Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Eidgenössisches Departement für
Umwelt, Verkehr, Energie und Kommunikation UVEK

Bundesamt für Energie BFE

Jahresbericht 29.11.2013

ISGAN Annex 3: Kosten-Nutzen-Analyse

Auftraggeber:

Bundesamt für Energie BFE
Forschungsprogramm Netze
CH-3003 Bern
www.bfe.admin.ch

Auftragnehmer:

Forschungsstelle Energienetze ETHZ
Sonneggstrasse 28 SOI C7
CH-8092/ Zürich
www.fen.ethz.ch

Autoren:

Dr. Turhan Demiray, Forschungsstelle Energienetze, demiray@fen.ethz.ch

BFE-Bereichsleiter: Dr. Michael Moser
BFE-Programmleiter: Dr. Michael Moser
BFE-Vertragsnummer: SI/500625-05

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 reached on the smartness methods proposed as a benchmark

- the Smart Grids Maturity Model – SGMM - developed by Software Engineering Institute at Carnegie Mellon University
- the Katholieke Universiteit Leuven (KUL) smart grid maturity model

Main quantitative innovation of Belmans' method (KUL) is the clear definition of a wide set of KPIs, proposed for assessing the "smartness" of an electricity grid. In a Smart Grid context, a common view may be lost: each stakeholder proposes his point of view, aimed at his specific targets. Belman's Method defines general parameters for measuring the smartness of a grid, without being influenced a priori by the aim of this evaluation. Six characteristics are defined, derived from DoE "Smart Grid System report", to capture the main innovations expected from Smart Grids.

1. Enabling informed participation by customers
2. Accommodating all generation and storage options
3. Selling more than kWh
4. Providing more power quality
5. Optimizing assets and operating efficiently
6. Operating resiliently to disturbances, attacks and natural disasters

Revisions to the KUL approach have been made to take into consideration also market features of the smart grids. Furthermore a web-based questionnaire has been developed for the initial smartness assessment of some on-going smart grid projects in participating countries. After a first trial test of the questionnaire it was found difficult to compare the results. It was decided to modify the questionnaire, in order to move from the original content/purposes to a new formulation. The main aim of the new version was 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**

The revised questionnaire aims at collecting technical information about the level of smartness of electricity grids. The questionnaire is referred to real life distribution and transmission grids, and consists mainly in quantitative questions, that can be answered based on homogeneous information related to:

1. a specific distribution grid (minimum consistence: at least one HV/MV substation)
2. a specific transmission grid
3. a whole distribution grid belonging to / operated by a single Company (DSO)
4. a whole transmission grid belonging to / operated by a single Company (TSO)

5. a set of distributions grids considered at a national/regional level
6. a set of transmission grids considered at a national/regional level.

Before starting the questionnaire, the respondents should declare the case he refers to (1-6). The use of data gathered is influenced by the general policy framework to which the data refer: to this aim, some preliminary information is needed.

1. How many customers are served by the electricity system? (#)
2. What is the load served? (yearly energy, MWh)
3. Is the electricity system vertically integrated? (YES/NO)
4. If N, are network activities (transmission, distribution) separated from generation? (YES/NO)
5. Is distribution network operated by DSOs (separated from TSO)? (YES/NO)
6. Is there an electricity market in place? (YES/NO)
7. If YES, what is the share of demand eligible for the market? (%)
8. Are support schemes for RES in place? (YES/NO)
9. What is the share of RES energy w.r.t. total system load (MWh/MWh: %)
10. Are support schemes for EV in place? (YES/NO)

In order to make a correct use of the answers to the questionnaire, some preliminary information about the specific grid under investigation are needed.

1. Is it a transmission network? (YES/NO)
2. Is it a distribution network? (YES/NO)
3. How many km of HV lines are there?
4. How many km of MV lines are there?
5. How many km of LV lines are there?
6. How many HV customers are served? (#)
7. How many MV customers are served? (#)
8. How many LV customers are served? (#)
9. What is the load served? (yearly energy, MWh)
10. Is the grid connected to the main/continental network? (YES/NO)

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

Different tools have been studied which are regarded as suitable to fulfill Annex 3 goals.

1. Mc Kinsey: The tool seems to be available for activities in the short-term period
2. IEA: ETP2012 needs to be further studied and developed. IEA has been asked to provide more info (a user manual of the tool).
3. JRC/EPRI: The JRC/EPRI methodology is a good starting point to fulfill Annex 3 goals.

JRC guidelines start from investments (assets). These are then linked to functionalities. And Functionalities are then related to benefits. On the basis of EPRI's methodological approach, JRC add and modify some steps to make it conformed with European practices of smart grid. The step by step process of JRC framework is as follows:

