Project no.: 282794

GRID+

SUPPORTING THE DEVELOPMENT OF THE EUROPEAN ELECTRICITY GRIDS INITIATIVE (EEGI)

Instrument: Coordination and support action
Thematic priority: ENERGY.2011.7.3-1 - Network of projects developing the future European electricity Networks
Start date of project: 01 October 2011
Duration: 36 months

D 4.2

DATA COLLECTION OF DSO PROJECTS

Revision: r0

Submission date: 2013-10-31

Comillas

Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential , only for members of the consortium (including the Commission Services)	

Submitted

Author(s)		
Name	**Organisation**	**E-mail**
L. Sigrist	Comillas	Lukas.sigrist@iit.upcomillas.es
K. May	KU Leuven	Kristof.May@esati.kuleuven.be
L. Rouco	Comillas	Luis.rouco@iit.upcomillas.es

Status of deliverable		
Action	**By**	**Date**
Verified		
Approved (GC)		

Abstract

Version history

Date	Version	Author(s)	Comments
2013-10-10	01	L. Sigrist, L. Rouco	First issue
2013-10-19	01	K. May	Revision
2014-02-07	01	L. Sigrist	Second revision

TABLE OF CONTENTS

Page

LIST OF ABBREVIATIONS

Abbreviation	Describtion
AMI	Automatic Metering Infrastructure
AMR	Automatic Meter Reading
AMS	Automatic Metering System
ANM	Active Network Management
CPU	Central processing unit
GPU	Graphic processing unit
IRR	Internal rate of return
NPV	Net present value
LV	Low voltage
MV	Medium voltage
OFDM	Orthogonal frequency division multiplexing
RES	Renewable energy source
ToU	Time of use

EXECUTIVE SUMMARY

GRID+ aims at ensuring cooperation among Member States in view of clustering national demonstration projects, mapping them to the implementation plan of the EEGI, thus leveraging on potential complementarities and fostering the extraction of the maximum European added value, and ensuring an optimal use of resources.

The objectives of Work Package 4 are to determine the scalability and replicability of smart grid projects of the EEGI, to propose methods and tools for this purpose and to propose solutions for enhancing the scalability and replicability of on-going and new projects.

The purpose of task 4.2 is to identify the data to be collected from DSO projects of the EEGI in view of scalability and replicability and to collect the data subsequently. The data collection itself is carried out by means of a set of questionnaires, which are answered by the project demonstrators of the analyzed projects. Project demonstrators are then the target audience. Whereas scalability and replicability factors already describe requirements for scalability and replicability, the answers to the questionnaires show the achievements and barriers.

In a first step, the scalability and replicability factors described in [4] have been revised and the methodology for the data collection of smart grid projects has been summarized. It is worthwhile to mention that the list of factors is not exhaustive and factors might be removed or added according to the demonstrators' answers to the questionnaires. The methodology consists in collecting data of DSO project demonstrators by means of questionnaires in order to assess and evaluate the identified scalability and replicability factors. Both, on-line and an off-line questionnaires have been used for that purpose. Whereas scalability and replicability factors already describe the requirements for scalability and replicability and thus necessary conditions, the answers to the questionnaires will show the achievements and barriers.

Finally and since different questionnaires have been used, the way answers have been received is analyzed. This gives a first insight into what type of questionnaire is more successful. So far, the InfoPath-written and Word-written questionnaire have been mainly used. The on-line questionnaire has been hardly used. In addition, a preliminary analysis of the participation and of the received answers of the questionnaires has been provided. With an average completeness of around 89% it can be stated that the received questionnaires were conclusively answered. The multiple choice questions and the questions regarding the importance of issue tackled by the questionnaire were fully answered by all projects. Questions asking for a description of a particular subject have been left blank sometimes, especially when the asked description is optional.

1 INTRODUCTION

1.1 Project Scope

GRID+ aims at ensuring cooperation among Member States in view of clustering national demonstration projects, mapping them to the implementation plan of the EEGI, thus leveraging on potential complementarities and fostering the extraction of the maximum European added value, and ensuring an optimal use of resources. The GRID+ project is a "Coordination and support action" that provides the necessary support to the EEGI Team (research centres, small and medium enterprises, universities, in close coordination with ENTSO-E and EDSO4SG)[1] during the 2012-2014 period.

1.2 Work Package 4

The objectives of Work Package 4 are to determine the scalability and replicability of smart grid projects of the EEGI, to propose methods and tools for this purpose and to propose solutions for enhancing the scalability and replicability of on-going and new projects.

The EEGI aims at accelerating innovation and development of the electricity networks of the future in Europe. Its RD&D programme focuses on system innovation rather than on technology innovation, and addresses the challenge of integrating new technologies under real life working conditions and validating the results. The functional demonstrators of the EEGI programme therefore aim at verifying at full-scale the functionality, usefulness, validity, interaction, and coordination of the different smart grids technologies and solutions envisaged. Currently, most smart grid projects are still in the R&D or the demonstration phases. The full roll-out of the tested solutions requires a suitable degree of scalability and replicability to avoid that demonstrators remain local experimental exercises.

Scalability can be defined as the ability of a system to change its scale in order to meet growing volumes of demand [1], [2]. A system is understood as a set of interacting elements with similar boundary conditions. By contrast, replicability denotes the property of a system that allows it to be duplicated at another location or time. Scalability and replicability are the preliminary requisite to perform scaling-up and replication successfully.

