WP7: D7.10

Final report on dissemination activities and description of exchanged experiences

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Report describing and evaluating the dissemination activities carried in IGREENGrid Project. This document also includes a short description on exchanged experiences on demonstrations and validation of the proposed solutions.			

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Abstract

The target of the “Final report on dissemination activities” (D7.10) is to describe and evaluate the dissemination activities carried in IGREENGrid Project. This document also includes a short description on exchanged experiences on demonstrations and validation of the proposed solutions.

Additionally this report allows:

- To summarize the dissemination activities.
- To manage/present the impact of the dissemination activities with the scientific communities and targeted audiences.
- To present the future dissemination activities.

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1 Introduction and scope of the document

The final report on dissemination activities shows a picture of all the dissemination activities conducted so far on the project and the future dissemination activities planned after the end of the project. It summarizes the activities carried out in order to introduce the project to external parties and internally according with the dissemination strategy defined at the beginning of the project [D7.1]. This document has been elaborated within the framework of the dissemination Work Package (WP7).

A particular highlight is provided concerning the main activities done in the second period by the dissemination Work Package. These are:

- Update the public web site and feed the social media with most up to date news of IGREENGrid and including synthesis of the confidential deliverables;
- Four Stakeholders Committee meetings;
- Four workshops including a common event with SiNGULAR and SuSTAINABLE projects;
- Publish two IGREENGrid newsletters.

1.1 Scope of the document

This document is organized as follows:

- Chapter 2 describes the dissemination plan objectives.
- Chapter 3 presents the communication roadmap updates and the project publications.
- Chapter 4 introduces the Stakeholders Committee and summarizes their opinion about the first results.
- Chapter 5 presents the main actions made concerning the website, social media, media publications, …
- Chapter 6 summarizes the IGREENGrid Public workshops contents and conclusions.
- Chapter 7 summarizes the IGREENGrid, SiNGULAR et SuSTAINABLE projects private dissemination activities.
- Chapter 8 summarizes the dissemination activities during the project and present the next dissemination activities scheduled.
- The Annex, in the chapter 9, presents a short description on exchanged experiences on demonstrations and validation of the proposed solutions.

1.2 Notations, abbreviations and acronyms

AD	Active Demand
ADMIE	Independent Power Transmission Operator in Greece
AMI	Advanced Metering Infrastructure
BA	Benefit Analysis
BAU	Business as Usual
CA	Cost Analysis
CAPEX	Capital Expenditures
CBA	Cost Benefit Analysis
CDF	Cumulated Distribution Function
DER	Distributed Energy Resources
DG	Distributed Generation
DMS	Distribution Management System
DRES	Distributed Renewable Energy Sources
DSE	Distributed State Estimator
DSM	Demand Side Management
DSO	Distribution System Operator
EC	European Comission
EEGI	European Electricity Grid Initiative
EPRI	Electric Power Research Institute
EU	European Union
HC	Hosting Capacity
ICT	Information and Communication Technologies
JRC	Joint Research Centre
KPI	Key Performance Indicator
LV	Low Voltage
MV	Medium Voltage
OLTC	On-Load Tap Changers
OPEX	Operating Expenditures
RTU	Remote Terminal Unit
PLF	Probabilistic Load Flow
PV	PhotoVoltaic
PVTC	Present Value of Total Costs
QoS	Quality of Supply
R&D	Research and Development
RES	Renewable Energy Sources
SCADA	Supervisory Control And Data Acquisition
SE	State Estimator
SG	Smart Grids
SM	Smart Meter
SRA	Scalability and Replicability Analysis
STATCOM	Static Synchronous Compensator

TSO	Transmission System Operator
WP	Work Package

Table 1 Acronyms

2 Dissemination Plan

At the beginning of the project, the Work Package 7 (WP7) produced the Dissemination Plan in order to define the most efficient ways to introduce the Project results internally and to third parties.

This plan aims at the following items:

- Proposing a dissemination policy for the knowledge and know-how shared by the projects.
- Defining the objectives of the shared dissemination actions.
- Defining the different types of communications, and the publication approval processes.
- Identifying the target audiences for each objective.
- Identifying the different communication delivery mechanisms
- Presenting a schedule of the dissemination actions along the three years of the projects.
- Summarizing the key factors of success for these shared dissemination actions.
- Proposing a methodology to assess the effectiveness at delivering information to the addressed stakeholders based on measurements of stakeholder feedbacks.

In this Plan, the communication needs have been identified and the communication channels to establish in order to satisfy the communication needs have been specified. The Dissemination Plan establishes the methodology to be followed for all dissemination activities during the project as the dissemination strategy.

The dissemination strategy of the project consists on planning and delivering an effective communication to all stakeholders concerned at both EU and national levels. Dissemination strategy is defined globally for all partners and for all demo projects (demonstrators) in order to ensure a wide impact at EU level.

In addition, the Dissemination Plan has defined the approval process for all dissemination materials, depending on the type of public.

3 Communication Roadmap update

The final version Communication roadmap defined in the [D7.1] was a table including internal and external events. In order to simplify the visibility of the information this table has been divided into two different tables one for internal dissemination activities and the other for external ones.

Table 2 summarizes the internal communication activities made during the project and the future actions. These activities are focused on sharing the knowledge of the project and results among the partners in order to facilitate the dissemination activities.

ID	Event	Audience	Event Objective	Chanel	Material	Responsible	When	Feedback Mechanism
1	Steering Committee	IGREENGrid Steering Committee members	Presenting global project progress	Committee	Internal presentation material	Iberdrola	19/06/2013 25/09/2013 27/11/2013 04/02/2014 09/04/2014 07/07/2014 28/10/2014 16/02/2015 04/05/2015 18/02/2016 31/03/2016	Minutes & Decision log
2	WP Leaders Meetings	IGREENGrid WP leaders	Presenting WP progress	Committee	Internal presentation material	Iberdrola	14/03/2013 13/05/2013 20/09/2013 08/11/2013 17/12/2013 21/02/2014 20/03/2014 09/04/2014 21/05/2014 27/08/2014 28/10/2014 16/02/2015 04/05/2015 29/06/2015 14/07/2015 19/10/2015 04/12/2015 14/12/2015 21/12/2015 11/01/2016 18/01/2016 01/02/2016 08/02/2016 18/02/2016	Minutes & Decision log

ID	Event	Audience	Event Objective	Chanel	Material	Responsible	When	Feedback Mechanism
							29/02/2016 07/03/2016 14/03/2016 21/03/2016 31/03/2016	
3	EC Meeting	European Commission	Presenting IGREENGrid global progress and focus on specific request by EC	Committee	Internal presentation material. Formal reporting	Steering Committee	15/01/2014 16/09/2015	Minutes & Decision log
4	Common private dissemination activities with SINGULAR and SuSTAINABLE Projects	DSO, DRES players, Manufacturers, Regulatory bodies, Standardization bodies, R&D institutions	Introduce projects assessments and outputs	Private Workshop	Packaged foreground publication	IGREENGrid, SINGULAR and SuSTAINABLE	10/04/2014 18/02/2015 26/11/2015	Proceedings of the 3 workshops available in the IGREENGrid Repository
5	IGREENGrid Repository online	Consortium members	Having qualified, up-to-date internal content on project website	Repository	All	Iberdrola	April 2013	Interview focus group
6	Create IGREENGrid posters	All	Displaying simple, key messages to be used during conferences, etc.	Conference/ Seminar	Poster	WP 7 contributor	Regularly	-
6	Create official presentation kits	All	Disseminating general information in an official, centralized format	All	Presentation kit	ERDF	Regularly	Interview

Table 2 Internal communication roadmap

Table 3 summarizes the external communication activities made during the project and the future actions. These activities are focused on sharing the knowledge of the project and the results among relevant audiences. They look for promoting IGREENGrid solutions and recommendations.

ID	Event	Audience	Event Objective	Chanel	Material	Responsible	When	Feedback Mechanism
1	Stakeholders Committee	Primary audience	Presenting global project progress	Committee	Internal presentation material	ERDF	25/09/2013 06/02/2014 30/10/2014 17/02/2015 17/07/2015 29/03/2016	Minutes & Decision
2	International Workshops for the Smart Grid Community	DSO, DRES players, Manufacturers, Regulatory bodies, Standardization bodies, R&D institutions	Introduce project assessments and outputs	Workshop	Packaged foreground publication	WP7	11/04/2014 04/12/2014 19/02/2015 22/10/2015	Proceedings of the 4 workshops available at the project website
3	Two additional events in collaboration with other relevant EU projects/initiatives	Energy community, Scientific community, Manufacturers	Introduce project assessments and outputs	Workshop	Packaged foreground publication	WP7	11/04/2014 19/02/2015 27/11/2015	Proceedings of the 3 workshops available at the project website
4	Common public dissemination activities with SINGULAR and SuSTAINABLE Projects	DSO, DRES players, Manufacturers, Regulatory bodies, Standardization bodies, R&D institutions	Introduce projects assessments and outputs	Public Workshop	Packaged foreground publication	WP7	11/04/2014 19/02/2015 27/11/2015	Proceedings of the 3 workshops available at the project website
5	Contribution to GRID+ activities	Primary audiences at international level	Disseminating detailed results per key business areas	Workshop	Packaged foreground publication	Iberdrola / ERDF	22/05/2014	Proceedings & contributions available online

ID	Event	Audience	Event Objective	Chanel	Material	Responsible	When	Feedback Mechanism
6	Conferences/ Seminars presentation	Primary Audiences	Presenting project and Disseminating detailed results	Conference/ Seminar	Packaged foreground publication;	WP7	See Table 4	Conferences proceedings available at the project website
7	Link from partners' websites to IGREENGrid website	Consortium members	Ensuring partners have a presentation of IGREENGrid (respecting its style sheet) and a link to project website on their Corporate website	Website	Corporate communication	ERDF	Q2 2013	Available at the project website
8	IGREENGrid project website online	All	Having qualified, up-to-date public (external) content on project website	Website	General communication; Interview; Newsletter, Press kit	ERDF	August 2013	Interview
9	Newsletter publication	All	Disseminating general communication, project updates, main achievements, etc	Website; Emailing	Newsletter	ERDF	August 2013 June 2014 January 2014 March 2016	Interview
10	Use of social networks	All	Introduce projects assessments and outputs	Internet	Presentation	ERDF and Iberdrola	Regularly	Interview
11	Press articles	Targeted depending on editorial positioning and topic addressed	Disseminating general communication, project updates, main achievements, etc.	Press	Press article	ERDF and WP leaders	Nine articles during the project	Feedback form; Focus group

Table 3 External communication roadmap

Finally, Table 4 presents the IGREENGrid publications or workshops participations of the project:

ID	Event	Type of event	Date	Responsible	Where	Type of material	Link
1	GENEDIS 2013	National	17/04/2013	Iberdrola	Madrid	Presentation	http://www.igreengrid-fp7.eu/conferences-events
2	Smart Grids Week - Salzburg 2013	National	13-17/05/13	EAG/SAG	Salzburg (Austria)	Poster	http://www.igreengrid-fp7.eu/conferences-events
3	Congreso de Metrologia	National	12-14/06/13	Iberdrola	Madrid (Spain)	Presentation	http://www.igreengrid-fp7.eu/conferences-events
4	European Utility week	International	15-17/10/13	GNF	Amsterdam (The Netherlands)	Presentation	-
5	Qatar Energy & Water Efficiency Conference	International	20/11/2013	Iberdrola	Doha	Posters	-
6	Innogrid 2020	International	26/03/2014	ERDF	Brussels	Presentation and posters	http://www.igreengrid-fp7.eu/conferences-events
7	Jornadas I+D CIGRE	National	27/03/2014	Iberdrola	Madrid	Presentation	
8	Hannover Messe STARGRID Workshop	International	10/04/2014	RSE	Hannover	Presentation	http://www.igreengrid-fp7.eu/conferences-events

ID	Event	Type of event	Date	Responsible	Where	Type of material	Link
9	Venteea Event	National	25/04/2014	ERDF	Toyes (France)	Presentation	-
10	European Master in Renewable Energy	International	28/04/2014	GNF	Zaragoza (Spain)	Presentation	http://www.master.eurec.be/en/Partnering-Universities/Spe-Grid-Integration-Univ-of-Zaragoza-Spain/
11	EEGI Team meeting 11	International	20/05/2014	Iberdrola	Brussels	Presentation	-
12	GRID+ Webinar cluster 2 DSO	International	22/05/2014	Iberdrola	Web	Presentation	http://www.grid4eu.eu/dissemination/all-news/grid4eu-participates-in-a-gridplus-webinar.aspx
13	Sustainable Energy week	International	24/06/2014	RSE	Brussels	Presentation	http://www.igreengrid-fp7.eu/conferences-events
14	CIGRE 2014	International	28/08/2014	ERDF	Paris	Presentation	http://www.igreengrid-fp7.eu/conferences-events
15	CIGRE 2014	International	28/08/2014	ICCS-NTUA	Paris	Paper	
16	IEEE Power & Energy Magazine	Magazine	January-February/2015	NETZOO, ENEL & ERDF	-	Article	http://ieeexplore.ieee.org/xpl/abstractAuthors.jsp?reload=true&arnumber=6999001
17	INNOGRID 2015	International	31/03/2015	Iberdrola	Brussels	Poster	http://www.igreengrid-fp7.eu/conferences-events
18	IEEE Power & Energy Magazine	Magazine	May-June/2015	IBERDROLA, ENEL, RSE, SAG, ICCS/NTUA,	-	Article	http://ieeexplore.ieee.org/xpl/articleDetails.jsp?reload=true&arnumber=7091082

ID	Event	Type of event	Date	Responsible	Where	Type of material	Link
				NETZOO			
19	CIRED 2015	International	16/06/2015	RSE	Lyon	Paper & Poster	http://www.igreengrid-fp7.eu/conferences-events
20	CIRED 2015	International	16/06/2015	ICCS-NTUA	Lyon	Paper and poster	http://www.igreengrid-fp7.eu/conferences-events
21	PowerTech 2015 - INCREASE Workshop	International	01/07/2015	ICCS-NTUA	Eindhoven	Presentation	http://www.igreengrid-fp7.eu/conferences-events
22	Smart Electric Distribution Systems and Technologies (EDST)	International	8-11/09/2015	ICCS-NTUA	Viena	Paper	http://ieeexplore.ieee.org/xpl/articleDetails.jsp?reload=true&arnumber=7315205
23	European Utility Week	International	3/11/2015	AIT	Viena	Presentation	-
24	Austrian PV conference	National	November 2015	AIT	Viena	Presentation	
25	14. Symposium Energieinnovation	National	10-12/02/2016	AIT	Graz (Austria).	2 Papers	
24	:3. Konferenz Zukünftige Stromnetze für Erneuerbare Energien	National	26-27/01/2016	AIT	Berlin	Paper	

ID	Event	Type of event	Date	Responsible	Where	Type of material	Link
25	Smart Grids Week	International	09-13.05.2016	Iberdrola	Linz (Austria)	Presentation	http://www.smartgridsweek.com/programm_en.html
26	Jornadas I+D CIGRE	National	19/05/2016	Iberdrola	Madrid	Presentation	-
27	CIRED Workshop	International	14-15/06/2016	AIT	Helsinki	Paper	
28	Energy Informatics Conference 2016	International	29-30/09/2016	AIT	Klagenfurt (Austria)	Paper	
29	IEEE ISGT Europe 2016	International	9-12/10/2016	AIT	Ljubljana (Slovenia)	Paper	

Table 4 Publications or workshops participations in the first period

Additionally, Table 6 in the chapter 5.5 presents other media publications.

4 Stakeholders Committee feedbacks

In order to draw on the analysis carried out during the Project and obtain feedback from reputed professional in distribution grid management and Distributed Renewable Energy Sources (DRES), IGREENGrid project contacted some relevant professionals (from energy sectors, equipment manufacturers, engineering companies, owners/operator of energy facilities, policy makers, R&D institutions,…) to form IGREENGrid Stakeholders Committee in order to incorporate the knowledge and expertise of this relevant energy professionals to the project. The main objective of the Stakeholders Committee is to collaborate in the following activities:

- Analyse and evaluate current situation, identifying the problems and obstacles presently restricting the large-scale integration of DRES in low and medium voltage grids.
- Propose solutions that could be tested during the Project.
- Provide feedback (according technical, regulatory and economic criteria) about inputs that could be taken into consideration and intermediate outputs.
- Carry out recommendations regarding Project outputs.