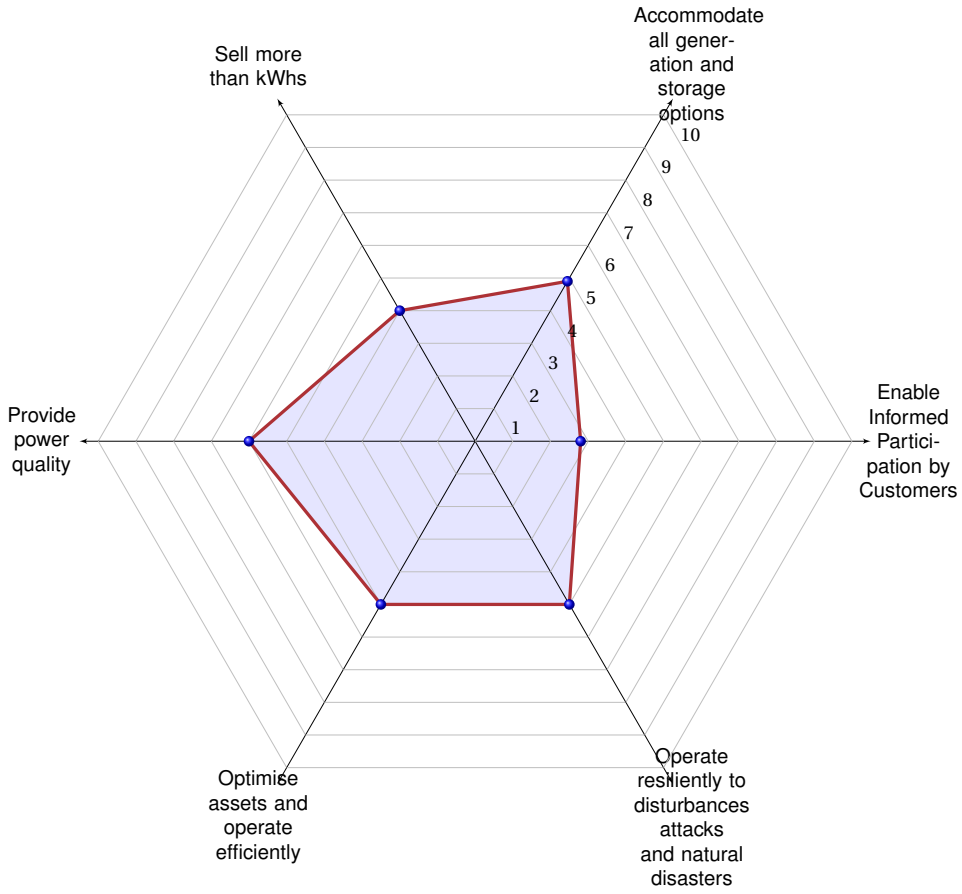

Figure 1: An example of post–processing of the questionnaire (Application to Italy)

1. Identify Project and Its Technologies
2. Identify Functionalities
3. Map each functionality to standardized benefit
4. Quantify Benefit
5. Estimate Cost
6. Compare Benefit and Cost

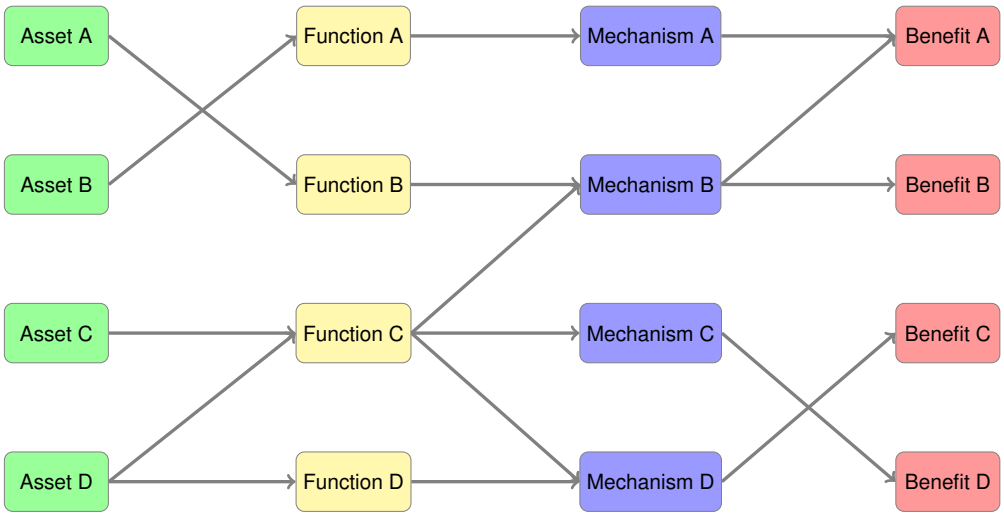

Figure 2: Illustration of Asset, Function, Mechanism, Benefit Mapping

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

Based on the JRC guidelines, first steps have been taken to develop a simplified/practical approach. The following example of a energy storage device installed on a LV distribution grid illustrates how costs and benefits are quantified using the developed approach.

Input Data

Storage size (kW)	100kW
Storage size (kWh)	25kWh
Installation costs	45'000 €
Storage type	Sodium Nickel
Yearly number of avoided transient interruptions and voltage dips	25
Yearly number of avoided short and long interruptions	12
Mean duration of the interruptions	3 min
Rated power of MV/LV transformer (kVA)	100kVQ
Specific cost of transient interruptions and voltage dips (€/int)	4€/kW
Specific cost of short and long interruptions (€/int)	0.18€/min/kW
L/f control requirements	0.015

Services and related benefits

Improve the continuity of service (SAIFI)	2'400.00 €
Improve the continuity of service (SAIDI)	324.00 €
Improve the quality of supply	5'000.00 €
L/f control and synthetic inertia	2'365.00 €
TOTAL	10'089.00 €

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

- Finalization of the questionnaire:
- Dissemination the questionnaire:

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

- Preparation a report including a preface with an “how to” guide

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

- Creation of a guide/tool to let policy makers and other stakeholders learn the general framework of CBA shared at ISGAN level