In order to achieve the objectives, Work Package 4 aims at providing a practical common tool that can be used in support of actual R&D projects. For that purpose, the following needs to be achieved:

- Identification of factors affecting scalability and replicability
- Data collection from smart grid projects to evaluate the factors
- Evaluation of the factors
- Derivation of rules and barriers for scalability and replicability

Scalability and replicability of smart grid projects are affected by factors, which have been identified in task 4.1 by means of a review of the state of the art of complex systems and smart grid

[1] The EEGI team is a team set up under the European Electricity Grid Initiative (EEGI) in order to provide a platform for planning and programming of actions to implement the EEGI.

projects. The results of task 4.1 are summarized in the deliverable D4.1 [4]. These factors are necessary conditions, describing the requirements for scalability and replicability.

Data collected from projects will assess and evaluate the identified scalability and replicability factors. The methodology for the data collection of smart grid projects has been presented in [3]. The data collection itself is the objective of task 4.2 and 4.3 and their corresponding deliverables D4.2 and D4.3. Task 4.2 is dedicated to DSO project demonstrators, whereas task 4.3 is dedicated to TSO project demonstrators. Task 4.4 is dedicated to the evaluation of the data collection and the identification of barriers and rules.

1.3 Data collection on scalability and replicability of DSO project demonstrators

The purpose of task 4.2 is to identify the data to be collected from DSO projects of the EEGI in view of scalability and replicability and to collect the data subsequently. DSO project demonstrators are the target audience.

A first requirement of this task is to define the data to be obtained from the different project demonstrators. The methodology for the data collection of smart grid projects has been presented in [3]. The data collection itself is carried out by means of a set of questionnaires which are answered by the project demonstrators of the analyzed projects.

The data to be collected and in particular the questionnaires depend on the scalability and replicability factors identified within task 4.1 [4][2]. Scalability and replicability factors already describe requirements for scalability and replicability. The answers to the questionnaires show the achievements and barriers. Actually, questions are closely linked to the factors.

Task 4.2 focuses on collecting data on the scalability and replicability of DSO project demonstrators of the EEGI. Candidates for DSO project demonstrators are for example the GRID4EU and LINEAR demonstrators. Other national and European project demonstrators are included as far as possible.

First, scalability and replicability factors are revised and the methodology is summarized. The data collection of DSO project demonstrators is based on questionnaires. Both, on-line and an off-line questionnaires are used for that purpose. The complete questionnaire can be found in the appendix.

Finally, some statistics on the answering of the questionnaires are given. In particular, the number of participants, the number of questions fully answered and the number of questions not answered are analyzed. This provides an overview of the impact of the questionnaire and its easiness to fill it out.

The overall structure of task 4.2 is presented in Figure 1 .

[2] The questionnaires only assess the identified scalability and replicability factors. However, no given set of KPIs is evaluated. Actually, there are no specific KPIs so far that measure a project demonstrator's scalability and replicability.

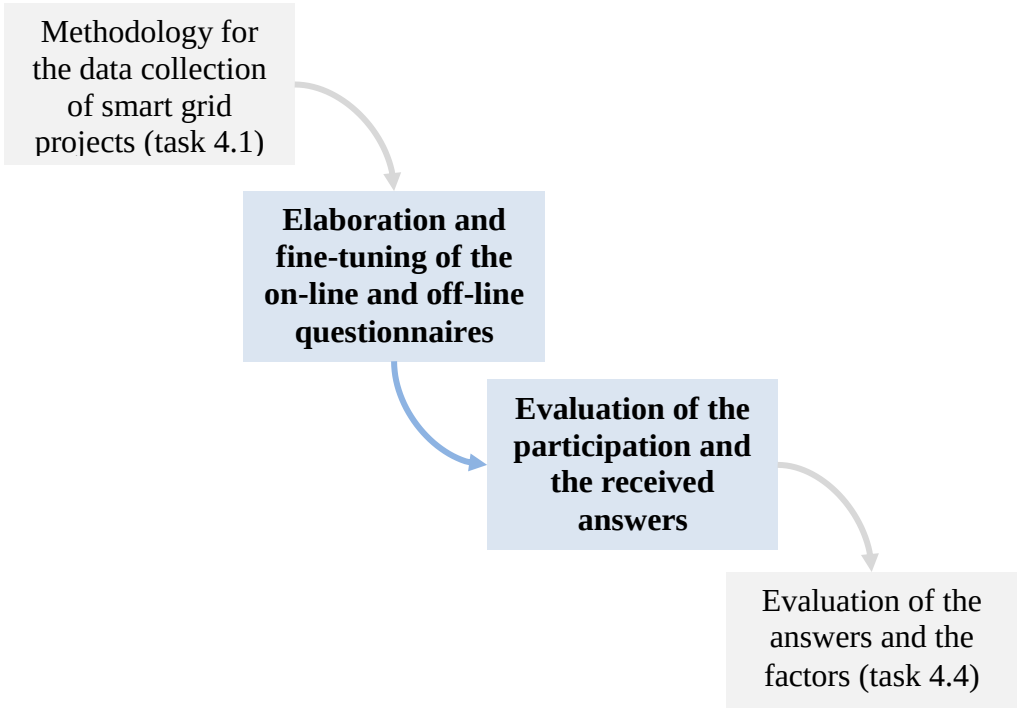

Figure 1: Overall structure of task 4.2.

2 SUMMARY OF THE DATA COLLECTION METHODOLOGY

This chapter revises scalability and replicability factors and it summarizes the methodology for the data collection of smart grid projects.

Firstly, the scalability and replicability factors, which have been identified in task 4.1 and which have been adapted in [4], are reviewed. In a second step, an overview of the methodology is given and its underlying idea is presented.