Table 5 present the Stakeholders Committee members:

Type of Stakeholder	Organisation	Members
Other Energy 2012.7.1.1 Projects	SiNGULAR	Anastasios Bakirtzis or João P. S. Catalão
	SuSTAINABLE	Antonio Aires Messias or Pedro Godinho Matos
	GRID4EU	Remy-Gauraude Verdier or Adel Jarifi
	GRID+	Javier González Gómez
R&D agents and Standardisation bodies	Technische Universität Wien (ESEA)	Wolfgang Gawlik
Other DSOs	SCOTTISHPOWER	Euan Norris
Manufacturers	General Electric	Said KAJAL
	SMA	Edoardo Tognon
	MASCHINENFABRIK REINHAUSEN GMBH	Manuel Sojer

Type of Stakeholder	Organisation	Members
	Fronius	Martin Heidl
Associations	ENTSO-E	Vu Van Thong, PhD
	EWEA	Arthuros Zervos
	T&D Europe	Massimiliano Margarone or Ian Paul or Giulano Monizza
	EPIA (European Photovoltaic Industry Association)	Manoël Rekinger
TSOs	ADMIE	George E. Koutzoukos
Consulting	CAP GEMINI	Philippe Vie
	Accenture	Pierre Launau or Stephanie Jamison
	Bearing Point	Patrice Mallet
Producers	Edf Energie Nouvelles	Pierre-Guy Therond

Table 5 Stakeholders Committee members

Two Stakeholders meeting have taken place during the first period, the 25th of September 2013 in Paris and the 6th of February 2014 via web-conference. Four Stakeholders Committee meetings have taken place during the second period, the 30th of October 2014 via web-conference, the 17th of February 2015 in Paris, the 17th of July via web-conference and the 29th March 2016 during the Final Event.

4.1 First Stakeholders Committee meeting

First Stakeholders Committee was focused on presenting the:

- Main objectives of the project.
- Demo presentation through a Poster session.
- First findings of the project, in particular the first identification of the barriers and Key

Performance Indicators (KPI).

Feedbacks of the stakeholders are summarized below:

- It is important to establish the responsibilities and scopes of TSO and DSO regarding the integration of DRES. Active coordination between TSO and DSO would increase the hosting of DRES.
- Most relevant issues are:
  - To define the best solution for the voltage control.
  - To manage with the big amount of data that the DRES usually provide.
  - To define/standardize the network codes parameters to connect DRES.
  - To determine which ancillary services can DRES provide and which ones not.
  - Definition of generic KPI to be used in different projects and situations, providing an essential mean to compare different solutions.
- The stakeholders are very interested in:
  - KPI definitions and management.
  - How the DRES can provide ancillary services.
  - Kind of model defined to implement the simulations of the solutions proposed in demos and how will be characterized the environmental conditions.
  - DRES cost-benefits analysis.
  - Replicability and scalability methodology and analysis.
  - Feedbacks of GRID+ and EEGI recommendations use. Limits of the EEGI KPIs.
  - DRES market integration models.
  - The way to involve customers to improve the penetration of DRES and how improved the social acceptance of smart metering solutions.

4.2 Second Stakeholders Committee meeting

Second Stakeholders Committee was focused on presenting the:

- Final barriers for connection of DRES in Distribution Grids.
- Final Indicative IGREENGrid Key Performance Indicators KPI.
- IGREENGrid Data gathering tool.
- Next steps, methodology.

Concerning the barriers, the most relevant stakeholders´ feedbacks are summarized below:

- Coordination between TSO-DSO (DSO role definition), remuneration of services, lack of incentives (not contracts with the generators).
- Interaction with new actors.
- Lack of coordination and remuneration.
- The situation is the same around the world, the barriers are common in the rest of the countries.
- Incentive the R&D programs of Smart Grids can help to reduce the barriers.

Concerning the KPI, the most important feedbacks are summarized below:

- Need to clarify the interaction with GRID+ KPI.

- Need to add a KPI around the reverse power flow or something equivalent to the frequency signal at the TSO level.
- Need to add an economic analysis.

4.3 Third Stakeholders Committee meeting

Third Stakeholders Committee was focused on presenting the:

- IGREENGrid Functionalities.
- The demonstration of the Data Gathering tool.
- The first experiences on the KPIs use.
- The methodology proposed by IGREENGrid for the solution evaluation.

Concerning the IGREENGrid functionalities, the project has identified 12 functionalities tested in the six demonstrators. The next table shows the functionalities and the demonstrators where are tested:

Functionalities	AT	IT	FR	ES	DE	GR
MV Voltage Control	X	X	X	X	X	
LV Voltage Control	X			X	X	
MV Congestion Management	X					
MV Power Flow & Ancillary Services with Storage		X	X		X	
LV Passive Demand Response	X	X				
LV Active Demand Response	X					
MV Fault Location Isolation and Restoration		X				
MV Monitoring	(X)	(X)	(X)	X	(X)	
LV Monitoring	(X)			X	(X)	
DRES forecasting tools		X	X			(X)
Distribution State Estimator	(X)		X	X		
Stochastic (vs. Deterministic) tools						X

In synthesis, almost all pilot projects include solutions related to Voltage VAr Control in order to satisfy power quality targets defined by the regulation and most of them include advance monitoring and control to gain access to real time network information and therefore improve the capacity of the DSO to manage the distribution network.

Concerning the KPI experiences, in IGREENGrid project the KPIs have been performed taking into account the possibility to apply them directly from the field measurements. Thanks to this experience and the presence of physical demonstrators, the KPIs applicability on real networks has been evaluated. In particular:

- Concerning the hosting capacity increase, the project highlights that at the current state of the art, there are not suitable tools which can be systematically used for the Hosting Capacity (HC) evaluation.
- KPIs related to the quality of supply can be easily calculated thanks to the exploitation of

field measurements but typically demonstrators are not subjected to voltage limits violations and the definition of indicators based on the power supply issues is tricky and the calculation needs several measurements (preferably at customer level).
- Estimation of the losses from the field measurements is complex and the uncertainty often doesn't allow to correctly evaluate the benefits introduced by the Smart Grid solutions

The methodology followed to make the solutions evaluation analysis follows the next steps:
- Pre-selection of most-promising solutions among all tested in the IGREENGrid demonstrators.
- Implementation into simulation environment.
- Simulation into reference networks (scalability and replicability): Technical evaluation (e.g. evaluation of KPI…) and economical evaluation.
- Overall evaluation.

The most relevant stakeholder's feedbacks are summarized below:
- For the MV network, voltage control is important but may not be the key issue at every distribution network. Several examples of projects show that local controls reacting to the measured voltage could be enough. Concerning the alternatives, in UK there are projects managing the voltage in one point for smaller generators. The coordination between TSO-DSO (DSO role definition) should be improved, remuneration of services defined, and the lack of incentives (not contracts with the generators) addressed.
- For the LV network, use the active demand to follow local generation with an automatic control could be a good solution to manage the voltage. The issue for this active demand is not technical but the commercial arrangements. It is also important to take into account the "social" acceptance of this kind of solution.
- Concerning the MV congestions management solutions, the curtailment is an option in some projects in the U.K. The level of curtailment determines the benefits. It could be used or not depending of the regulatory framework. Again the commercial arrangements are difficult but it is an important factor.
- The use of storage is expensive but can work. There are examples of successful coupling of storage systems with wind farms. For example it could be an efficient solution combined with a wind farm if it is of 10% of the capacity of the wind farm.
- Improve the monitoring of the distribution networks is a key requirement enabling higher penetration levels of DRES because of enhanced information of the real situation of the network.
- DRES forecasting tools are not a solution but a part of the solution. The accuracy is still an issue.
- It's necessary to consider the feedbacks of other projects initiatives concerning the use of the KPIs (for example Endesa experiences, future PV, USA initiatives).
- For the Cost Benefit Analysis (CBA), it could be difficult to agree on the assumptions which are very important and in fact even more important than the methodology. It is also important to identify the assumptions to be used to conduct the Scalability and Replicability Analysis (SRA) and the CBA.

4.4 Fourth Stakeholders Committee meeting

Fourth Stakeholders (STK) Committee was focused on presenting the:

- IGREENGrid solutions tested.
- Methodology used by the project to select the solutions.
- Scalability and Replicability Analysis.
- Cost Benefits Analysis.

The most common elements found at many of the IGREENGrid demonstrators are focused on voltage control and need for network monitoring. Most of demonstrators are focused on voltage control and include Distribution State Estimator (DSE) as a solution. Most pilots include advance monitoring to gain access to real time network information and therefore improve the capacity of the DSO to manage the distribution network.

Main issues for DRES integration are:

- Urban networks have more current problems because the length of the feeders is less than rural ones. The main problem in rural networks is related to Voltage Control. The STK considers that voltage is a common problem in rural networks where multiple generators are connected. The thermal constraint is usually relevant for transmission networks but not at distribution network.
- The penetration levels, type of technologies employed and sizes of DRES varies from one country to other as a function of past and current incentive schemes. This influences the type of solutions developed by each demo. The STK considers that these factors define the sort of challenges faced by each DSO and condition how they are addressed. Each country is different. In addition, the same technical solution could be preferred by some DSO but rejected by other taking into account its background.

Compared to GRID4EU and GRID+, IGREENGrid project is more focused on technical and economic implications of smart grids solutions. Regulations will also be covered to a lower extent in form of discussions. The analysis will be made using

- About 3-10 MV networks by DSO.
- About 3-10 LV network (for only 3 DSOs).
- PV data from Fronius raw data from 108 installations in 6 countries.

IGREENGrid project proposes a three step approach for the SRA analysis:

- Determination of scenarios of Renewable Energy Sources (RES) distribution along feeders. Favorable, medium and unfavorable.
- Determination of Business as Usual (BAU) & maximal HC.
- Detailed case study for a specific scenario. We really implement a DSE, a Probabilistic Load Flow (PLF), loads,…. , number of sensors, controllable Distributed Generators (DG) needed, …

Additional feedbacks of the Stakeholders are the following:

- They are interested on PV inverter active power limitation as a function of the local measured voltage. The possible side effects for the PV installation must be considered in particular when the PV brought out of the optimal point as the received solar energy should be evacuated somehow and the additional heat could increase PV panel temperature and affect its life expectancy.

- They consider that an important consideration for “Scalability and Replicability” is the compatibility and the interoperability. Concerning the “Social aspects” sometimes it is needed to remind also the positive effects like increased renewable penetration to help into selling the project to the public, community benefit, etc. Privacy concerns are another cause for doubts and rejection.
- They consider that generator owners are offered new types of contracts so curtailment could be interpreted as off periods. These projects may require of explanations and detailed information to the generator owners explaining reasons, justifying needs and solving their doubts. There is a gap between DG plants (owners, operators…) and DSOs (planners, operators…).
- The curtailment can be forecasted analysing past data and conducting studies about the expected impact. Even if these results are not promised but given for reference purposes. At the end it is a Curtailment versus Reinforcement decision to be taken by the DRES owner or promoter.

4.5 Fifht Stakeholders Committee meeting

Fifth Stakeholders Committee was focused on presenting the:

- Most promising solutions first results.
- Technical and economical evaluation of the solutions.
- Regulatory and technical recommendation for DRES integration.

The solutions are evaluated according to several criteria: performance, social aspects, scalability & replicability, reliability, risks, technical complexity, technical requirements, regulatory requirements and economic requirements. Several solutions have been selected for the studied categories allowing identifying the most promising solutions for these categories:

- MV Voltage Monitoring.
- LV Voltage Monitoring.
- MV Voltage Control.
- LV Voltage Control.
- MV Congestion Management.
- LV Congestion Management.

The main conclusions of the preliminary quantitative evaluation are that MV voltage Control solutions are expected to provide economic benefits by exploiting On-Load Tap Changers (OLTC) and Distributed Generation (DG); and that monitoring solutions will optimize the operation and the planning of the network. For the majority of these solutions a regulatory framework adaptation is needed.

For the LV network the use of the Advanced Metering Infrastructure (AMI) could be a real opportunity to improve the observability of the network and the planning of the DG connections, avoiding the phase-phase imbalance.

KPI calculation was made for the increase of Hosting Capacity Distribution Networks, the improvement of Quality of Supply and the increase of Energy Efficiency for the voltage control solutions. Because of different issues (time dependency of loads, difficulty to gather data for all the demonstrators, etc.), simulations were used to reproduce BAU and R&I scenarios in order to calculate the KPIs. The stakeholders highlight the dependency of KPIs on the boundary conditions of demonstration projects and signal that is hard to deduce from KPIs results the relevant aspects related to Scalability and Replicability Analysis (SRA) for the investigated smart grid solutions.

A strongly collaboration has been established between other European projects, in particular with GRID4EU in order to share the experiences concerning the Scalability and Replicability Analysis. Concerning the SRA analysis, this is very dependent of some factors such as the network status (level of monitoring, DRES penetration levels), the regulatory framework or the DSOs' strategy. This influence on the results means that there is not a single most promising solution from the SAR point of view. Additional evaluations have to be performed for each solution:

- The technical evaluation is done by simulation. The simulation uses the parameters of the reference networks provided by each country and the definition of each most promising solution selected. The expected results will be the calculation of KPIs for the solutions and outputs required for the economical studies. These outputs are for example the amount of reinforcement needed to enable the same hosting capacity in the current network as the hosting capacity that can be reached with the smart grid solution.
- The economical evaluation is based on costs analysis estimation (the costs for implementing a new smart grid solution) and on a benefits analysis (listing the benefits that will be provides by the new solution). As the benefits are not all monetized, each benefit will be identified at the least in a qualitative way

Concerning the Regulatory and Technical recommendations for DRES integration, the feedback of the stakeholders are provided bellow:

- Encourage Electric Vehicle (EV) to provide services to release network constraints could have a negative effect because the battery has a number of cycles limited. The use of the battery has to be saved for its initial purpose: mobility use. Using the battery for network services will negatively affect the economical benefit of the device. The economics are negative. It would work only if the battery has a calendar aging: in this case, it is better to use it as much as possible.
- It's important to test and simulate different DER control schemes in different network conditions (low or high loads, possible reconfigurations).
- There is a need to study and develop new feasibility study tools (including DER) for DSOs, investors and customers (as prosumers).
- Concerning the study and research on new batteries materials/technologies to increase efficiency and cost reduction, they consider that it's important but perhaps not realistic. It would be good having cheap battery, but this statement does not really add value. Battery will remain expensive for a while.
- It's also needed to develop optimization techniques (Optimal Power Flow) integrating the newest network services (e.g. curtailment, storage, etc.).
- Concerning the recommendation to the generators to accept the perspective that DSO can control DG production, they agrees on this but insist on the fact that the limits should be

well set up. A modulation of power should be encouraged rather than complete curtailment. To facilitate the dialogue, it would be good to know a relation between the amount of “clever” curtailment and the increase of Hosting capacity.

- Concerning the non-firm connection contracts, they consider that this kind of connection contract allows the generator to connect and/or to have access to the distribution network while minimising its connection costs and time, and potential economic losses. The generator accepts to limit its active power a given number of hours per year to prevent constraints on the distribution network as alternative to network reinforcement and as a way to optimise network use and investments.
- They consider that the quality and performance of communication is a big technical barrier today. This may be addressed more.
- Concerning the settlement of a common EU connection rules to connect DRES to the grid, independently of country or utility, they think that it is almost impossible in practice, due to the different nature of networks in Europe.
- Generators would support the possibility for the DSO to send reactive management reference targets to DRES in order to stabilize the Grid.
- It’s important to allow DSO the use of distributed flexibilities (Active Demand (AD), generation, storage) to solve the network constraints.
- It exists a need to agree a standard for DRES communication with DSOs (to homogenize interfaces) as much as to standardize the ITCs (Information and communication technologies).

