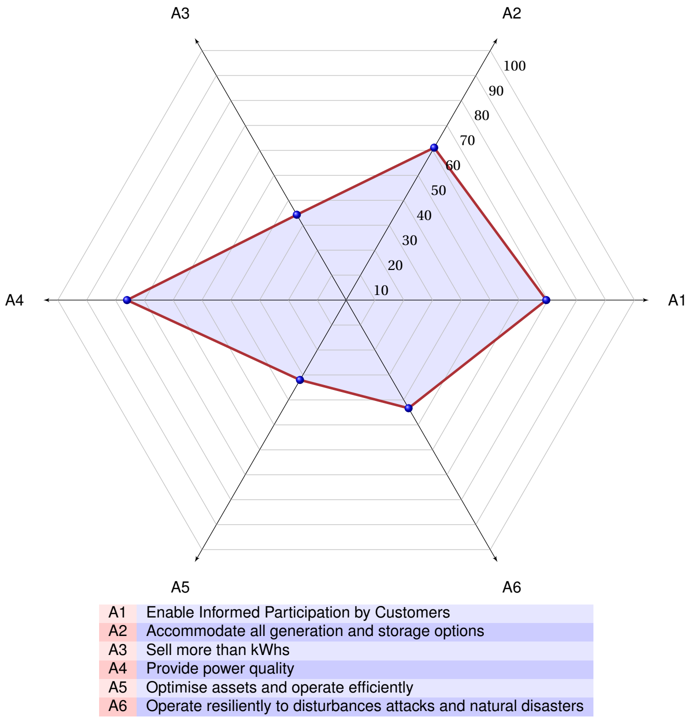

Figure 1: An example of post–processing of the questionnaire (Application to Italy)

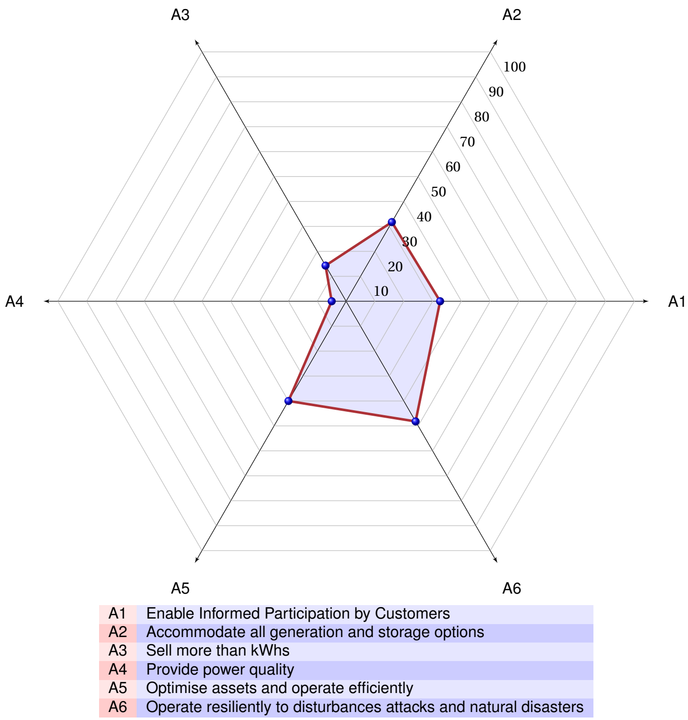

Figure 2: An example of post–processing of the questionnaire (Application to Kepco)

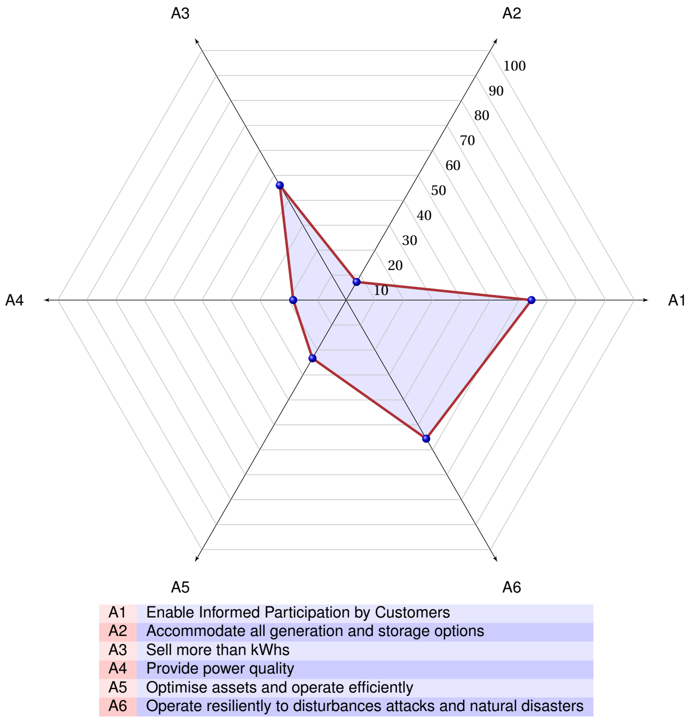

Figure 3: An example of post–processing of the questionnaire (Application to India)

Task 2: Assess Current Benefit-Cost Analytical Methodologies and Tools

In 2014, the review of possible tools for cost benefit analysis has been completed with up-to-date information. For this purpose following models have been studied:

- EA Technology „Transform Model": The model provides a detailed representation of a given electricity network and describes the impact that future scenarios may have on those existing networks

- Synapse Energy Economics „Benefit – Cost Analysis for Distributed Energy Resources": The model results should be reported using the Societal Cost Test, the Utility Cost Test and the Rate Impact Measure test.