2.1 Scalability and replicability factors

Both, prototypes of highly complex systems and European and national distribution and transmission smart grid projects have been reviewed in terms of scalability and replicability. The basic idea behind this review was to find a list of factors, playing a role in assessing scalability and replicability of a system. The main factors for scalability identified by this review of complex systems and smart grid projects were [4]:

- Evolution of technology (adopted solution)
- Modularity (easy adding of new functionalities, etc.)
- Interface design (control strategies, etc.)

The main factors for replicability were [4]:

- Technological standardization (e.g., the use of developed and available solutions)
- Interoperability (e.g., the compliance with universal standards)
- Plug & play characteristics
- Availability (presence of resources, customer involvement, etc.)
- Regulatory conditions

Additional economic and technical aspects such as costs, losses, etc. also appear to be important for the actual scaling-up and replication of a solution. However, these aspects primarily show whether and to what extent it is worthwhile or not to scale or replicate. For example, economic aspects determine if a project is economically interesting for different stakeholders at different times and in different places.

Starting from this initial set of scalability and replicability factors, an extended set of factors has been deduced on the basis of work done by ENTSO-E and the experience gained through the analysis of distribution-related demonstrator projects. Table 1 and Table 2 show the extended set of scalability and replicability factors. Note that some of the economic and technical aspects identified in task 4.1 have been included [4]. This became necessary since for example costs are essential for scaling-up and replication. For instance, a scalable project might be scaled-up by using some kind of subsidies and instigates this way an increase of the production of some of the projects components, reducing the component's price and enabling the further scaling-up. Further it shall be mentioned that this list is not exhaustive and factors might be removed or added according to the demonstrators' answers to the questionnaires.

Areas	Subareas	Factors
Technical	Technology	Modularity

		Technology evolution
	Communication, control systems and interface	Interface design (interconnection with other systems)
		Software tools integration
	Infrastructure	Compatibility analysis
Economic	Economies of scale	Economies of scale
	Cost effectiveness	Profitability
Acceptance/involvement	Regulatory issues	Regulatory issues
	Consent by grid users, customers, local authorities and public	Consent

Table 1: Extended list of scalability factors with their corresponding areas and subareas.

Areas	**Subareas**	**Factors**
Technical	Technology	Standardization
		Interoperability
	Control systems and interface (both software and technology)	Standardization
		Interoperability
	Infrastructure	Network configuration (former: availability)
Economic	Profitability analysis	Macro-economic factors
	market design analysis (sensitivity analysis)	Market design
	Business model	Business model
Acceptance/involvement	Regulation	Regulation
	Acceptance	Acceptance

Table 2: Extended list of replicability factors with their corresponding areas and subareas.

Within this extended set, three main areas of scalability and replicability factors have been identified. The first area includes the technical factors. They determine whether the solution developed in a particular project is inherently scalable and/or replicable. Paying attention to these factors will not automatically guarantee the scalability/replicability, but a failure to do so will rule out any chances to it. They are therefore necessary but not sufficient conditions.

The second area, the economic factors, reflect whether it is economically viable to pursue scaling up or replication. This crucial step – validating whether investment analysis (NPV, IRR or similar)

and business models hold at a larger scale or in a different setting than the original case – is often neglected and constitutes a major barrier in gaining a critical mass.

The third and final area contains the factors related to acceptance and involvement of users, regulators, authorities and stakeholders. They reflect the extent to which the new environment is suitable for receiving the project.

2.2 Summary of the methodology for the data collection

The methodology consists in collecting data of DSO project demonstrators to assess and evaluate the identified scalability and replicability factors. The evaluation of the factors allows then quantifying the status quo of on-going and new projects with respect to the scalability and replicability, i.e., they provide a feedback on to what extent projects take into account these factors and on whether the projects' results and solutions are actually able to be scaled-up and replicated.

The data collection is carried out by means of questionnaires. Both, on-line and an off-line questionnaires are used for that purpose. Predefined answers have been formulated for nearly all questions (see appendix). The questions are closely linked to the scalability and replicability factors. Whereas scalability and replicability factors already describe the requirements for scalability and replicability, the answers to the questionnaires show the achievements and barriers. The evaluation of a question translates its answer into a numerical value.

The methodology is summarized in Figure 2. For example, if a particular project is inherently scalable due to its technical design but benefits grow slower than costs do when increasing its size, the project is deemed to be potentially not scalable or it is only partially scalable. Similarly, if a particular project of country X is inherently replicable and its business model focus on loss reduction but country Y doesn’t incentive loss reduction, the project might be potentially not replicable in country Y. However, if the business model of the project can be adapted for example by envisaging the participation in reserve markets and this participation is allowed by the regulation of country Y, the project might be potentially replicable.