4.6 Sixth Stakeholders Committee meeting

Sixth Stakeholders Committee has taken place during the Final Event as a round table. The objective of this round table was to obtain the feedback of the stakeholders about the IGREENGrid final results.

Some feedbacks provided by the stakeholders are the following:

Concerning the “Most promising solutions”:

- There are other side effects that we need to take into account. For that the DSE has a high potential because we can take advantage for other functions. There is not a single solution for the same problem in some cases we need to combine local solutions with others solutions.
- Simple solutions in some cases are the most relevant solutions for the DSOs. Solutions used for HV could be easier to put in place than other because there are less innovative and well known.
- Send voltage set points to the renewable generators taking into account a coordination with the DSO is a good solution. It doesn’t work on real time now but near to real-time. The control of active and reactive power for the generators is already implemented for generators bigger than 10MW.

Concerning the “KPIs“ :

- Centralised solutions have a more important impact on HC than decentralized ones.
- The combination of centralized and decentralized solutions could also contribute to increase the hosting capacity of the network.
- In general, DSOs prefer to use centralized solutions for MV networks and decentralized for LV networks.
- They wonder about the feasibility to find the right KPI to measure the performance of the solutions. There are a lot KPIs possibilities to measure the performance but KPI need to be adapted to the situations of each demonstrator/project.
- KPI calculation needs a lot of effort to recuperate the data needed to calculate them.

Concerning the “Economical analysis”:

- CBA results depend of the baseline (starting point), of the actual situation on the network, of the level of DRES already install, level of automation of the network. Specific studies must to be done for each kind of solutions. They consider a good idea to separate the CA from the BA.
- Methodology used by the IGREENGrid project is most interesting than the final results. The situation could change very quickly reducing the cost and the solution could be interesting from an economical point of view.
- Costs are important but we need to consider also the benefits either if they are difficult to monetize. The regulatory framework could be very dependent of both.

Concerning the “Performance Analysis”

- DSOs can use this kind of tools to calculate the HC. The main barrier is a regulatory one. Today the DSOs are paid to reinforce the network and not to optimise the solutions.
- Regulatory Authorities needs to incentivise this kind of solutions. This kind of tools can help the DSO to identify where the problem is and which solution is the most adapted.
- Data can help the DSO to improve the network planning/operation. To use this tools we need more data near to the real time

5 Website and Social media

The Web presence is a main element of the Dissemination work in the IGREENGrid project and includes:

- Public website to present the Project objectives and scope to third parties;
- Use of social networks to spread the Project results: LinkedIn, Facebook, Twitter.

Altogether with IGREENGrid project public web site a project data repository, only available to the project partners, is used to share information among consortium members. This repository allows to improve the internal dissemination of the project

5.1 Unified project visual identity

A graphical charter has been defined for the project and is now in use for all IGREENGrid documents.

It has been used for the templates used of all IGREENGrid documents (e.g. Word and PowerPoint templates) and applied to the project website detailed below.

5.2 IGREENGrid website

During this period of the project the project website has been launched and upgraded. The launch of the website had been announced by a special Newsletter.

Figure 1 IGREENGrid website homepage

The project's public website address is: http://www.igreengrid-fp7.eu. The site is hosted by ERDF as part of dissemination activities which is under its responsibility. This public section, which is accessible for everyone, contains:

- General information about the aims of the project.
- Detailed information about the demonstrators.
- Links to the IGREENGrid social media accounts.
- All the news of the project.
- A list of events where the project is presented.
- All public material that has been generated in the project.
- The most important results, including synthesis of the restricted deliverables.
- Links to the project partners' homepages.
- …

Furthermore, the website includes the coordinator contact information, hosting details and organizations in charge of its content.

The website is regularly updated with information and project results available to general public. The most relevant updating concerns:

- The description of the demonstrators.
- The news.
- The publications.
- The deliverables.

First period of the project has not been monitored. A total of 3 929 sessions have been registered during the second period with a total of 3 655 users. Figure 2 shows the top locations of the visits of the webpage.

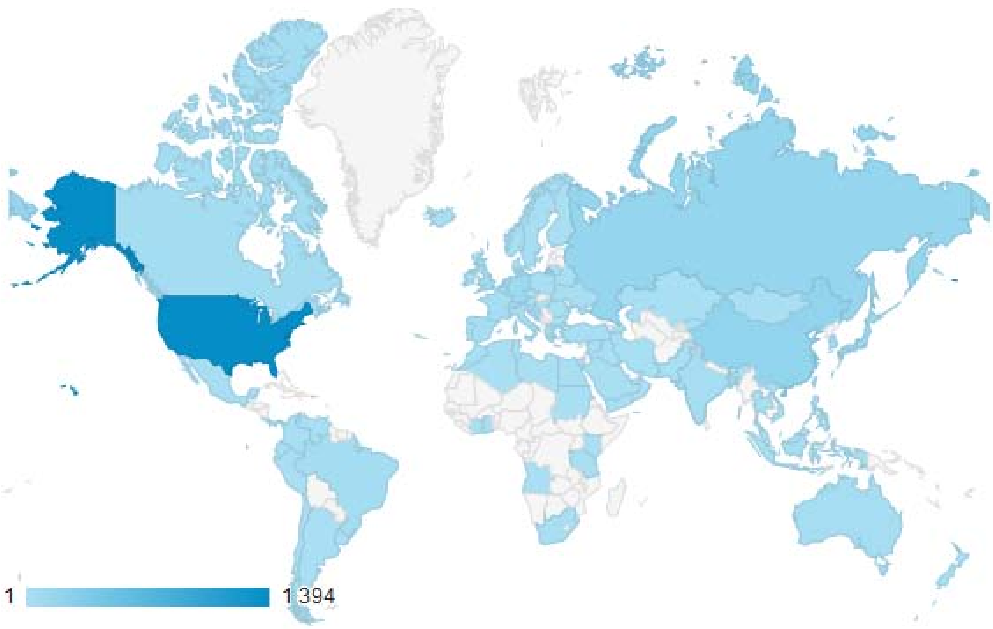

Figure 2 Top locations of the visits of the IGREENGrid webpage

5.3 IGREENGrid Repository

During this period of the project, a repository has been put in place and upgraded daily. The project consortium members can access the Consortium Repository, so can read, upload, and download its content.

This repository allows sharing the documentation between project members, and mainly contains:

- Information about past meetings.
- Deliverables and management reports.
- Administrative documents and forms.
- Planned publications.
- Detailed contact information for all project partners.
- etc…

5.4 Social Media

Four different IGREENGrid project social media accounts have been created in the following social medial:

- **LinkedIn**: IGREENGrid project account is available using the following link: http://www.linkedin.com/groups/IGREENGrid-5129466/about.
- **Facebook:** IGREENGrid project account is available using the following link: https://www.facebook.com/pages/IGREENGrid/308145559331213?fref=ts.
- **Twitter:** IGREENGrid project account is available using the following link: http://twitter.com/IGREENGrid.
- **Google +:** IGREENGrid project account is available using the following link: https://plus.google.com/communities/116995301085226269518?fd=1.

The project uses these social media in particular to communicate about the most interesting results of the project.

Some statics of the social media are the following:

- LinkedIn: 13 members.
- Facebook: 24 Like it!
- Twitter: 38 followers and more than 50 re-tweets.
- Google +: 3.179 visits.

5.5 Other media publications

Table 6 below shows the most import “other media” publications:

	Media	Partner responsible	Number of publication	Type of material	
1	Iberdrola web	Iberdrola	5	Articles	-
2	GNF web	GNF	1	Article	http://www.unionfenosadistribucion.com/es/redes+inteligentes/proyectos+de+id/internacionales/1297143470155/igreengrid.html
3	Construible	Iberdrola	1	Article	http://www.construible.es/noticias/iberdrola-lanza-el-proyecto-igreengrid-para-estudiar
4	Metering	Iberdrola	1	Article	http://www.metering.com/?p=22124/
5	EDSO internal newsletter	ERDF	1	Article	-
6	Patrasevents	HEDNO	1	Article	http://www.patrasevents.gr/article/101860-deddie-imerida-gia-ta-eksipna-diktia
7	EEGI newsletter 9	Iberdrola	1	Article	http://www.gridplus.eu/publicationsandresults/newsletter
8	ERDF webpage	ERDF	1	Article	http://www.erdf.fr/igreengrid
9	Venteea webpage	ERDF	2	Article	http://www.venteea.fr/fr/actualites/les-membres-du-consortium-igreengrid-visitent-venteea.html http://www.venteea.fr/fr/actualites/igreengrid-projet-europ%C3%A9en-dint%C3%A9gration-des-enr.html
10	HEDNO webpage	HEDNO	1	Article	http://www.deddie.gr/en/kentro-enimerwsis/programmata-ereuna/igreengridapr27201531833083pm
11	RWE webpage	RWE	1	Article	http://www.rwe.com/web/cms/en/2866180/rwe/innovation/projects-technologies/power-and-gas-grids/power-grid/igreengrid/
12	INTrEPID webpage	-	1	Article	http://www.fp7-intrepid.eu/index.php/news-events/13-news-events/events/31-intrepid-igreengrid-event,-2015-madrid,-december-4.html

	Media	Partner responsible	Number of publication	Type of material	
13	GRID4EU webpage	ERDF	1	Article	http://www.grid4eu.eu/articles/grid4eu-invited-in-a-joint-igreengrid,-singular-and-sustainable-workshop/
14	EvolvDSO webpage	ENEL	1	Article	http://www.evolvdso.eu/Home/News-events/IGreenGrid-final-workshop
15	Tecnalia webpage	Tecnalia	1	Article	http://www.tecnalia.com/en/energy-and-environment/events/4th-igreengrid-project-workshop.htm
16	RSE webpage	RSE	1	Article	http://www.rse-web.it/progettieu/progetto/566
17	AIT webpage	AIT	1	Article	http://www.ait.ac.at/departments/energy/smart-grids/smart-grids-projects/igreengrid/
18	INCREASE webpage	-	1	Article	http://www.project-increase.eu/index.php?cmd=s&id=127
19	Energati webpage	-	1	Article	http://www.engerati.com/on-demand/igreengrid-pilots-large-scale-deployment-%E2%80%93-scalability-and-replicability-potential-smart-grids/15486

Table 6 Other media publications

5.6 Newsletter

The IGREENGrid project started its official newsletters on the second year of the project. A total of four newsletters were sent.

A first newsletter (non official one) was sent the 22nd August 2013 to announce the launch of the website.

The official newsletter 1 was sent in July 2014. This newsletter was focused on:

- Introduction of the project coordinator.
- Austrian, German and Greek demonstrators description.
- General information of SiNGULAR and SuSTAINABLE projects.

Second newsletter was sent on January 2015. It was focused on:

- Introduction of the project coordinator.
- French and Spanish demonstrators description.

- Data gathering tool.
- Announce of the Paris public workshop.

Third newsletter was sent on March 2016. It was focused on:

- Introduction of the project coordinator.
- Selecting the most promising solutions for DRES integration using results from demonstration projects.
- KPI results for the most promising solutions and recommendations about KPI methodology.
- Technical evaluation.
- Cost Analysis (CA) and Benefit Analysis (BA).
- Recommendations.

Newsletters allow IGREENGrid to disseminate on the results, past activities, news, conferences and publications.

IGREENGrid's Newsletter mailing list is now over 550 recipients selected among different world-class professionals (from energy sectors, equipment manufacturers, engineering companies, owners/operator of energy facilities, policy makers, R&D institutions…).

All the newsletters were opened and read at least once by on average 40% of subscribers. Figures bellow, show the statistical of readers among the world.

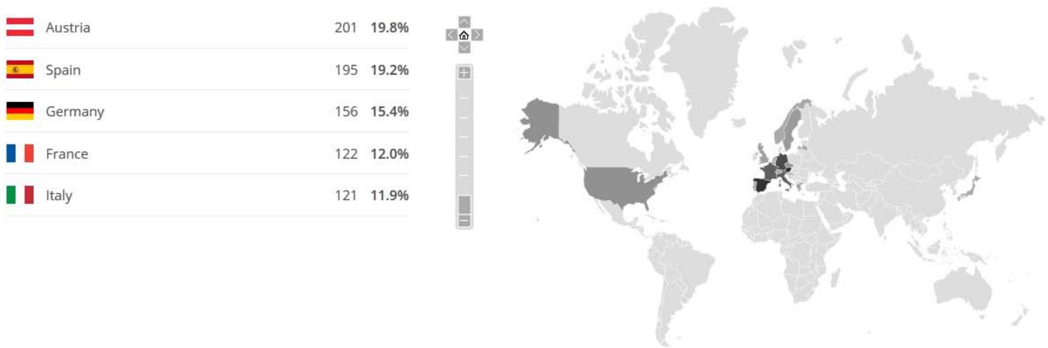

Figure 3 Top locations by opens of the newsletter announcing the IGREENGrid newsletter

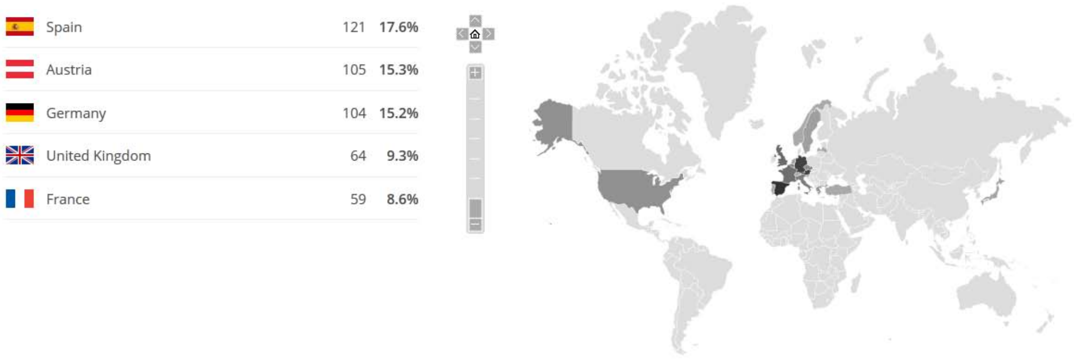

Figure 4 Top locations by opens of the IGREENGrid newsletter 1

Spain	181	29.2%
Germany	133	21.5%
France	52	8.4%
Greece	50	8.1%
Austria	42	6.8%

Figure 5 Top locations by opens of the IGREENGrid newsletter 2

Spain	185	28.1%
Germany	133	21.5%
France	55	8.6%
Greece	53	8.1%
Austria	48	5.8%

Figure 6 Top locations by opens of the IGREENGrid newsletter 3

6 IGREENGrid Public workshops

IGREENGrid project scheduled four dedicated workshops towards professional associations and research performers aiming at disseminating detailed results per key business areas.

6.1 Workshop 1

First public workshop was organized together with SiNGULAR and SuSTAINABLE projects and was held in Athens on the 11th of April 2014. [D7.6] presents a complete description of the contents and conclusions of the public common workshop.

Table 7 presents the agenda of the meeting. All the presentations are available on the IGREENGrid webpage:

Agenda	Speakers
Opening	**Mr. George Kollias** *HEDNO Chairman &CEO* **Mr. Pedro Godinho Matos** *Sustainable Project Coordinator*
Key Note Speech	**Mrs. Irene Bonvissuto** *European Commission*
Projects Presentations	
IGREENGrid	**Mr. David Miguel Rubio**
SINGULAR	**Professor João Catalão**
SuSTAINABLE	**Mr. Pedro Godinho Matos**
Poster Session	
Panel Session	**Professor Nikos Hatziargyriou**
EDSO4SG Presentation - “An evolved DSO-a prerequisite to meet the EU Energy and climate objectives”	**Mr. Per-Olof Granström** *(EDSO4SG)*
evolvDSO Presentation - “New DSO Roles”	**Mr. Carlos Costa** *(evolvDSO Project*
Panel session	**Mr. Jesus Varela** *(IGREENGrid Project)* **Mr. Luis Seca** *(SuSTAINABLE Project)* **Professor Anastasios Bakirtzis** *(SINGULAR Project)* **Mr. Per-Olof Granström** *(EDSO4SG)* **Mr. Carlos Costa** *(evolvDSO Project)*

Table 7 Agenda of the first workshop

A total of 81 people participated to the public workshop.