EA Technology „Transform Model"

The model is a parameter-based model based on real data from distribution networks, local authorities, central government and a range of other sources, which allows the network to be constructed of common elements. It can assess and optimise investment over a range of conventional and *smart* strategies, and involving a wide range of solutions. The Transform Model is based on four steps:

1. Scenarios

2. Existing Networks

3. Solutions

4. Modelling Combinations

Synapse Energy Economics Model

One advantage of the model is that it accounts also for non monetized impacts. The process of accounting for costs and benefits includes one section for all of the monetized impacts and a separate section for the non monetized impacts to indicate how each of them will be accounted for. The monetized section includes a presentation of the results in terms of net benefits and in terms of a benefit/cost ratio. The „non monetised benefits" section of the template is a reminder that the monetised results should not be considered in isolation. The non monetized results need to be accounted for somehow in order to ensure that the BCA framework fully accounts for all relevant costs and benefits. This is achieved by multi-attribute decision analysis.

Task 3: Develop Toolkits to Evaluate Benefit-Costs at the Technology or Sub-system Level

Annex 3 focused on a simplified/practical approach, based on simple excel spreadsheets, where investments (assets) are directly linked/related to benefits, with some calculations and some practical results. In June 2014, some ISGAN experts were involved in a real case of CBA performed/validated by the Italian/French NRA (AEEG-SI / CRE). The smart grid project taken under investigation was „Grid integration of REnewables Energy sources in the North-MEditerranean". The GREEN-ME project will cover a large area between the North of Italy and the South of France, involving 2 TSOs (Terna in Italy, RTE in France) and 2 DSOs (ENEL Distribuzione in Italy, ERDF in France) According to JRC methodology, the steps in the Cost Benefit Analysis performed are:

1. Technologies, elements and goals of the project (Table 1 and Table 2)
2. Mapping assets on to functionalities (Table 3)
3. Mapping functionalities on to benefits (Table 4 and Table 5)
4. Definition of the baseline and Smart Grids scenarios
5. Monetized benefits
6. Identifying and quantifying the costs
7. Comparing costs and benefits

Tables 1-5 show their application to the reference project.

code	Assets
1	**SCADA upgrade (Transmission level)** Location: TSOs central and regional centres
2	**Automation and control devices (Transmission level)** Location: TSOs substations
3	**Devices to control power plants (Transmission level)** Location: power plants connected to HV level
4	**Fault locators (Transmission level) Location**: transmission lines
5	**Dynamic line rating Location**: transmission lines
6	**Multifunction device for automation, support, backup protection and dispatching, with IEC 61850 & protocol** Location: HV/MV substations
7	**New MV protection system** Location: HV/MV and MV/LV substations
8	**Comunication devices (e.g. routers, antennas...)** Location: HV/MV and MV/LV substations, MV active and passive customers
9	**Storage Location**: HV/MV substations
10	**Solutions for reactive power compensation** Location: HV/MS substations
11	**Devices to control DG active (Active Power Regulator, APR) and reactive power** Location: MV active users
12	**Fault locators** Location: MV/LV substations
13	**Remote Terminal Units** Location: MV/LV substations
14	**IEC 61850** & interface for General Protection Relay and for Interface Protection Relay Location: MV active users
15	**SCADA upgrade (Distribution level)**
16	**Information system** 1. Information system between the DSO and the Distributed Generators operators sharing power injection of DGs monitored. 2. Information system between the DSO and the TSO sharing power injection of DGs monitored. 3. Load forecast tool related to demand forecast at the HV/MV substations.
17	**Diag on Line (DOL)** French DSO only
18	**Broadband communication system**

Table 1: Technologies, elements and goals of the project

code	Assets
1	Coordinated Operation On France-italy Interconnection (it-fr)
2	Transmission Network Monitoring (fr)
3	Mv Network Monitoring And Mv Circuit breakers Monitoring (it)
4	Predictability Of Generation From RES Ang DG (it)
5	Large Scale Dynamic Line Rating On Transmission Network (fr)
6	Control Functions And Data Collection For Local Dispatching d Tso Information (it - Fr)
7	Coordinated Voltage Control On Transmission Network (it - Fr)
8	Real Time Reactive Power Compensation For DSO-TSO Interface ()
9	Innovative Voltage Control On Distribution Network
10	Active Power Flow Control
11	Limitation/modulation Of active Power Generation And Load Shedding In Case Of Emergency (it)
12	Outage Management Coordination And Operational Planning (fr)
13	MV Grid Automation For Mv Distribution Network Failure Management
14	Anti-islanding On Mv Grids