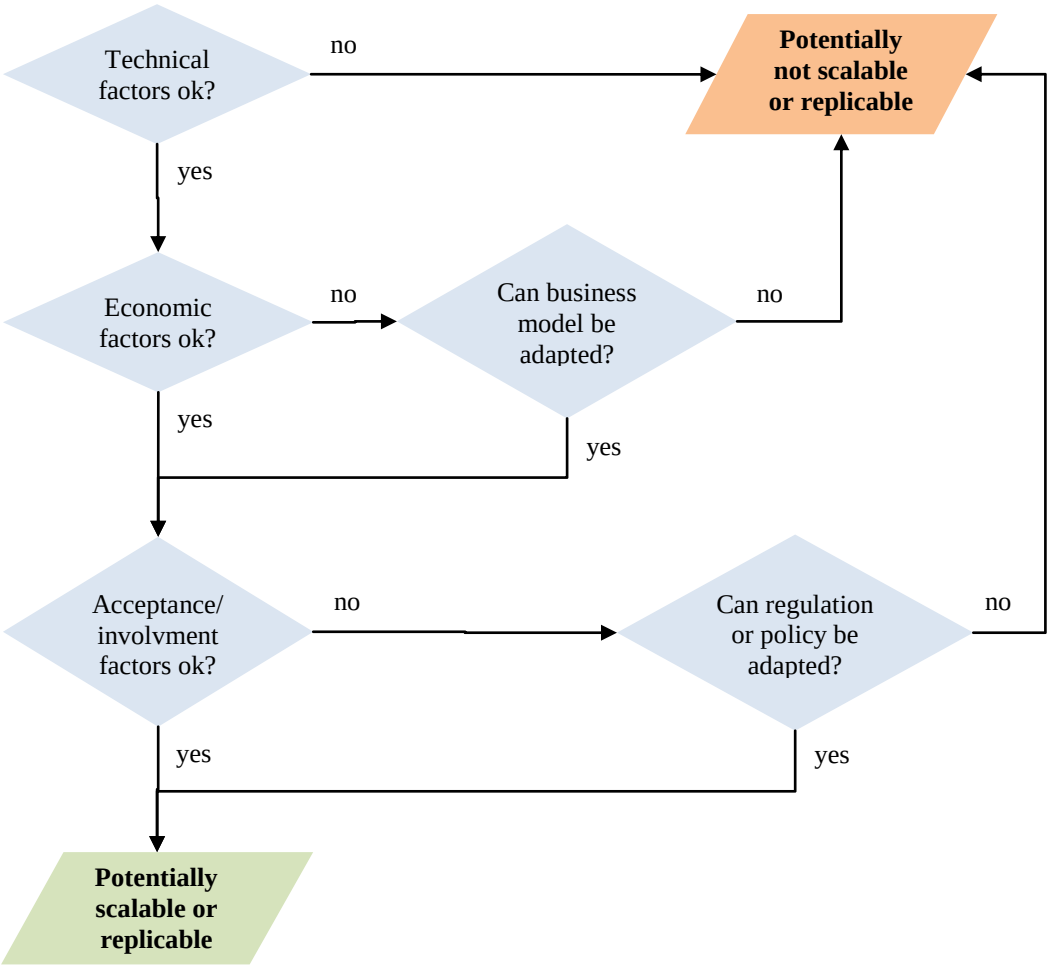

Figure 2: The overall methodology

In addition to the factor-related questions, additional questions on the project, its nature and on the importance of a specific question have been included. The latter provides a feedback on which questions and congruently, which factors the participant deems important.

3 PRELIMINARY ANALYSIS OF ANSWERS

Data collection has been carried out by means of on-line and off-line questionnaires. This chapter deals with the preliminary analysis of the participation and the received answers of the questionnaires. The idea is not to analyze the answers in detail, but to give an overview to what degree the questionnaires have been answered.

First and since different questionnaires have been used, the way answers have been received is analyzed. This gives a first insight into what type of questionnaire is more successful. In a second step, a preliminary analysis of the participation and the received answers of the questionnaires is provided, highlighting questions which are difficult to answer and congruently to evaluate, etc.

3.1 Type of questionnaires

The data collection of DSO project demonstrators is based on questionnaires. Three types of questionnaires have been initially elaborated and used: two off-line questionnaires and one on-line. The off-line questionnaires have been written in Word and InfoPath. The latter uses Microsoft SharePoint for sharing its answers. All three types of questionnaire are available to the participants. The advantage of this three-fold way of collecting data is that

- the on-line questionnaire improves the visibility of the problem and that, in theory, a larger target group of participants is available
- the off-line questionnaire are sent out and re-collected by email, allowing for a closer contact with the participant
- the off-line questionnaire can be partially filled in and forwarded, i.e., the answers can be saved.
- the off-line questionnaire can be filled in by various members of the same project demonstrator.

The answers of all three types of questionnaires can be exported to an Excel file. This greatly simplifies the analysis of the questionnaires.

At present, mainly Word-written and InfoPath-written questionnaires have been received. From the 6 received questionnaires, the following conclusions can be drawn:

- Web-based questionnaire:
  - This type of questionnaire has not been used so far.
  - The main drawback of this questionnaire is that answers cannot be saved and the questionnaire needs to be filled in at once.

- InfoPath-based questionnaire
  - This type of questionnaire has been sporadically used.
  - The advantage is that this questionnaire can be partially filled in and forwarded by email.
  - It can be filled in without opening a program (e.g., Word).

- Word-based questionnaire
  - This type of questionnaire has been mostly used.
  - The advantage is that this questionnaire can be partially filled in and forwarded by email.

- It is written in a well-known format.
- This type has been available from the very beginning, which explains to a certain extent is major use.

Table 3 shows an overview of the use and the type of used and answered questionnaire. So far, Word-based and InfoPath-based questionnaire has been used.

Type of questionnaire	Number of use
Web-based questionnaire	0
InfoPath-based questionnaire	3
Word-based questionnaire	3

Table 3: Overview of the type of questionnaire answered by DSO project demonstrators.

As a concluding remark, it can be said that the ability to save answers and share the questionnaire among members of a project demonstrator seems to be of high importance.

3.2 Statistics of answered questionnaire

Although the data collection is still on-going, some preliminary statistics can be extracted from the answered questionnaires.

3.2.1 Completeness of the answered questionnaires

With an average completeness of 88.61%, it can be stated that the answered questionnaires were conclusively answered. The multiple choice questions and the question regarding the importance of issue tackled by the questionnaire were fully answered by all projects. Questions asking for a description of a particular subject have been left blank sometimes, especially when the asked description was optional. Neglecting questions asking for a further description, the questionnaires were fully answered.