Table 8 and Figure 7 show the categories of audience participating to the meeting.

Category	Number	Percentage
Association	1	1,2
Consultant	3	3,7
DSO	27	33,3
EC	1	1,2
Manufacturer	6	7,4
Producer	2	2,5
Regulator	2	2,5
Research Institutes	39	48,1
TOTAL	81	100

Table 8 First workshop - Categories of the audience

Almost eighty percent of the attendees were from "Research institutes" and "DSOs". The next one was “manufacturers” albeit with a much smaller presence for the other categories. The participation of two representatives of the "regulators" is very important given the difficulty of engaging them in this kind of activities. The group with smallest representation was the “associations”.

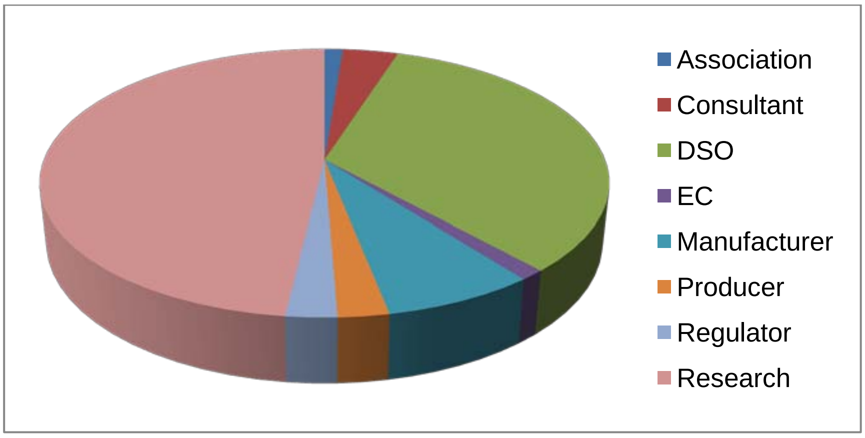

Figure 7 First workshop - Graphical illustration of the categories of the audience

Table 9 and Figure 8 show the country of origin of the audience participating to the meeting:

Country	Number	Percentage
Austria	3	3,7
Belgium	2	2,5
Cyprus	4	2,5
France	4	4,9
Germany	3	3,7
Greece	31	38,3
Italy	6	7,4
Portugal	13	16,0
Romania	2	2,5
Spain	11	13,6
Switzerland	1	1,2
Turkey	1	1,2
TOTAL	81	100

Table 9 First workshop - Country of origin of the audience

Twelve European countries were represented in the meeting. Most of the attendees were from "Greece" where the meeting took place. Significant number of attendees was from Portugal and Spain. The participants of the others countries were less than seven.

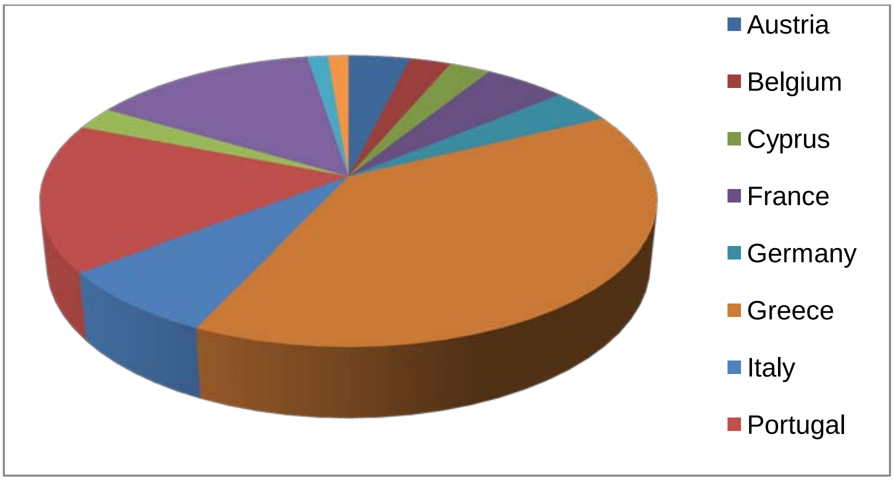

Figure 8 First workshop - Graphical illustration of the country of origin of the audience

The most important conclusions of the workshop are listed below:

New ENTSO-E Networks Codes, could impact the security of the distribution networks. In order to limit the risks and to improve the costs for the end users connected to the distribution network, it is necessary to guarantee:

- Data and communication should be handled by the DSO.
- The distribution users should only receive signals and requests from the DSO.
- The DSO should prescribe how to test the compliance of distribution network users.
- The actively management of the grid.
- New DSO roles are necessary in order to guaranty the security, as for example, the Distribution System Optimizer, Neutral Market Facilitator or the Distribution Constraints Market Operator. A new regulatory framework is required to put in place these new roles and to define adapted incentives to invest in Smart Grids solutions

One of the most important issues is therefore to establish a good interaction with the national and European regulators.

6.2 Workshop 2

The second public workshop was held on the 4th of December 2014. Twelve projects participated to this workshop including IGREENGrid. The complete list of projects that participated is: PVGrid, INTrEPID, MetaPV, I3RES, INERTIA, SiNGULAR, DISCERN, SuSTAINABLE, INCREASE, EnR Pool, ACR and evolvDSO. [D7.7] presents a complete description of the contents and conclusions of the public common workshop.

Table 10 presents the agenda of the meeting. All the presentations are available on the IGREENGrid webpage:

Agenda	Participants
Welcome	**Mr Jesus Varela** *Iberdrola*
IGREENGrid Presentation and introduction	**Mr Jesus Varela** *IGREENGrid Project Coordinator*
Introduction and presentation of participant projects	
PV Grid	**Mr Carlos Mateo** *IIT*
INTrEPID	**Mr Alberto Cantalejo** *Advanticsys*
meta-PV	**Mr Benoit Bletterie** *AIT*
I3RES and INERTIA	**Mr Inaki Angulo** *Tecnalia*
SiNGULAR	**Mr Javier Contreras** *UCLM*
DISCERN	**Ms Katrin Spanka** *KEMA*
SUSTAINABLE	**Mr Pablo Frias** *IIT*
INCREASE	**Mr Bart Meersman** *UGent*
EnR-Pool	**Mr Martin Daronnat** *Energy Pool*
ACR	**Mr John Moffat** *SPEN*
evolvDSO	**Mr Marco Baron** *Enel Distribuzione*
Panel Session I	**Mr Andreas Abart** *EAG*
“Experiences in the implementation of solutions for renewable integration and how evaluate these solutions”	**Mr Javier Contreras** *(UCLM)* **Mr Benoit Bletterie** *(AIT)* **Mr John Moffat** *(SPEN)* **Mr Bart Meersman** *(UGent)* **Mr Martin Daronnat** *(Energy Pool)*
Panel Session II	**Mr Marco Rossi** *RSE*
“KPI experiences related with the measurement of solutions effectiveness in renewable integration”	**Mr Benoit Bletterie** *(AIT)* **Mr Jesus Varela** *(Iberdrola)* **Ms Katrin Spanka** *(KEMA)*

Table 10 Agenda of the second public workshop

A total of 57 people participated to the public workshop.

Table 11 and Figure 9 show the categories of the audience participating in the meeting.

Category	Number	Percentage
Aggregator	1	2
Association	1	2
Consultancy	4	7
DSO	19	33
Manufacturers	9	15

Producer	1	2
Public Administration	5	9
Research	17	30
TOTAL	57	100

Table 11 Workshop 2 - Categories of the audience

Almost sixty percent of the attendees were from "DSOs" and "Research institutes". The next group was "manufacturers" and "public administration" with a much smaller presence than the other categories. The participation of public administrations representatives is very important due to the difficulty of engaging them in this kind of activities. The groups with smallest representation were the "aggregators", "associations" and "consultancy".

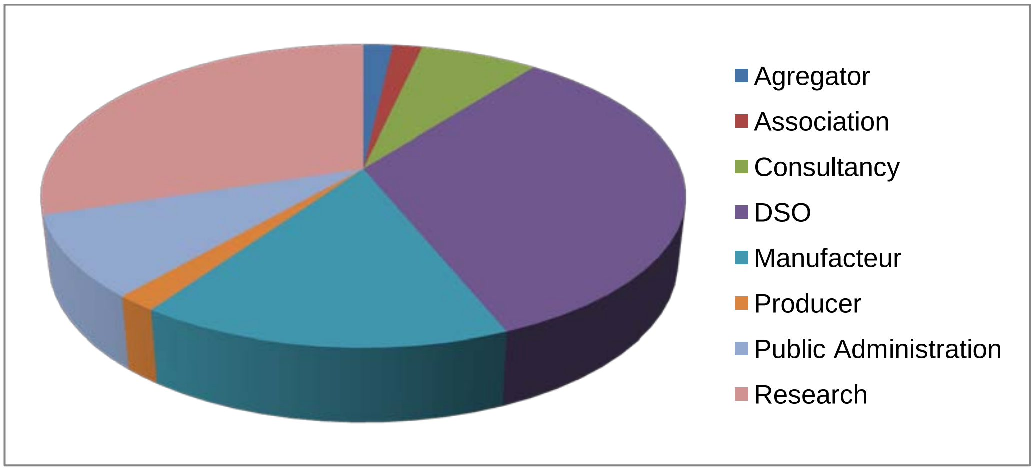

Figure 9 Workshop 2 - Graphical illustration of the categories of the audience

Table 12 and Figure 10 show the country of origin of the audience participating to the meeting:

Country	Number	Percentage
Austria	2	3
Belgium	1	2
France	3	5
Italy	2	3
Netherlands	1	2
Norway	1	2
Scotland	1	2
Spain	46	81
TOTAL	57	100

Table 12 Workshop 2 - Country of origin of the audience

Eight European countries were represented in the meeting. Most of the attendees were from Spain, where the meeting took place, the other participants by country were less than four.

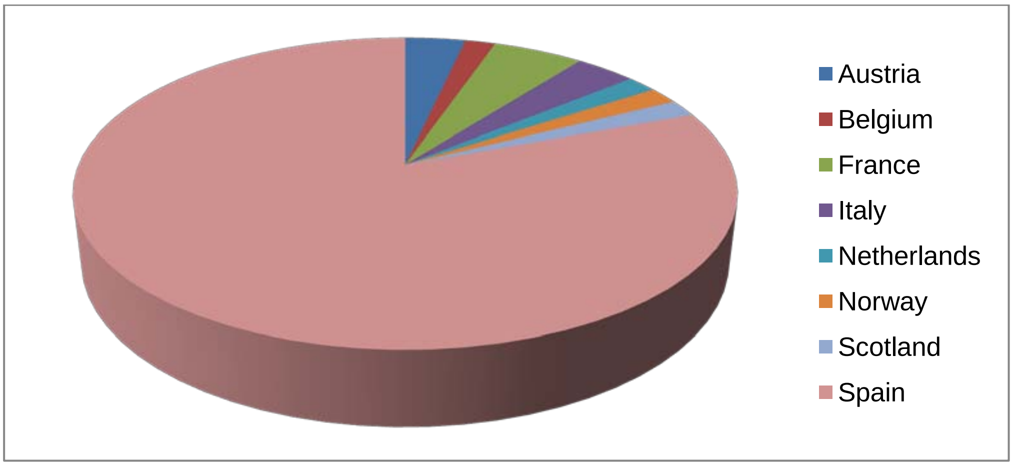

Figure 10 Workshop 2 - Graphical illustration of the country of origin of the audience

The most relevant conclusions of the workshop are listed below:

- Concerning the DSO:
    - Regulatory Framework does not incentivize SG development. DSOs should be incentivized to use SG solution. An adaptation of national regulatory frameworks to promote "Smart Grid" investments will be needed.
    - Coordination among DSO ("operator/supervisor" or the communication system), inverter manufacturer and researchers (test plan) is difficult.
    - DSO needs to implement an active distribution system management approach due to increased complexity.
    - DSO has a central role to play as market facilitator to better support the energy markets.
    - DSO must exploit the end users potential flexibility (not yet implemented) to optimize the management of the distribution network.
- Concerning the demonstrators:
    - A demo can foster a better understanding from all parties (DSO, equipment manufacturer, R&D) and demonstrate the functionality
    - A lot of efforts are needed to reach the projects KPI computation.
    - Many efforts are required to deploy the equipment into the field.
    - Communication "issues" in real life are more difficult than expected.
    - Demonstration phase is usually too short (despite project extension) to enable a quantitative validation for the (too many) different controls (statistical significance).
    - A demo usually does not study the potential for scalability and replicability (beyond the particular conditions of the demo), neither provide guidance on how to replicate the solution and provide "general results".
- Concerning the PV integration:
    - Curtailment of small amounts (less than 5% of annual generations) of active power on the year can improve the HC. They solve congestion and voltage constraints.
    - Insufficient DSO access to advanced PV inverter capabilities is a barrier for DRES integration.
- Concerning the storage:
    - Prosumer storage could be a solution for the PV fluctuations. An economic compensation when storage reduces the PV peak could incentivize their installation.

  - DSO's roles, rights and limitations concerning the storage must be clearly defined as well as the impact on the market.
- Concerning the Demand response:
  - Insufficient framework for Demand Response (Increase or decrease) based on a voluntary basis. The communications system should be defined. Smarts meters can help to develop it.
  - The electric system would take great benefits if industrial consumers knew better how to use their flexibilities to address RES production issues.
  - Aggregation enhances electric system performance and cost-effectiveness by coupling industrial flexibilities and RES production.
  - Aggregation entities should be geo-located as RES production is decentralized.

6.3 Workshop 3

Third public workshop was organized together with SiNGULAR and SuSTAINABLE and was held in Paris on the 19th of February 2015. [D7.8] presents a complete description of the contents and conclusions of the public common workshop.

Nine projects participated to this workshop including IGREENGrid. The complete list of projects that participated is: SiNGULAR, SUSTAINABLE, GRID4EU, evolvDSO, INCREASE, EnR Pool, Solar Mobility and Plan Grid EV.

Table 13 presents the agenda of the meeting. All the presentations are available on the IGREENGrid webpage:

Agenda	Participants
Welcome	**Mr Jesus Varela** *Iberdrola*
Introduction and presentation of participant projects	
IGREENGrid	**Mr Jesus Varela** *Iberdrola*
SUSTAINABLE	**Mr Pedro Godinho Matos** *EDP*
SiNGULAR	**Mr João Catalão** *UBI*
GRID4EU	**Mr Paul Douard** *Accenture*
INCREASE	**Mr Bart Meersman** *UGent*
EnR-Pool	**Mr Martin Daronnat** *Energy Pool*
evolvDSO	**Mr Aymeric Billet** *ERDF*
Solar Mobility	**Mr Jens Merten** *CEA-INES*
PlanGridEV	**Ms Suzete Alburquerque** *EDP*

Table 13 Agenda of the third public workshop

A total of 68 people participated to the public workshop.

Table 14 and Figure 11 show the categories of the audience participating in the meeting.

Category	Number	Percentage
Aggregator	1	2
Consultant	1	2
DSO	26	38
Manufacturers	7	10
Retailer	3	4
Regulator	1	2
Research	29	42
TOTAL	68	100

Table 14 Workshop 3 - Categories of the audience

Almost eighty percent of the attendees were from "DSOs" and "Research institutes". The next group was "manufacturers" with a much smaller presence than the other categories. The participation of a National Regulator representative is very important due to the difficulty of engaging them in this kind of activities. The groups with smallest representation were the "aggregator", "regulator" and "consultant".