Table 2: Functionalities

A \ F	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	✓	✓		✓		✓	✓	✓		✓	✓			
2		✓				✓	✓	✓		✓	✓			
3							✓			✓				
4		✓												
5					✓									
6			✓	✓		✓		✓	✓	✓	✓	✓	✓	✓
7									✓		✓		✓	
8			✓	✓		✓		✓	✓	✓	✓	✓	✓	✓
9														
10								✓						
11						✓	✓	✓	✓	✓	✓			
12			✓						✓			✓	✓	✓
13			✓	✓					✓	✓	✓	✓	✓	✓
14						✓		✓	✓	✓	✓			
15			✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
16			✓	✓		✓		✓		✓	✓			
17													✓	
18			✓	✓		✓		✓	✓	✓	✓	✓	✓	✓

Table 3: Mapping assets (A) in Table 1 on to functionalities (F) in Table 2

Economic	Reduced maintenance costs	A1	Reduced Maintenance Costs - Transmission network (FR)
		A2	BAU maintenance expenditures avoided during project period 2015-2019 (CAPEX+OPEX) - Distrbution system (FR)
		A3	Reduced Operational and Maintenance costs : DOL impact Distribution System (FR)
	Avoided or deferred investments	B1	Deferred investment on distribution network (IT)
		B2	Deferred investments on distribution network (FR)
		B3	BAU 2020-2029 Smart Grids deployment avoided because of GreenMe project (CAPEX + OPEX) - Distribution system (FR)
	Improved efficiency of dispatching service market (DSM)	C1	Improved efficiency of dispatching service market (DSM) at system level (IT)
Reliability	Reduction of generation losses	D1	Reduced generation losses (due to network failure) - Transmission network (FR)
	Reduced outages	E1	Reduction of Energy Not Supplied - Transmission network (FR)
		E2	SAIDI reduction : DOL impact - Distribution System (FR)
		E4	SAIDI reduction : PCCN impact - Distribution System (FR)SAIDI reduction
		E4	SAIDI reduction : Smart Secondary Substation impact - Distribution System (FR)
		E5	Increased value of service due to lower interruptions - Distribution system (IT)
Environment	Reduced primary energy usage	F1	Saved TEP due to wider diffusion of renewable sources - Distribution system (IT)
	Reduced CO_2 emissions	G1	Reduced CO2 emissions due to reduction of RES connection period & production interruption for maintenance - Distribution system (FR)
		G2	Reduced CO2 emissions due to reduction of RES connection period & production interruption for maintenance - Distribution system (IT)
	Reduced NO_x and SO_x emissions	H1	Reduced NOx emissions due to wider diffusion of renewable sources - Distribution system(IT)
		H2	Reduced NOx emissions due to reduction of RES connection period & and SOx production interruption for maintenance - Distribution system (FR)
		H3	Reduced SO2 emissions due to wider diffusion of renewable sources - Distribution system (IT)
		H4	Reduced SO2 emissions due to reduction of RES connection period & production interruption for maintenance-Distribution system(FR)
	Reduction of over generation	I1	Reduction of over generation (OG) at system level (IT)

Table 4: List of Benefits

B \ F	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A1		✓			✓									
A2														
A3			✓						✓					
B1			✓						✓					
B2			✓						✓					
B3			✓											
C1						✓		✓					✓	
D1					✓		✓			✓				
E1				✓						✓				
E2			✓										✓	
E3			✓											
E4			✓										✓	
E5									✓				✓	
F1									✓			✓	✓	
G1									✓			✓		
G2									✓			✓	✓	
H1									✓			✓		✓
H2									✓			✓		
H3									✓			✓		✓
H4									✓			✓		
I1				✓		✓				✓				

Table 5: Mapping functionalities (F) in Table 2 on to benefits (B) in Table 3

National Collaboration

The ongoing activities in Annex I (Global Smart Grid Inventory) and Annex III (Benefit & Cost Analyses And Toolkits) were regularly communicated with Dr. Rainer Bacher from BACHER ENERGY LTD, who is the Annex I swiss representative.

International Collaboration

The Tasks and Subtasks within the ISGAN Annex III are carried out on a task-sharing basis. The task-sharing basis allows close collaboration with participating countries (Austria, Canada, France, India, Italy, South Korea, Mexico, Russia, Spain, Sweden, Switzerland, UK, USA).

Outlook 2014

Task 1: Assess Current Network Maturity Models and Tools available

- Encourage ISGAN experts to select one or more test cases on to apply both questionnaire
- This will lead to the development of an excel file to obtain an overall picture of the maturity level based on the answers gathered from the questionnaire for the electric system of a given country/region (transmission + distribution)

Task 2: Assess Current Benefit-Cost Analytical Methodologies and Tools

- Report on existing benefit-cost analyses with recommendations of best practices

Task 3: Develop Toolkits to Evaluate Benefit-Costs at the Technology or Sub-system Level

- Creation of a guide/tool to let policy makers and other stakeholders learn the general framework of CBA shared at ISGAN level
- List the various best practices / lessons learnt options/toolkits available