Table 4 provides a general statistic of the total number of unanswered questions. The statistics are given in function of the type of the question (technical, economical, and regulatory). Most unanswered questions are to be found within the group of the technical questions. This group contains the bulk of the questions (55.7%). However, in relative terms, most unanswered questions belong to the group of economic questions (18.75%).

Type of question	Number of questions in questionnaire	Total number of questions asked	Number of uncompleted questions	% uncompleted questions
Introductory questions	6	36	1	2.78%
Technical questions	42	252	24	9.52%
Economical questions	16	96	18	18.75%
Regulatory questions	15	90	11	12.22%
TOTAL	79	474	54	11.39%

Table 4: General statistics of the total number of unanswered questions by type.

Figure 3 graphically shows the answered and unanswered questions by participant.

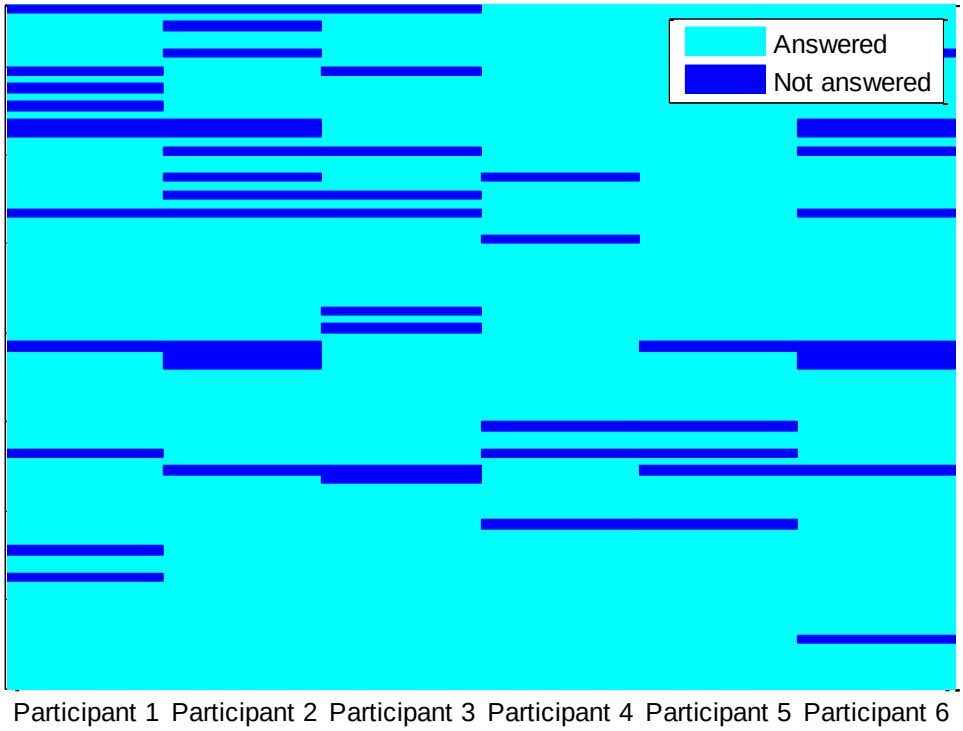

Figure 3: Representation of answered and unanswered questions by participant.

It can be readily seen that most questions were answered by all participants. Sometimes, a particular question was not answered by more than one participant. The questions, which were not answered by all or at least 75% of the participants, are:

- "*Does the correct functioning of the solution depend on a natural resource that is specific/abundant in the current environment? If yes, which resource?*", and in particular, the optional description,
- "*Is the solution standards compliant? If yes, with which standards (mandatory, voluntary, open or proprietary)? Could you mention the benefits and/or challenges you expect for being your system/solution compliant with the contemplated standards?*", and in particular, the optional description of the challenges

3.2.2 Importance of treated topics seen by projects

The questionnaire also tries to determine whether projects consider the factors described in section 2.1 as important for their project. The intention behind this is to verify which scalability and replicability factors are seen by the project as important today and which are neglected. This way, a feedback is provided on the importance of the factors.

The majority of the factors approached during the survey are considered as important by the project themselves. On the average, 69% of the factors are important and 23% of the factors have been equally evaluated as important and unimportant. 69% of the factors questioned by the questionnaire are seen as important by at least 71% of the surveyed projects.

Finally, 82% of the participants do not consider the question "*Can your solution be exported to other countries and still be profitable considering the different macro-economic factors?*" as important.

4 REFERENCES

[1] Yaneer Bar-Yam, "Concepts: Scale", New England Complex System Institute, 2011. Available at http://necsi.edu/guide/concepts/scale.html.

[2] Bonnefoy, Philippe; Hansman, R. John, "Scalability of the Air Transportation System and Development of Multi-Airport Systems: A Worldwide Perspective", MIT, Report No. ICAT-2008-02, 2008.

[3] GRID+, D4.1b – Methodology for the data collection of smart grid projects, October 2013.

[4] GRID+, D4.1 – Review of the state of the art, January 2013.

5 APPENDIX

The appendix contains the Word-based questionnaire.

Questionnaire on Scalability and Replicability

Welcome to the GRID+ project

The overarching goal of the GRID+ project is to implement and support the management, planning and networking process of the European Electricity Grid Initiative (EEGI) over the years 2012-2014. The aim is to align the activities of demonstration projects within and beyond the European borders with the objectives of the EEGI roadmap. This will enhance the delivery by the European network operators of the new knowledge needed to deploy Smart Grid solutions in the most effective way possible in EU27. This questionnaire on Scalability and Replicability is a part of the WP4 of the GRID+ project.