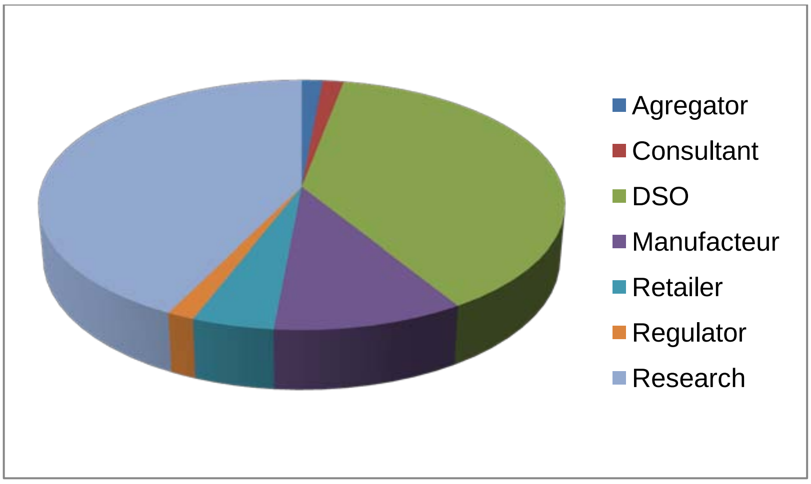

Figure 11 Workshop 3 - Graphical illustration of the categories of the audience

Table 15 and Figure 12 show the country of origin of the audience participating to the meeting:

Country	Number	Percentage
Austria	5	7
Belgium	1	1
France	21	31
Germany	5	8
Greece	10	15
Italy	3	4
Portugal	8	12
Romania	1	2
Spain	11	16
United Kingdom	3	4
TOTAL	68	100

Table 15 Workshop 3 - Country of origin of the audience

Ten European countries were represented in the meeting. Most of the attendees (31%) were from France, where the meeting took place. Other countries with more than 10% of participants were Spain; Greece and Portugal. The other participants by country were less than ten.

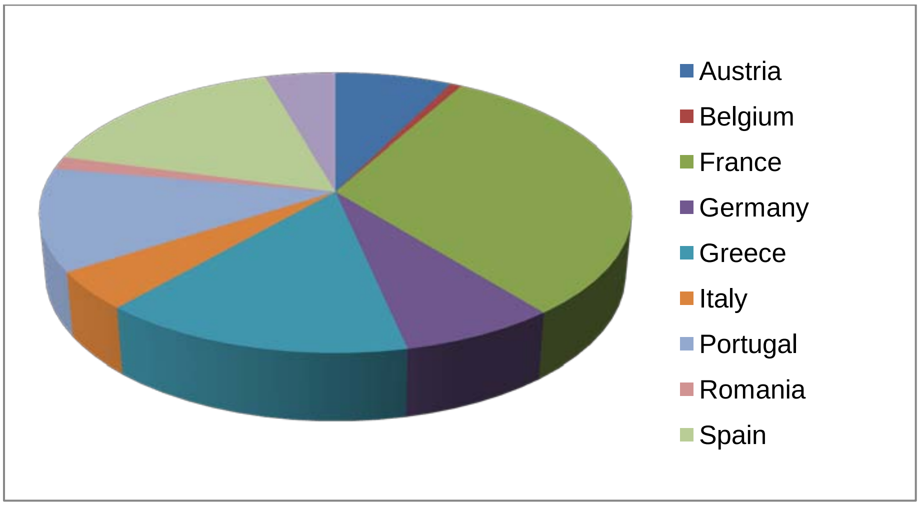

Figure 12 Workshop 3 - Graphical illustration of the country of origin of the audience

This workshop was dedicated to the presentations of the different projects participating.

6.4 Workshops 4 and 5

Two public workshops were organized, the first one in Bilbao on the 22nd of October 2015 and the second one in Lisbon on the 27th of November 2015. Lisbon workshop was organized together with SiNGULAR and SuSTAINABLE. [D7.9] presents a complete description of the contents and conclusions of both workshops.

6.4.1 Bilbao workshop

The fourth IGREENGrid public workshop was held in Bilbao on the 22nd of October 2015. Seven projects participated to the Bilbao workshop including IGREENGrid. The complete list of projects that participated is: IGREENGrid, SiNGULAR, SuSTAINABLE, GRID4EU, COTEVOS, INCREASE, EnR Pool. In addition three Manufacturers presented its vision of potential markets. They were: ZIV, ARTECHE and INGETEAM.

Table 16 presents the agenda of the meeting. All the presentations are available on the IGREENGrid webpage:

Agenda	Participants
Welcome and Presentation introduction	**David Miguel Rubio** *Iberdrola*
Conference on Scalability and Replicability	
IGREENGrid	**Nerea Ruiz** *Tecnalia*
SiNGULAR	**Javier Contreras** *UCLM*

COTEVOS	**Jose Antonio Lopez** *Tecnalia*
GRID4EU	**Paul Douard** *Accenture*
Conference on Cost Benefits Analysis	
IGREENGrid	**Irantzu Urcola** *Tecnalia*
EnR-Pool	**Luis Gonzalez** *IIT-COMILLAS*
INCREASE	**Daniel Steiner** *Joanneum Research*
Potential Markets (Vendors View)	
ZIV	**Laura Marron** *ZIV*
ARTECHE	**Raul Rodriguez** *ARTECHE*
INGETEAM	***Luis Manuel Saiz*** *INGETEAM*
Conclusions and Discussion	**David Miguel Rubio** *Iberdrola*

Table 16 Agenda of the Bilbao workshop

A total of 25 people participated in the public workshop.

Table 17 and Figure 13 show the categories of the audience participating in the meeting.

Category	Number	Percentage
Consultant	2	8
DSO	9	36
Manufacturers	6	24
Research	8	32
TOTAL	25	100

Table 17 Bilbao workshop - Categories of the audience

Almost seventy percent of the attendees were from "DSOs" and "Research institutes". The next group was "Manufacturers" with 24%. The group with the smallest representation was the "Consultant" with less than 10%.

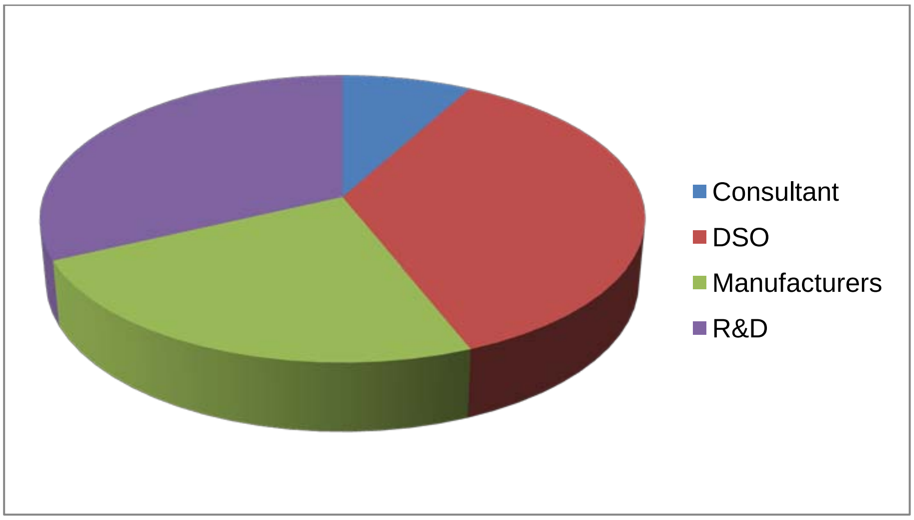

Figure 13 Bilbao workshop - Graphical illustration of the categories of the audience

Table 18 and Figure 14 show the country of origin of the audience participating in the meeting:

Country	Number	Percentage
Austria	2	24
France	2	8
Italy	3	12
Spain	14	56
TOTAL	25	100

Table 18 Bilbao workshop - Country of origin of the audience

Four European countries were represented in the meeting. Most of the attendees (56%) were from Spain, where the meeting took place. Other countries with more than 10% of participants were Austria and Italy. French representation was less than 10%.

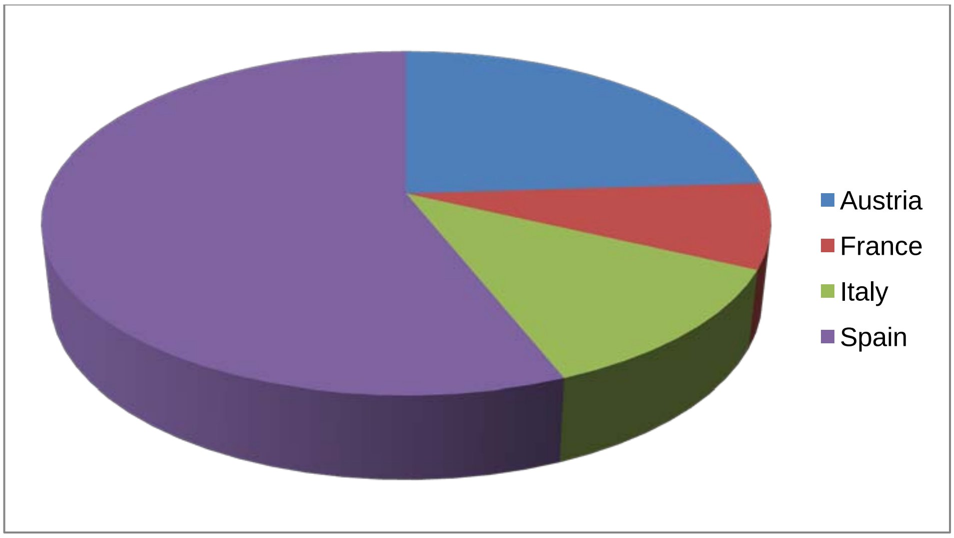

Figure 14 Bilbao workshop - Graphical illustration of the country of origin of the audience

The more relevant conclusions of the workshop are listed below:

- Barriers identified by the IGREENGrid project for DRES integration are the following:

  - Regulation does not allow the DSOs to control DER.
  - Coordination between TSOs and DSOs is insufficient for the effective DRES integration.
  - Lack of a proper regulation for DRES connection.
  - Lack of an adequate remuneration for DSO services.
  - DRES do not have any incentive to take part in the network operation.
  - Interactions with the new actors resulting from DRES integration are not clearly defined.
  - Lack of a standard Smart Grid solution components.
  - Distribution network processes are not adapted to the realities of the integration of DRES.
  - Lack of experience of the DSO in the operation of new devices and systems.
  - Power system reliability may be affected by the massive DRES penetration.
  - ICT solutions for remote areas may be unaffordable.
- IGREENGrid conclusions on the SRA are the following:
  - There is not a single “most promising” solution from the SRA point of view.
  - All implementations represent valid alternatives. The selection depends on several factors: network status, regulatory conditions, DSO’s approach, etc.
  - Final choice has to be made for each particular case taking into account: the mentioned factors such as regulatory evolution and the CBA results.
- For GRID4EU, examples of SRA observations on AD to be shared are:
  - Overall, Smart Meters functionalities can greatly determine whether Use Cases are replicable in other countries (e.g. collection of power quality data by smart meters).
  - A lack of standardized list of functionalities of AMI.
  - Might require hardware and software adaptations.
  - Hampers the replicability potential of GRID4EU Use Cases on AD.
  - Data access could be a barrier for SRA also when data are provided to customers.
  - The use of AMI for network supervision is facilitated if the DSO is in charge of metering data management and if AMI is widespread.
  - Absence of regulatory mechanisms enabling DSOs the access to AD flexibilities in transparent and competitive conditions is a key barrier for those use cases where load control could contribute to increase the HC or to ensure network stability reducing local congestions at distribution level.
- Main conclusions of the SuSTAINABLE CBA are the following:
  - RES Forecasting in market operation:
    - Measuring devices present an important cost.
    - Major benefit is obtained from reduction of ancillary services.
    - **Ideal scenario**: Area with large RES penetration.
  - Smart Monitoring and Control in Continuity of Supply:
    - First automation investments drastically improve continuity of supply indicators.
    - From 40%-50% automation, continuity of supply indicators are less affected.
    - **Ideal scenario**: Urban area with low automation. Regulatory incentives are needed.
  - Voltage Control in Quality of Supply:

  - Energy losses reduction and voltage quality improvement have been proved as good source of benefits for this functionality.
  - Control decisions are based on information from measuring devices and forecasts, which complicates the assessment of the real impact of voltage control.
  - **Ideal scenario**: Rural network with long feeders and high RES penetration.
- Manufacturers conclusions are the following:
  - Smartization of the Distribution grid needs a real improvement of the grid observability.
  - LV grid supervision is a cost effective solution in order to improve the service availability and the quality of supply (QoS), increase grid capacity, reduce technical & commercial losses and know MV grid status based on LV grid measurements.
  - Technology is already ready beyond AMI: LV grid supervision over existing AMI deployments.

6.4.2 Third Global Joint Conference (IGREENGrid-SiNGULAR-SuSTAINABLE)

The third IGREENGrid-SiNGULAR-SuSTAINABLE Global Joint Conference was held in Lisbon on the 27th of November 2015. Nine projects participated to the joint conference. The complete list of projects that participated is: SiNGULAR, SUSTAINABLE, FLEXICENCY, UPGRID, AnyPLACE, SENSIBLE, NobelGrid and TILOS.

Table 19 presents the agenda of the meeting. All the presentations are available on the IGREENGrid webpage:

Agenda	Participants
Opening Session	
Global Joint Conference	
SiNGULAR	**Joao Catalao** *UBI*
SuSTAINABLE	**Mr Pedro Godinho Matos** **EDP**
IGREENGrid	**David Miguel Rubio** *Iberdrola*
External Project presentation	
FLEXICENCY	**Stefano Galletti** *Enel*
UPGRID	**Pedro Manuel Nunes** *EDP*
AnyPLACE	**David Rua** *INESC*
SENSIBLE	**Ricardo André** *N.E.W. R&D of EDP*
NobelGrid	**Anabela Pronto** *NOVA Univ. of Lisbon*
TILOS	**Salvador Suarez**

	ICT
Questions	**Joao Catalao** *UBI*

Table 19 Agenda of the third global joint conference

A total of sixty people participated in the third global joint conference.

Table 20 and Figure 15 show the categories of the audience participating in the meeting.

Category	Number	Percentage
Consultant	2	3
DSO	25	42
Manufacturers	3	5
R&D	29	48
EC	1	2
TOTAL	60	100

Table 20 Third Global Joint Conference -Categories of the audience

Almost ninety percent of the attendees were from "DSOs" and "Research institutes". The next group was "Manufacturers" with 5 %. The other group's representation is less than 4 %.

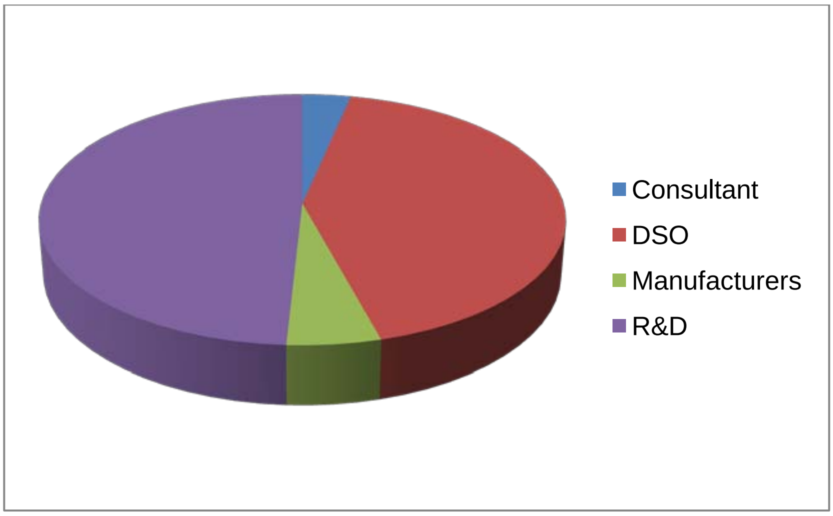

Figure 15 Third Global Joint Conference - Graphical illustration of the categories of the audience

Table 21 and Figure 16 show the country of origin of the audience participating in the meeting:

Country	Number	Percentage
Austria	2	3
France	1	2
Italy	3	5
Spain	8	13
Portugal	29	48
Greece	8	13
Romania	4	7
UK	1	2
Germany	2	3

Switzerland	1	2
Belgium	1	2
TOTAL	25	100

Table 21 Third Global Joint Conference - Country of origin of the audience

Eleven European countries were represented in the meeting. Most of the attendees (48%) were from Portugal, where the meeting took place. Other countries with more than 10% of participants were Spain and Greece. Other country's representation was less than 10%.