What is the purpose of this questionnaire?

This questionnaire investigates the scalability and replicability of smart grid projects i.e. how can the technical solution of your demo project be deployed on a larger scale, and how can it be transferred to other countries? It takes +/-45min to answer.

The final goal is to create, for the very first time, a guideline for new projects to come concerning what is needed to be taken into account to be scalable and/or replicable. For more information, see: http://www.gridplus.eu/.

Who should fill it in?

The target group of this questionnaire are EEGI projects, both European and national ones. When answering the questions, the main focus should be on the network operator's (DSO/TSO) point of view and thus on **system solutions** (e.g. network planning & operation solutions).

Demonstrator leaders are encouraged to answer this questionnaire. However, additional input (on standards, interoperability, technology evolutions, etc.) might be provided by or in collaboration with the remaining project demonstrator's partners (manufacturers, ICT providers, etc.).

Why is filling out this questionnaire important for your demo?

Multiple smart grid projects test technology and functionalities on a small scale and the full roll-out of their solutions and functionalities depends on the projects' scalability and replicability. Scalability and replicability allow for growth and reuse of project demonstrators and they avoid project demonstrators of being merely a local experimental exercise.

It is crucial to notice that this questionnaire is not aiming to judge the demonstrator projects' work on scaling and/or replication. It is neither the intention to judge the demonstrator's scalability and replicability. However, filling in the questionnaire is very beneficial for the following reasons:

- A major objective of GRID+ is to study and identify rules for and gaps of scalability and replicability of smart grid projects. The general results of the analysis of the received questionnaires will be publicly available. Achievements and barriers with respect to scalability and replicability will be highlighted. Results and answers specific to your project demonstrator will be anonymized for that purpose.

- A particular analysis of the questionnaire is provided to each participant, highlighting strong and weak aspects of its project demonstrator with regard to scalability and replicability. This particular analysis is for the participant only and it is not publicly available.
- Each participant might receive contact information of project demonstrators that successfully addressed an aspect determined as weak of the participant's project. This allows your demonstrator to learn from experiences with other demonstrators.
- The questionnaire and its results might be of interest for projects envisaging a continuation of their demonstrator activities.
- Filling-in the questionnaire repeatedly over a certain time horizon provides the participant with useful information about the evolution its project's scalability and replicability.
- The EEGI labelling process includes criteria on scalability and replicability.

The answers to the questionnaire will be public within GRID+, i.e. accessible by all GRID+ project partners, but the answers will not be publicly available outside GRID+ and the results will be anonymized.

Contact info:

Lukas Sigrist
lukas.sigrist@iit.upcomillas.es

Questionnaire manual and definitions

Manual:

The questionnaire is structured into four main categories: introductory questions, technical questionnaire, economical questionnaire and regulatory questionnaire. Most questions propose predefined answers to the questions, which could be enriched with additional information. This allows participants to respond quickly and in detail if they want. For some questions however, it will be mandatory to provide the additional information.

Definitions:

- **Scalability** can be defined as the ability of a system to change its scale in order to meet growing volumes of demand (e.g. increasing the number of elements interacting in the system).
- A system is understood as a set of interacting elements with similar boundary conditions.
- By contrast, **replicability** denotes the property of a system that allows it to be duplicated at another location or time (e.g. duplicating a system somewhere else).
- **Components** are derived from the use case information on actors[3]. Actors can be of type devices, applications, persons and organizations. For example, power system equipment (typically located at process and field level), protection and tele-control devices, network

[3] CEN-CENELEC-ETSI Smart Grid Coordination Group, "Smart Grid Reference Architecture", November 2012.

infrastructure (wired / wireless communication connections, routers, switches, servers) and any kind of computers.

Introductory questions

1.1 Name of the demo project:

Your answer

1.2 Contact information and your function within the demo project:

Your answer

1.3 Could you shortly describe the demo project?

(Which objectives does the demonstrator aim at and which solution(s) to achieve them will the demonstrator team develop?)

Your answer

1.4 Which technological components (devices, applications, etc.) are necessary to realize the demonstrator's objectives? (e.g., see component level of the SGAM, p. 27, 35 and 67[4])

E.g. a new type of smart plug, new PMU

Your answer

1.5 Do you have plans to investigate the scalability and replicability of your project? If yes, describe them briefly. If not, why not?

☐	Yes
☐	No, not considered yet
☐	No

If yes, describe the plans briefly. If no, why not?:

[4] CEN-CENELEC-ETSI Smart Grid Coordination Group, "Smart Grid Reference Architecture", November 2012.

Your answer

Technical questionnaire on Scalability and replicability

2.1 Can you easily (technically) add components to your solution to increase your solution's size? If yes, which ones and how? If no, why not?

E.g.: Additional PMUs or smart meters can be integrated into the solution without any technical difficulty and at a low cost.

☐	Yes, with major change
☐	Yes, with certain change
☐	Yes, with minor change
☐	No, not considered yet

Describe which ones and how or why not (optional):

Your answer

Do you consider this important for your project?

☐	Yes
☐	No

2.2 Are there limits, affecting the proper functioning of the solution, on adding extra components within your solution (if any). If yes, explain what the constraint in the technical solution will be.

E.g.: A data concentrator can manage a certain number of data sources. If the number of data sources increases to an extent the data concentrator is not able to cope with, an upgrade is needed (implying increased fixed costs).

☐	Yes, major limits
☐	Yes, certain limits
☐	Yes, minor limits
☐	No

Describe that constraints and why they arise (optional):

Your answer

2.3 Does the current infrastructure where the project is deployed (outside of your solution), create any limits on the maximum size that can be reached? If yes, what are these external limits and can they be easily overcome?

E.g.: Rating of the substation transformer that allows hosting a RES project; alternatively, more parallel substation transformers are needed

☐	Yes, major limits
☐	Yes, certain limits
☐	Yes, minor limits
☐	No

Describe the limits and how they can be overcome (optional):

Your answer

Do you consider this important for your project?

☐	Yes
☐	No

2.4 How is the interaction between the components controlled? If control is organized centrally, describe how this is done and indicate at which level centralized control is needed/optimal.

E.g.: On Load Tap Changers could be centrally controlled to solve voltage issues; residential heaters could be centrally controlled to support the integration of PV panels. This control is most optimally organised at national/regional/local/etc. level.

☐	Centralized
☐	Decentralized

If centralized, describe the control briefly and its level (mandatory):

Your answer

Do you consider this important for your project?

☐	Yes
☐	No

2.5 Do you foresee technological advances in the short to medium term that will make adding components easier (technologically)? If yes, which ones and why?

E.g.: The introduction of IEC 61850 – a standard for the design of electrical substation automation – could make it easier to include components into a substation; Replacing a data concentrator which only reads meters by a new data concentrator with automation capabilities (reading meters, automate secondary substations, control switches, etc.).

☐	Yes
☐	No

Describe which ones and why (optional):

Your answer

Do you consider this important for your project?

☐	Yes
☐	No

2.6a If some components are software products (tools, databases, models, etc.), does the growth of your solution affect their performance (calculation time, etc.)? If yes, how and why? If no, why not? Are there other limits to the software solution (if applicable)?

E.g.: Computation effort of simulations explodes with increasing model size; Computation effort of optimization tools used for dispatching units explodes with increasing number of units.

☐	Yes, major impact (go to 2.6b)
☐	Yes, certain impact (go to 2.6b)
☐	Yes, minor impact (go to 2.6b)
☐	No

Describe how and why or why not (optional):

Your answer

Do you consider this important for your project?

☐	Yes
☐	No

2.6b Do you foresee technological advances in the short to medium term that will mitigate a possible performance reduction?

E.g.: Improved CPUs or using unused resources such as GPU

☐	Yes
☐	No
☐	Not of importance

If yes, describe these advances (optional):

Your answer

2.7 Does the correct functioning of the solution depend on a natural resource that is specific/abundant in the current environment? If yes, which resource?

E.g.: the availability of wind for wind power generation in a specific geographic area

☐	Yes, major reliance
☐	Yes, certain reliance
☐	Yes, minor reliance
☐	No

Describe the resource (optional):

Your answer

Do you consider this important for your project?

☐	Yes
☐	No

2.8 Is the functioning of the solution influenced by the specific infrastructure of the location of your demo? If yes, by which aspects?

Possible aspects: Terrain conditions (mountains vs. lowlands / forest vs. desert), local generation mix, demographics (urban vs. rural population), size of the given area and distances, etc.

☐	Yes, major influence
☐	Yes, certain influence
☐	Yes, minor influence
☐	No

Describe this infrastructure (optional):

Your answer

Do you consider this important for your project?

☐	Yes
☐	No

2.9 Is the solution standards compliant? If yes, with which standards (mandatory, voluntary, open or proprietary)? Could you mention the benefits and/or challenges you expect for being your system/solution compliant with the contemplated standards?

E.g.: Compliance with proprietary standards will usually not enhance replicability when the solution is applied to another utility.

☐	Yes, mandatory standards
☐	Yes, voluntary standards
☐	Yes, open standards
☐	Yes, proprietary standards
☐	No

Standards	Benefits	Challenges
Your answer	Your answer	Your answer

2.10 Is the solution easily (economically <u>and</u> technically) made compliant with a defined different set of standards? If yes, describe how? If no, explain why not?

E.g.: convert or adapt your proprietary standard to an open standard

☐	Yes, with major change
☐	Yes, with certain change
☐	Yes, with minor change
☐	No

Describe how (optional):

Your answer

2.11 Are all components/functions of your solution plug & play, i.e. able to adapt their working and interactions to a different setting? If no, which ones not? If yes, why and how has the plug & play characteristic been obtained?

☐	Yes, all units are plug & play
☐	Yes, the majority of the units are plug & play
☐	Yes, certain units are plug & play
☐	Yes, a minority of the units are plug & play
☐	No, none are plug & play

Describe why and how (optional):

Your answer

Do you consider this important for your project?

☐	Yes
☐	No

2.12 Can the solution be easily deployed in different environments without additional investment (time/money)? If no, why not? If yes, describe how?

E.g.: Can a component provided by manufacturer A in a utility be substituted by a component provided by manufacturer B?

☐	Yes, with major investment
☐	Yes, with certain investment
☐	Yes, with minor investment
☐	No

Describe how or why not (optional):

Your answer

2.13 Is your approach/solution evaluated at or even applied to another utility/grid operator? If no, why not? If yes, why and how is it applied?

E.g. No, the demo is an innovative solution and we are not aware of an application elsewhere; Yes, the suppliers of the components of the solution are aware of a similar solution being tested in …

☐	Yes
☐	No
☐	Not yet considered

Describe why and how (optional):

Your answer

Economical questionnaire on Scalability and replicability

3.1 Is the actual project economically viable? If yes, what is the main reason for the benefits being larger than the costs (summarize briefly)? If no, why not?

Your answer

3.2 Do you foresee evolutions in the short to medium term which will have a positive influence on the cost-benefit ratio of your solution?