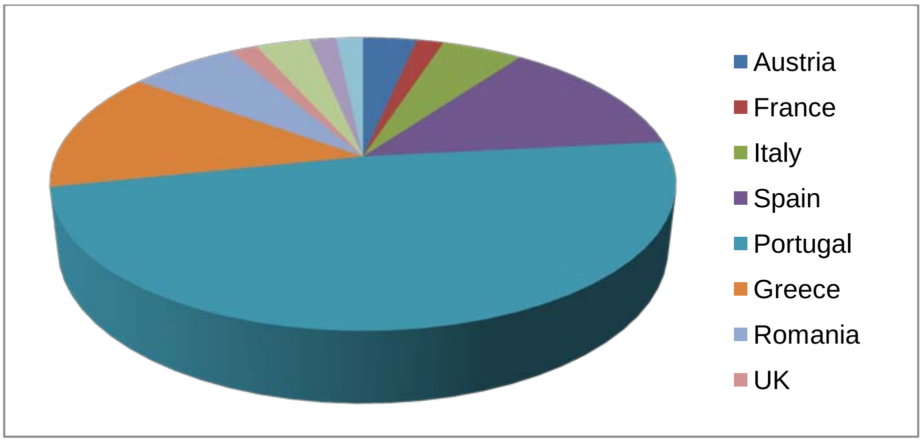

Figure 16 Third Global Joint Conference - Graphical illustration of the country of origin of the audience

The more relevant conclusions of the workshop are listed below:

- SiNGULAR develops advanced mathematical optimization models and tested and validated them in real-world cases, handling forecasting, operations and planning of power systems in an integrated, novel and improved.
- Most important conclusions of the SuSTAINABLE demonstrations are the following:
  - Their concepts allow increasing the grid flexibility and the RES integration.
  - Forecasting tools help the DSOs to do active grid management.
  - The voltage control scheme implemented reduces the PV curtailment.
  - Smart Meter HAN interface allows the DER controllability.
  - Centralised LV Voltage control installed at the Secondary Substation is a key element for LV grid management.
  - Voltage control is an increasing challenge for the DSOs due to DG.
  - Integrated system for Operation is key for functionalities adoption!

7 IGREENGrid, SiNGULAR and SuSTAINABLE common communication activities

IGREENGrid project scheduled three private common workshops with SINGULAR and SuSTAINABLE projects. These project teams strongly believe that close collaboration and interaction among the family of projects funded under the EC call "ENERGY.2012.7.1.1: Integration of variable distributed resources in electricity distribution networks", is vital towards the fulfillment of their mutual goals, the wide dissemination of their expected outcomes and the consistent exploration of their results.

7.1 First common workshop in Athens

Private common workshop was held on the 10th of April 2014. [D1.5] presents a complete description of the contents and conclusions of the private workshop.

Table 22 presents the agenda of the meeting:

Session 1 – Leader IGREENGrid	
KPI experiences	Comillas
New DSO functionalities and roles to integrate DER	HEDNO
DSO new services (ancillary, …)	EDP
Session 2 – Leader SiNGULAR	
Barriers in DRES integration	Comillas
Storage experience to cope with RES variability	TUB
Management of uncertainties introduced by DRES	UNIMAN
Session 3 – Leader SuSTAINABLE	
Integration of Forecasting in DSO network operation	NTUA
Voltage Control Architecture (centralized vs. decentralized)	INESC
DSO Smart Grid Architecture (experiences and ideas sharing)	EFACEC

Table 22 Agenda of the private common workshop

7.2 Second common workshop in Paris

Second Private common workshop was held on the 18th of February 2015. [D1.6] presents a complete description of the contents and conclusions of the private workshop.

Table 22 presents the agenda of the meeting:

IGREENGrid Progress
SuSTAINABLE Progress
SiNGULAR Progress
Session 1: Specific presentation of solutions, products and/or functionalities

implemented in the projects/demos
Session 2: Methods and procedures used for the evaluation of above solutions, products and/or functionalities
Session 3: Scalability and Replicability Analysis
Session 4: Cost Benefit Analysis

Table 23 Agenda of the private common workshop

7.3 Third common wokshop in Lisbon

Third Private common workshop was held on the 26th of November 2015. [D1.6] presents a complete description of the contents and conclusions of the private workshop.

Table 22 presents the agenda of the meeting:

IGREENGrid Progress	
SuSTAINABLE Progress	
SiNGULAR Progress	
Session 1 – Voltage Control	SuSTAINABLE lead
Session 2 – Forecasting	SiNGULAR lead
Session 3 – Curtailment	IGREENGrid lead
Session 4 – Demand Management	SiNGULAR lead
Session 5 – Energy Storage	SuSTAINABLE lead
Session 6 – Scalability & Replicability	IGREENGrid lead
Final Debate	

Table 24 Agenda of the private common workshop

8 Conclusions

The dissemination activities of IGREENGrid project include physical events in national and international workshops, as well as presence on the World Wide Web and the interaction with the social networks to spread the project results.

The first version of the website pages was designed in May-June 2013, and its first content version was approved by the project consortium at the end of July 2013. The website is live and operational since August 2013 and update regularly.

IGREENGrid dissemination key figures

Since the beginning of the project, IGREENGrid project has:

- Attended 28 events and conferences.
- Created 30 articles on the IGREENGrid website.
- Summarize confidential deliverables of the project and publish them on the webpage and the social media pages of the project
- Created news at each partner intranet
- Organized 6 Stakeholders Committee meetings.
- Organized 5 international public workshops.
- Organized 3 private workshops in collaboration with SiNGULAR and SuSTAINABLE projects.
- Contributed in 1 GRID + webinar.
- Published 4 newsletters.

In addition, during the project, the following communication tools have been produced:

1. Unified project visual identity.
2. Extranet service/public portal in the form of a project website (http://www.igreengrid-fp7.eu).
3. Social media accounts.
4. Intranet service in the form of a project Share Point in order to facilitate the internal dissemination.

Next Period Dissemination activities

In addition to the already identified activities listed the communication roadmaps on the Table 2 and Table 3 for the internal and external activities respectively, the project has identified the next list of conferences after the end of the project showed in Table 25. The participation of the first five conferences are confirmed, the papers are already submitted. IGREENGrid consortium studies now, the opportunity of additional project participations.

ID	Event	Type of event	Date	Responsible	Where	Type of material	Link
1	Smart Grids Week	International	09-13/05/2016	Iberdrola	Linz (Austria)	Presentation	http://www.smartgridsweek.com/programm_en.html
2	Jornadas I+D CIGRE	National	19/05/2016	Iberdrola	Madrid	Presentation	-
3	CIRED Workshop	International	14-15/06/2016	AIT	Helsinki (Finland).	Paper	-
4	Energy Informatics Conference 2016	International	29-30/09/2016	AIT	Klagenfurt (Austria)	Paper	-
5	IEEE ISGT Europe 2016	International	9-12/10/2016	AIT	Ljubljana (Slovenia)	Paper	-
6	European Utility week	International	15-17/11/16	To be determined	Barcelona (Spain)	Presentation	-
7	CIRED 2017	International	12-15/06/17	To be determined	Glasgow	Papers	-

Table 25 First proposition of next conferences participations to be studied

9 Annexes- Short description on exchanged experiences on demonstrations and validation of the proposed solutions

This chapter presents a short description on exchanged experiences on demonstrations and validation of the proposed solutions.

9.1 Reliability & Interoperability of Most Promising Solutions

This chapter presents how most promising solutions defined in IGREENGrid can be exploited taking into account the technical reality of DSOs and countries. Solutions are grouped attending main categories, according to the Deliverable D4.2.

1. MV Voltage Monitoring.

Regarding MV Voltage monitoring, three most promising solutions of this category have been identified with a high deployment potential:

- MV Voltage Monitoring (PLF).
- MV Voltage Monitoring (RTU).
- MV Voltage Monitoring (SE).

Although MV Voltage Monitoring is not a solution of high technical complexity, it has a great dependency of ICT and Communications. The impact of an ICT failure on these solutions, which is entirely based on field measurements, would degrade the functionality of the monitoring system. The extent of the impact of an ICT failure would depend on the type and location of the fault.

Duration of loss of communication impacts the quality of the service. When real-time data is mandatory a long period without communication will have a high impact. This is the case for MV Voltage Monitoring based on Remote Terminal Units and MV Voltage Monitoring based on State Estimator. It is possible to reduce the time of lack of communication designing a network that includes duplication of routes and equipment, but in this case, more investment will be needed.

Regarding measurement devices failure, its overall reliability is considered to be high. The technologies or application of these devices are not new to power systems and companies normally have maintenance plans to minimize degradation of these devices.

MV monitoring is a prerequisite for Voltage Control. The increase of the quantity of real-time measurements, decreases the operational risk the grid. Thus, the highest performing solution for MV monitoring is the one based on State Estimate. SE uses quasi-real time measurements, and that allows the operator knowing the real state of the grid at any moment. The advantage of the SE when compared with the use of Remote Terminal Units (RTUs), which are also able to provide real-time information, is that SE provides the added value of correcting wrong and incoherent values. SE has been considered more accurate than Probalistic Load Flow (PLF), because the last one, even working with more data (historical grid and generation information from years, months, days), it works with a low amount of sensors that provide, in the best case, data from the day before. This solution is especially useful for grids with a low degree of automation.

The PLF solution is the most scalable one, because it is totally based on off-line studies, using load and generation profiles from the existing sensors, off-line voltage measurements and Advanced Metering Infrastructure (AMI) data, whichever is available. Due to the use of historical data, it does not lay on the use of a large amount of sensors. SE and RTU solutions could be less scalable because they involve a large amount of sensors in their deployment and they work in real-time demanding new telecom infrastructure development but they allow improving the voltage control performances.

2. LV Voltage Monitoring

This category includes just one promising solution, which presents a high deployment potential:

- LV Voltage Monitoring (AMI).

LV monitoring (AMI) technical requirements are higher than in MV. This is due to the fact that there is a higher rate of voltage fluctuations, and that measurement must be made in three phases. It is therefore expected that the communications bandwidth or memory storage and data processing requirements would be very high compared to similar solutions that are developed for the MV network.

Regarding the loss of communication and device failure, the reliability of the LV monitoring solutions would be expected to be very similar to the MV voltage monitoring solution. But LV monitoring will require the installation of more devices which increases the probability of failure.
The use of AMI to provide voltage profile monitoring it is not easy nowadays, as voltage monitoring functions are not standard for meters and in some countries the DSO is not responsible for metering (e.g. Germany, UK) and would have to request data from each customer. However, AMI would provide statistical data to reduce bandwidth/memory/data processing requirements. A solution providing data only for relevant intervals regarding maximum & minimum or certain percentiles of voltage levels all over the LV-grid would perfectly meet the requirements in respect to network planning.

If the solution based on AMI is going to be applied on a network that has already deployed the Smart Metering (SM) and provided that these meters are capable of measuring voltage, it becomes very easy to be scaled up, given that is basically software based. If the DSO has not deployed SM yet, which is the habitual case in Europe, the implementation implies an enormous amount of equipment to be installed. Another relevant aspect is the low standardization level of these solutions.

3. MV Voltage Control

Regarding MV Voltage Control eight most promising solutions of this category have been identified with a high deployment potential:

- MV Centralised (field measurements) Voltage Control with OLTC.
- MV Centralised (SE & OPF) Voltage Control with OLTC.
- MV Centralised (SE & OPF) Voltage Control with OLTC & DG.
- MV Centralised (SE) Voltage Control with OLTC.
- MV Distributed Voltage Control with OLTC.
- MV Distributed Voltage Control with OLTC, DG.
- MV Supervised (field measurements) Voltage Control with OLTC & DG.
- MV Supervised Voltage Control with OLTC & DG.

Solutions using control systems, centralised or distributed, present a relatively high technical complexity. When these systems are already available in DSOs, the introduction of new measurement or algorithms are more easily deployed.

Again, communication and device failure is an important factor to consider. Although the impact is high, the probability of a SCADA or communications failure is very low. The SCADA and communications systems are not new technologies and there is therefore very low risk of uncertainty that might be expected from using new technologies. Since transformers with OLTC are standard in most networks across Europe, in most cases the transformer itself would not be considered as part of the solution. Failure of the transformer (OLTC) would also prevent functionality of the solution; however the likelihood of such a failure is very low. Again, the OLTC transformer is nothing new at this voltage level.

The MV Voltage Control solutions can be categorised in terms of control system and technology used. Distributed control systems would generally have a low investment and operational cost due to the reduced need for communications infrastructure however centralised control systems are being developed for improved levels of control, in any case both approach would usually provide an increased hosting capacity for DG and also where the communications infrastructure can be used for additional functionalities, such as automation, DSO-TSO interface.

A range of different technologies are available, such as DG invertors with capability to control the injected power (either active or reactive), STATCOM, OLTC (generally considered to already exist on nearly all MV networks), AVR and storage facilities. In many cases either of these technologies could provide the required performance and be technically feasible. The comparison of which solution would be the most promising would mainly be a question of cost (it is for this reason that some of them as the STATCOM, the storage or the AVR are not identified as most promising solutions) and in some cases the feasibility under current regulatory conditions. In terms of reliability, technologies that have been tried and tested for many years (such as the OLTC) and those that use the fewest number of components (such as controlling the DG invertors) are considered to have the greatest reliability.

Finally systems including also State Estimation or /and OPF algorithms helps to complete its functionality and performance.

4. LV Voltage Control

Regarding LV Voltage Control, four most promising solutions have been identified with a high deployment potential:

- LV Distributed (field measurements) Voltage Control with OLTC.
- LV Distributed Voltage Control with DG.
- LV Distributed Voltage Control with OLTC.
- LV Distributed Voltage Control with OLTC, DG.

LV Voltage control faces the same situation as MV Voltage Control: a relatively high technical complexity and the same communication dependency. The reliability of the LV control solutions would be expected to be very similar to the MV voltage control solution.

In general DSOs have more advance SCADA systems in MV than in LV, which makes the deployment of control system more difficult in LV grid.

Similar to MV, centralised control is less scalable than distributed one, mainly because of the large amount of sensors and telecom equipment. DG Flexibility (active power modulation) is not easy to scale and replicate due to the need of modifying contracts and regulation requirements.

5. MV Congestion Management

Finally, two most promising solutions of this category have been identified with a high deployment potential regarding MV congestion management.

- MV Congestion Management with DG non-firm grid connection contracts (including DG modulation).
- MV Congestion Management with Use of Flexibility (DG, DSM, STR ...).

The MV non-firm contracts require fewer devices to be monitored and managed, than the use of flexibilities. Both need a SCADA integration in order to simulate and calculate the flexibility needed. Concerning the non-firm contracts, they need a bilateral communication between the DSO and the generator. For the use of flexibility, a communication between the DSO and one aggregator could be enough but it needs a “market platform”.

The highest performing implementations are ones using all kind of flexibilities that DSO may contract: curtailment of generation, demand side management, storage, aggregators, etc.

Solutions using all kind of flexibilities are less easy to scale up and replicate than the solutions using only ”non firm grid contracts”. It is due to the fact that the need of communications is higher, as well as the need to involve a lot of participants.

9.2 Guidelines to perform technical assessments (methodologies and tools)

The aim of this chapter is to introduce methodologies and tools used during IGREENGrid project to develop technical assessments. The approaches used to carry out these evaluations are based on the analysis of the scalability and replicability of smart grid interventions. These smart solutions are evaluated under different scenarios to assist decision makers in future distribution network planning, taking into account different type of networks, DRES penetration levels and the limitations on data availability and confidentiality among other factors.