E.g.: More wind power, cheaper smart meters, etc.

☐	Yes, evolutions with major influence
☐	Yes, evolutions with certain influence
☐	Yes, evolutions with minor influence
☐	No

If yes, describe the evolutions (optional):

Your answer

3.3 If the size of your solution increases, how does the cost of your solution increase (economies of scale)?

E.g.: If the number of wind generator in a RES project is increased by 10%, the incurred costs are less then 10%; if the number of wind generators is increased by 10%, the system savings amount at least to 10% with respect to the current system costs

Your answer

Have you considered this for your project?

E.g.: Plans existing to scale the demo up to regional or national level.

☐	Yes
☐	No
☐	Not yet considered

Describe why or why not (optional):

Your answer

3.4a The profitability of your solution when exported to a different country depends strongly on the different macro-economic factors. The influence of these factors can typically be found via a limited scenario analysis on a few selected target countries. Have you undertaken or do you plan such an analysis?

E.g.: Case studies for the deployment of your solution in other regions

☐	Yes (go to 3.4b)
☐	No

Describe for which countries (optional):

Your answer

3.4b Can your solution be exported to other countries and still be profitable considering the different macro-economic factors?

E.g.: the discount rate which defines the initial investment is a function of the inflation and the interest rate. These factors can differ between countries, leading to different initial investment costs. Another possible factor might be carbon cost.

☐	Yes, major effort
☐	Yes, certain effort
☐	Yes, minor effort
☐	No

Describe (optional):

Your answer

Do you consider this important for your project?

☐	Yes
☐	No

3.5a Is the project still economically viable under a different setting (e.g., other EU member state)? Do you already have plans for exporting your solution abroad?

It is highly likely that the original project's business model will not hold – at least not without modification – in a new setting. E.g.: the deployment of distributed generation could help reduce distribution grid losses. However, not all European countries incentivize loss reduction.

☐	Yes, we made an analysis and it is viable and concrete plans exist to export the solution abroad (go to 3.5b)
☐	Yes, we made an analysis and it is viable. However NO concrete plans exist to export the solution abroad (go to 3.5b)
☐	No, we made an analysis and it is NOT viable
☐	We have not yet made an analysis

If no, please describe why not (optional)?

Your answer

Do you consider this important for your project?

☐	Yes
☐	No

3.5b If so, which barriers (economically and regulatory) did you detect?

Regulatory barriers	Economic barriers
Your answer	Your answer

Regulatory questionnaire on Scalability and replicability

4.1 Are there any regulatory barriers with respect to the size and scope of the project? If yes, which ones and how do they affect the project's solution?

E.g.: In Spain, the ability of photovoltaic plants to choose its economic regime (selling at a tariff or participating in the market and obtaining a premium) is restricted by a maximum installed capacity and by the requirement that these plants are connected to the grid through a single transformer.

☐	Yes, major barriers
☐	Yes, certain barriers
☐	Yes, minor barriers
☐	No

Describe which ones and how they affect the project's solution (mandatory):

Your answer

Do you consider this important for your project?

☐	Yes
☐	No

4.2 Is stakeholder acceptance important for your project? If yes, explain.

E.g.: Some stakeholders like regulators, policy makers and end users aren't ready to embrace a new project, e.g. the construction of a new overhead line; some field tests (LINEAR project) require an important financial effort from the participants, for example, to buy smart house appliances.

☐	Yes, of major importance
☐	Yes, of certain importance
☐	Yes, of minor importance
☐	No

If yes, explain why (optional):

Your answer

4.3 Do you foresee any challenges with respect to the stakeholder acceptance? If yes, which ones and how could they be overcome?

E.g.: End users aren't always ready to embrace the construction of a new overhead line.

☐	Yes, major challenges
☐	Yes, certain challenges
☐	Yes, minor challenges
☐	No

Describe which ones and how they could be overcome (mandatory):

Your answer

4.4a Does your solution depend on elements of current national or regional regulation that are necessary for your solution to be feasible and viable? If yes, which ones (describe these elements briefly)?

E.g.: In France, strong landscape protection slows down wind power deployment (prior to 2005, wind farms must not exceed 12 MW to benefit from the power purchase obligation, for the ultramarine department this still holds). In some European countries, it is not clear whether energy storage systems provide grid services or utility services with the corresponding impact on the ownership of such systems; In Spain, neither DSO nor TSO can interact with electric vehicles to optimize grid operation because it is not permitted by regulation; In Switzerland, the PV feed-in is capped by law, but in Germany not; Regulatory consistency may guarantee return on the investment; Tariff structure and remuneration schemes; Market players

☐	Yes (go to 4.4b)
☐	No

Describe which ones or why not (mandatory):

Your answer

Do you consider this important for your project?

☐	Yes
☐	No

4.4b Are there barriers arising from the dependency on those elements of current regulation for the feasible deployment of your solution in other environments?

☐	Yes, major barriers
☐	Yes, certain barriers
☐	Yes, minor barriers
☐	No

Describe the barriers (mandatory):

Your answer

4.5 Do you foresee acceptance problems when exporting your solution to other countries?

Acceptance of the solution by the stakeholders is key. It will be more difficult for them to embrace something entirely new, rather than a larger version of something that already existed.

☐	Yes, major problems
☐	Yes, certain problems
☐	Yes, minor problems
☐	No

Describe the acceptance problems (optional):

Your answer

Do you consider this important for your project?

☐	Yes
☐	No

Thank you very much for completing this questionnaire!
Please send the completed version to lukas.sigrist@iit.upcomillas.es.