The general approached followed in the technical assessment has been a top-down approach. This approach is based on the analysis of artificial scenarios defined by the hosting capacity. This approach has been selected since it allows a common comparison between solutions independent on questionable scenarios about DRES deployment in the next decades.

9.2.1 Methodologies to develop technical assessments

The methodology proposed by IGREENGrid project is based on three steps with an increasing level of complexity. It is interesting to note that the results of each one of the three steps provides some answers to the main question of the actual deployment potential of smart grids solutions for the considered networks. Figure 17 and Figure 18 provide a general and detailed overview of the chosen methodology respectively.

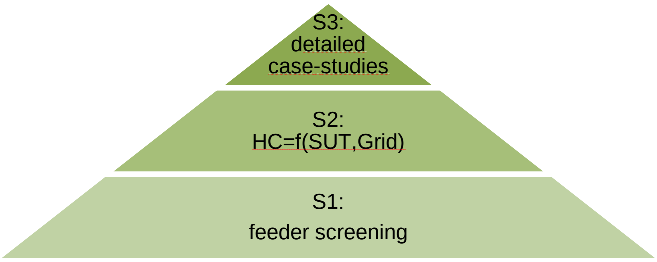

Figure 17 General overview of the three steps for SRA

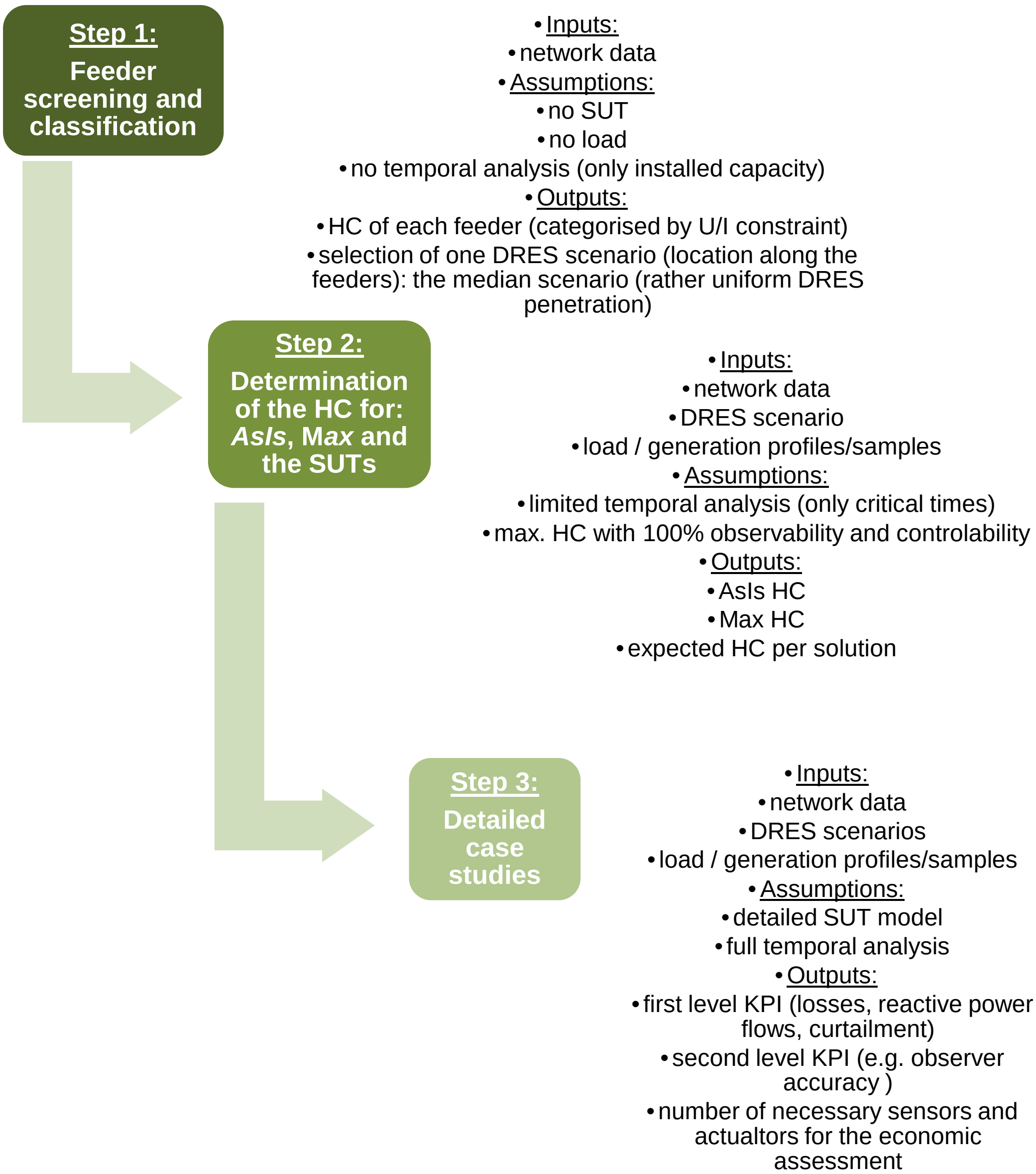

Figure 18 Detailed overview of the three steps for SRA

9.2.1.1 Step 1 – Feeder screening and classification

This first step aims at selecting one DRES scenario, i.e., to select a common reference distribution of generation units along the feeders. Indeed, the hosting capacity of a feeder heavily depends on the location of the generation along the feeder (high hosting capacity when the generation is connected at the beginning and low when it is connected at the end in the case of a voltage constraint). While the determination of the “horizontal” DRES distribution could be based on a priori considerations (e.g. generation profile along the feeder), the scenario is defined on the basis of its implication on the hosting capacity since this is the main KPI. This definition allows a fully automated implementation (see Figure 22).

For the whole study, one single DRES distribution has been proposed: an ‘average hosting capacity' scenario, corresponding to a rather uniformly located generation along the feeders and leading to the median hosting capacity. In the reality, each feeder might experience specific conditions (many small highly distributed generators or large generators at the beginning or at the end of the feeder). In some countries, depending on the subsidies in place to support DRES, some may prevail. For example, the largest share of the installed PV power is located in LV networks in Germany while most of the PV generation in Spain is connected at MV level. In any case, the purpose of the technical assessment of smart grid solutions is to perform a comparative study, even if the selected scenario is only one of many possible scenarios in terms of DRES distribution along the feeder.

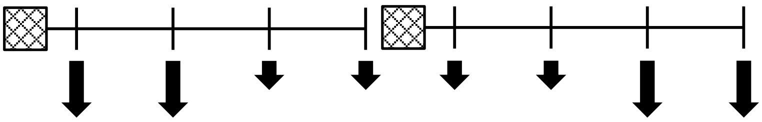

Figure 19 Two examples of "horizontal" DRES scenarios.
Left: generation dominantly at the beginning. Right: generation dominantly at the end

For each single distribution of generation, the hosting capacity is evaluated by scaling up the power of each generator according to the distribution along the feeder until one of the constraints (voltage/current) is reached. This is done by a script which uses an own programmed Secant Method algorithm (the script finds the scaled generation power leading to one of the two constraints).

Loads are not considered in this step since the objective is only to screen all the possible scenarios in terms of distribution of the generation power along the feeders. Out of this procedure, the hosting capacity (in fact a lower limit of it since load is not considered and the coincidence factor is assumed to be 100 % for all the generators) as well as the limiting constraint are determined. Figure 20 illustrates, for two types of feeders with a given random DRES distribution, the calculation process leading to the hosting capacity: in the Feeder A, identified as rural, the voltage constraint is reached before the loading (thermal) constraint when the PV power increases; in the Feeder B, the thermal limit is reached before the voltage limit as it is semi-urban. Thus Feeder A is classified as voltage constrained (blue point) and Feeder B is classified as loading constrained.

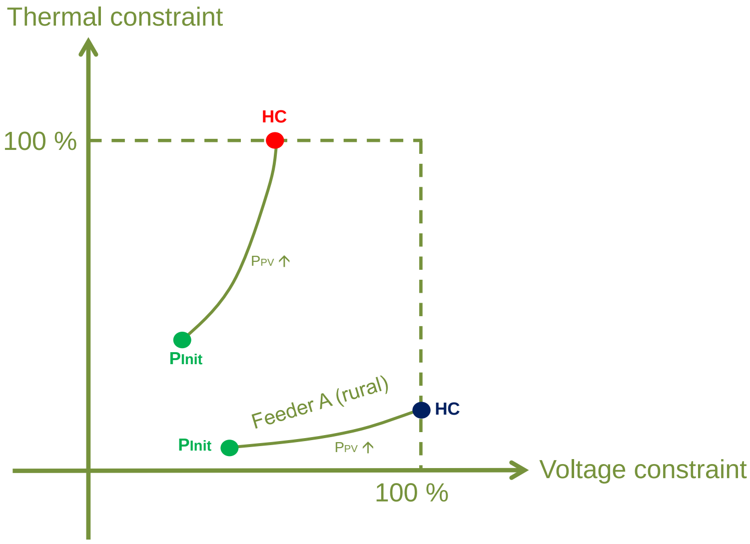

Figure 20 Illustration of the hosting capacity calculation for two types of networks

This procedure is repeated for each DRES distribution generated in the Monte-Carlo simulations and the hosting capacity Cumulated Distribution Function (CDF) is created. In addition to the hosting capacity figures, the type of constraint (voltage or current) is stored and shown on the CDF. Finally, the average hosting capacity distribution can be extracted from it.

Figure 21 shows an example of the outcomes from Step 1:

- The hosting capacity Cumulated Distribution Function (CDF) coloured according to the constraint (blue: voltage / red: current).
- The 50 %-point on the CDF-curve corresponding to the DRES scenario selected for further study.

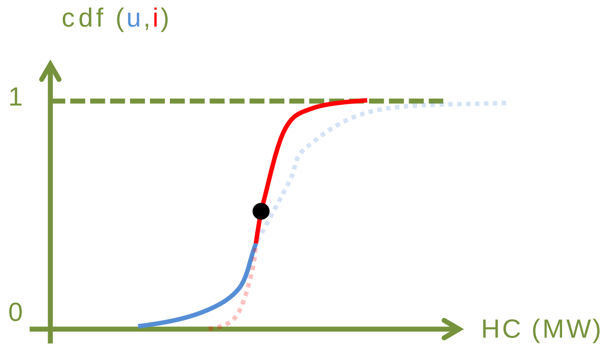

Figure 21 Cumulative distribution function – CDF of the hosting capacity

The implementation of the procedure used in Step 1 is explained in Figure 22. Note that this definition of the DRES distribution is based on a uniform probability of having generators connected along the feeders. It does therefore not consider the probability of having generators mostly at the end of the feeder, which might be observed in regions in which the penetration of PV installations on farms which are usually connected to remote nodes is higher (e.g. in the South of Germany).

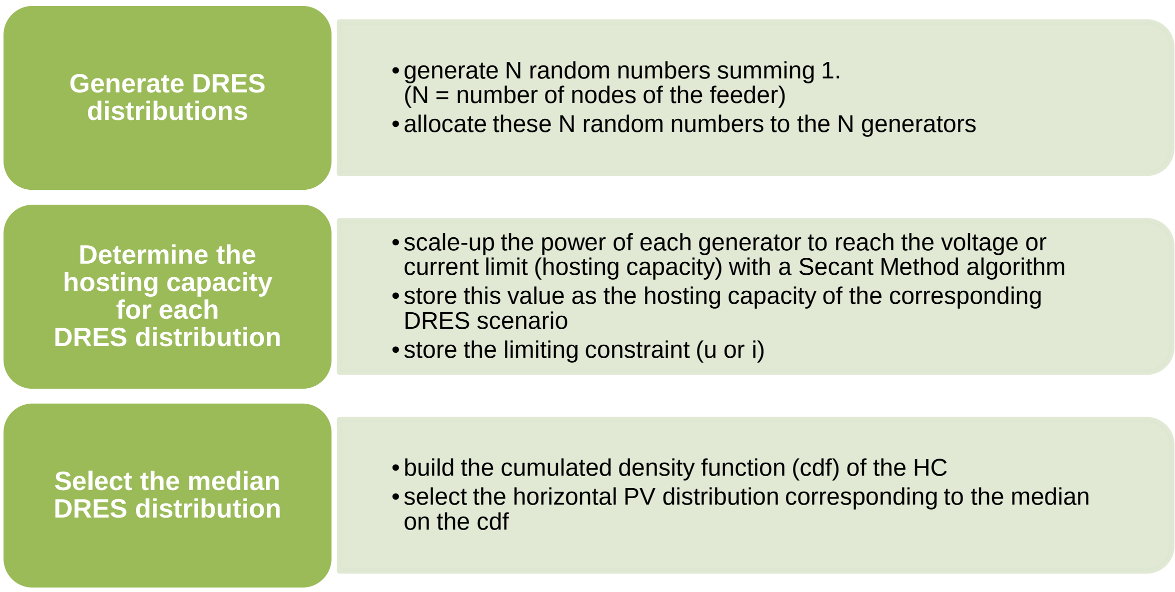

Figure 22 Implementation of Step 1

9.2.1.2 Step 2 - Determination of the expected hosting capacities for the case-studies

The second step aims at determining a more realistic hosting capacity value for the following cases:

- Without any modification: AsIs hosting capacity (network as it is, without reinforcement and without smart grids solutions).
- With a perfect control assuming 100 % observability and 100 % controllability (active and reactive power at generators and tap changers at transformers) and without reinforcements: Max hosting capacity.
- With the solution under tests (or families of solutions): Expected hosting capacity.

Contrary to Step 1, the time characteristics of load and generation are considered in this step. In a first phase, a probabilistic power flow is computed considering load and generation samples, with the DRES distributions previously determined (Step 1). The probabilistic power flow is based on Monte-Carlo simulations and it uses (268.800 samples).

If a violation caused by the load is observed inside a feeder, i.e. an under voltage or an overloading (due to inaccuracies in the provided feeder load profiles), the installed load power is reduced in order to respect the planning rules set by the DSO.

After this phase, another probabilistic power flow is computed with the (possibly modified) load values. In order to limit the computation burden, critical times have been introduced: for each solution which does not involve the OLTC, the critical times correspond to the occurrence of the highest voltage among all the nodes and highest loading among all the lines of the feeder. For OLTC-based solutions, the critical time corresponds to the occurrence of the maximum voltage spreading inside the network.

Once these critical times are determined (two critical times per feeder or one critical time for the network), the hosting capacity is evaluated by considering these critical times. The procedure to calculate the hosting capacity for a given solution is the following: firstly, the system is parametrised accordingly to the study-case; then a snapshot is made at the critical times determined previously. Finally, the hosting capacity (to reach one of the limits) is determined, as for Step 1, by scaling the installed power with a Secant Method algorithm. Note that for the solutions which do not involve any OLTC, two critical times are determined for each feeder, leading to two possible values of the hosting capacities in case the maximum voltage and maximum loading don't occur at the same time. In this case, the selected hosting capacity is the smallest.

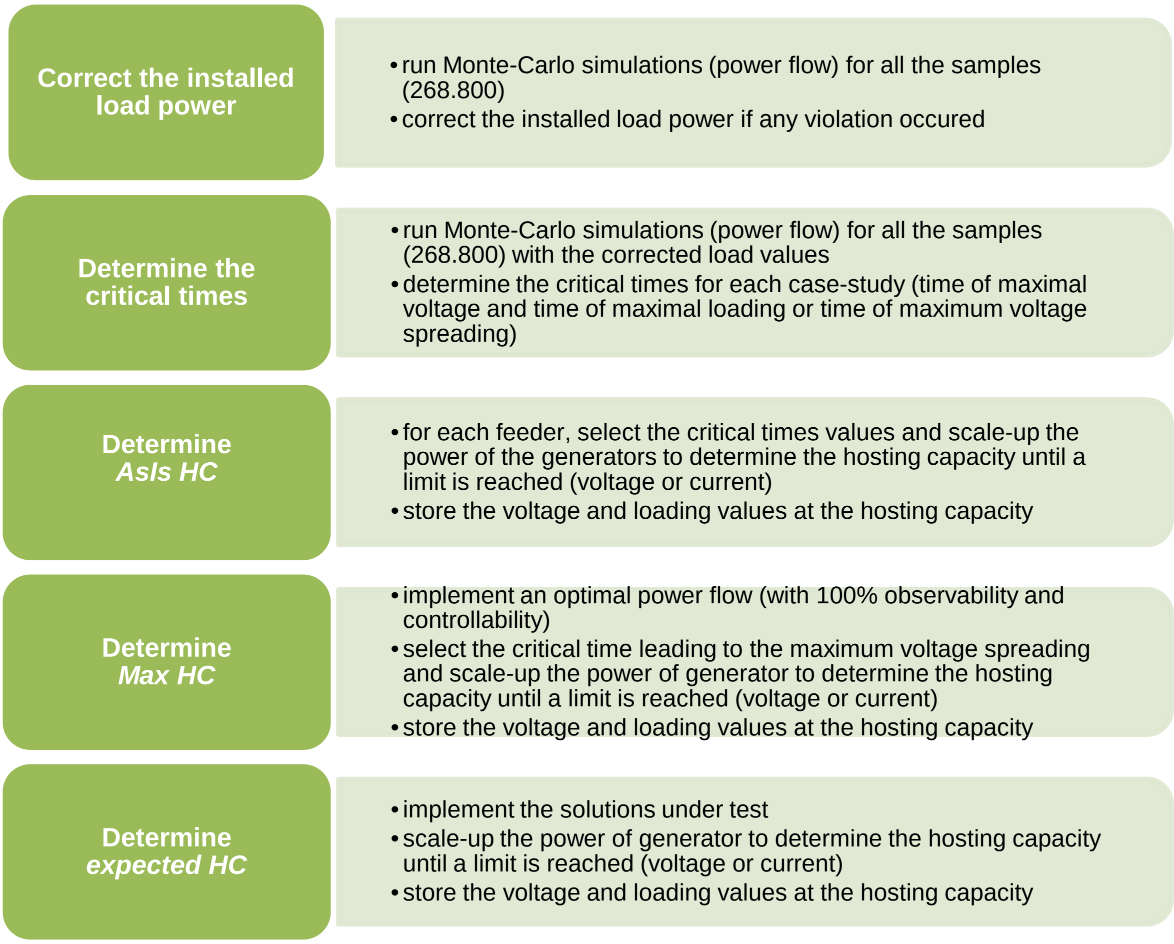

Figure 23 Implementation of Step 2

9.2.1.3 Step 3 – Detailed analysis of case-studies

This last step presents the highest complexity in terms of simulations. For the detailed case-studies, more accurate models of the solutions under tests are used and the full temporal analysis (i.e. using load and generation samples generated from time series) is done in order to be able to evaluate integral values (e.g. annual network losses or curtailment). By using a detailed model of the solutions, their actual performance (e.g. accuracy) can be assessed.

First, the solutions are implemented and the expected hosting capacity is then used and the solution is simulated for the full amount of samples. The simulation results are then analysed and the results are analysed (e.g. losses, curtailment, monitoring accuracy…).

In addition to the pure technical evaluation of the results, some key results are forwarded to the economic analysis. Moreover, the maximum voltage and loading of each feeder are analysed to validate the HC calculated in Step 2.

The individual subtasks of Step 3 are summarised in Figure 24.

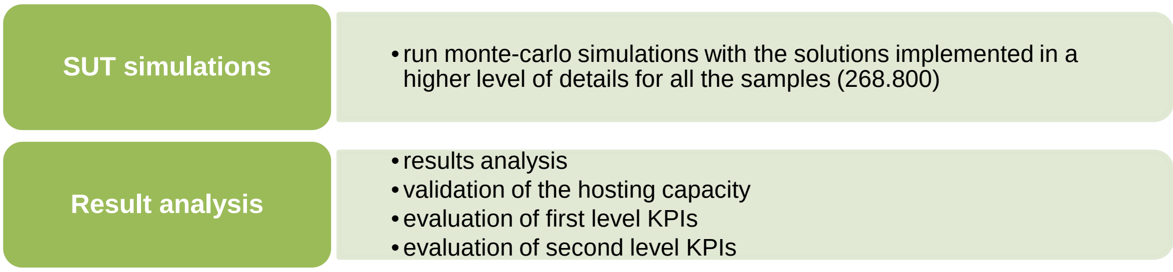

Figure 24 Implementation of Step 3

9.3 Guidelines to perform economic assessments (methodologies and tools)

The aim of this chapter is to introduce methodologies and tools used during IGREENGrid project to develop economic assessments. The approaches used to carry out these evaluations are based on the analysis of the scalability and replicability of smart grid interventions. These smart solutions are evaluated under different scenarios to assist decision makers for future investment planning.

9.3.1 Methodologies to develop economic assessments

9.3.1.1 Approach for the economic evaluation

The economic approach is based on the reference report for CBA on smart grid projects, proposed by the European Commission (EC) Joint Research Center (JRC). These European guidelines have the advantage of considering two types of benefits in the assessment:

- Quantitative benefits that can be monetised.
- Qualitative benefits, those represented by KPI that qualitatively capture the deployment merit of the smart grid project towards the achievement of the ideal smart grids and of the policy goals behind it.

Down below is presented on Figure 25 the workflow proposed by EC JRC to undertake a CBA of smart grids projects:

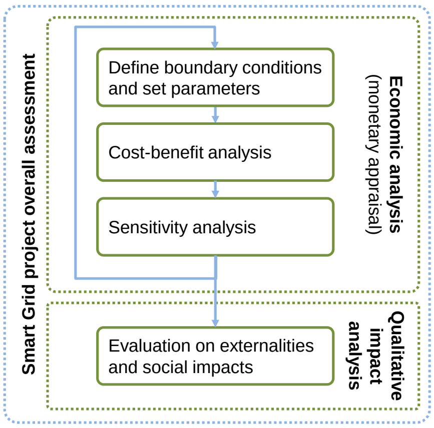

Figure 25 Work flow proposed by EC JRC for a CBA of a smart grids project

9.3.1.2 Concept for the evaluation of costs and benefits in IGREENGrid: CA&BA

The methodology to evaluate costs and benefits for the IGREENGrid project is based on the EC JRC CBA methodology. However, several modifications have been performed with the aim of simplifying the scope and making it more suitable for the characteristics of the project. The main difference between the methodology followed in IGREENGrid and the CBA methodology proposed by the JRC is that costs are not compared with benefits (not monetized), i.e., in the IGREENGrid project Cost Analysis (CA) and Benefits Analysis (BA) are carried out instead of Cost-Benefit Analysis (CBA).

Here after, it is introduced the CA&BA methodology to evaluate the costs and benefits of the different solutions included in this study:

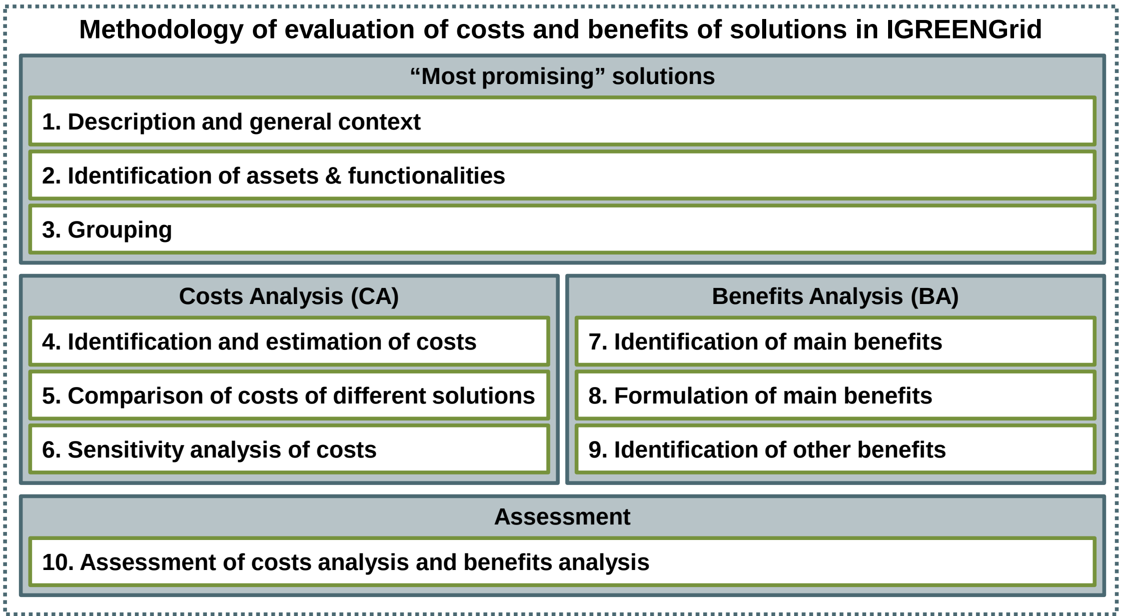

Figure 26 Methodology of evaluation of costs and benefits of solutions – CA&BA considered in IGREENGrid

Then, the different steps by section for the evaluation of the solutions are introduced.

<u>Part 1: Description of the most promising solutions</u>

<u>Step 1: Description and general context</u>
The very first step is the description of the solution under study. It is also necessary to summarise the elements of the solutions, taking into account voltage levels, control type, control system tools, measurements nodes, controlled devices and solution requirements, among other factors.

In addition, the overall project assessment should be tailored to local conditions, considering different geographies and contexts that may have different impacts on costs and benefits. Therefore, these specified conditions, such as regulatory framework, relevant macroeconomics factors and the characteristics of regions, should be described in this point.

Step 2: Identification of assets & functionalities

The first task at this step is to identify and categorise the main components / technologies deployed in each solution according to the location of assets:

- Low voltage (LV) line.
- Medium-Low voltage (MV/LV) secondary substation.
- Medium voltage (MV) line.
- High-Medium voltage (MV/HV) primary substation.
- Distribution management system (DMS).

After that, the main smart grids functionalities ("JRC-functionality" onwards) that are activated by the identified assets need to be identified. These "JRC-functionalities" are taken from the list of 33 functionalities grouped in six services proposed by the EC Task Force from smart grids 2010a.

Step 3: Grouping

Some of the "most-promising" solutions identified in WP4 solve the same problem, i.e. they have the same main functionality or objective to accomplish. In the third step, these most-promising solutions are clustered by functionality (main objective of the solution):

Functionality
LV Voltage Monitoring
MV Voltage Monitoring
LV Voltage control
MV Voltage control
Congestion Management

Table 26 Grouping of most promising solutions by functionality

Part 2: Cost Analysis (CA)

The objective of Costs Analysis (CA) is to analyse the costs related to the most-promising solutions and to compare them with the costs of reinforcing the network to reach the same hosting capacity (just negative cash flow or costs incurred by DSOs are considered). The savings of deploying smart solutions instead of the wire solution can be understood as the main or monetized benefit of the solutions under study in IGREENGrid project.

Step 4: Identification and estimation of costs

The use cases analysed in this evaluation of costs and benefits are characterized in technical simulations and thus this analysis is performed and limited to cases that are technically feasible.

Once use-cases are characterized and validated technically, the costs incurred by DSOs when implementing the technical configurations of the solutions resulting from the simulations can be classified into two categories:

- Capital Expenditure (CapEx): it refers to the capital amount which has been dedicated to the acquisition/development/deployment of the assets under test. It represents the investment related to the realization of the R&I solutions and it includes the installation and replacement costs of the related assets.

- Operational Expenditure (OpEx): it considers the capital amount dedicated to the operation and management of the solution under test. It includes the scheduled maintenance operation, the primary energy supply (fuel for active assets), control resources, etc.

A list of potentially attributable CapEx and Opex is provided in Table 27.

Cost type	Cost name	Brief description of the cost
CapEx	**Investment**	Components acquisition
	I+D costs	Attributable research and development costs
	Field testing costs	Costs related to necessary and/or compulsory testing in case of the solution operability
	Installation	Costs related to work performance, including costs of construction management, civil engineering...
	Bureaucracy	Administrative paperwork: permits, licenses…
	Other CapEx	Any other attributable CapEx
OpEx	**Corrective maintenance**	Costs related to activities undertaken to detect, isolate, and rectify a fault so that the failed equipment, machine, or system can be restored to its normal operable state
	Preventive maintenance	Costs related to systematic inspection, detection, correction, and prevention of incipient failures, before they become actual or major failures
	Components replacement	Costs related to replace components which useful time is shorter than the installation´s lifetime
	Other OpEx	Any other attributable OpEx (such as primary fuel, if needed)

Table 27 List of potentially attributable CapEx and OpEx

After the identification, the estimation of costs of the solutions is performed. Unit costs and certainty/uncertainty of unit costs values are determined and applied to the technical configurations of solutions or use cases that result from the simulations. In this manner, an average (or probable) cost and a reasonable range of variation of the costs are estimated/calculated for each solution and solution group in the IGREENGrid project.

Step 5: Comparison of costs of the different solutions

The objective in this step is to compare the costs of different smart grids solutions included within a solution group among them and also with the “business as usual” case (network reinforcement). In other words, the aim in this task is to arrange or prioritize the solutions with a common objective (intended to solve the same problem) in terms of the costs associated to them and incurred by the DSO.

The Cost Analysis (CA) proposed in IGREENGrid project consists on the application of the following two exercises or methods:

- The **Present Value of Total Costs (PVTC)** method consists of estimating the sum of net present value of annual costs (CapEx + OpEx) of the smart grids solution for the entire study period, in other words, the PVTC can be understood as the total costs 'brought back' to the first year (commonly called "year zero") by applying a discount rate (thereby accounting for the time value of money). The PVTC is calculated as shown by equation (1):

$$PVTC = \sum_{t=0}^{n} \frac{R_t}{(1+i)^t} \qquad (2)$$

t	Time
i	discount rate
R_t	Cost incurred by the DSO in time t
n	Total number of periods considered

- The **Annual Costs Comparison method** consists of compiling the annual costs of the solutions over the study period (20 years) in order to make annual comparisons and identify individual years in which costs are higher and lower.

Step 6: Sensitivity analysis of costs

In this step a sensitivity analysis of the costs is carried out. The purpose of performing this analysis is to assess the impact of changes in project variables on the project´s performance; this is to evaluate whether the smart grids project would be economically feasible in the case that some changes in the project variables occurred.

A sensitivity analysis can aim at varying a type of costs, one at a time or in combination. This technique helps to assess whether and how project decisions could be affected by such changes and helps to identify actions that could mitigate possible adverse effects on the project.

Carrying out some kind of sensitivity analysis seems logical and necessary in a costs analysis of a smart grids project, because (1) depending upon each national context the return on investment can essentially change, and (2) the calculations rely on estimated data, simulations and predictions.

In order to develop a quality work, it is necessary to identify key variables that most influence the project's costs. While the selection of the variables to be varied is not straight forward, the proposal is to select variables of subjective nature (e.g. the discount rate), in order to standardize the sensitivity analysis.

It is necessary to identify key variables that most influence the costs incurred by the DSOs for the solutions under analysis. In IGREENGrid project two variables have been identified so that the sensitivity analysis will be carried out varying these two variables:

- Discount rate (i). This sensitivity analysis is intended to reflect the impact that the economic situation of the markets may have on the costs associated with the implementation of the solutions. In addition to the average discount rate considered in the analysis, a large range of discount rate is considered in order to ensure that the final and real costs of the implementations will very probably be within the total costs ranges estimated.
- Number of DG units to be retrofit. Some of the DSOs have indicated that retrofitting of

already connected DG units to include P&Q control is not planned in their countries. In order to take into consideration the impact that this possible cost of retrofitting DG units may have in the total costs of a solution, some scenarios have been defined and a sensitivity analysis is carried out.

If in any case, if any other variable were also considered a key variable for the cost of the project, an ad doc sensitivity analysis should be defined and developed varying that key variable.

Part 3: Benefits Analysis (BA)

The purpose Benefits Analysis (BA) is to identify benefits (taken from the list of 22 potential benefits and the list of 54 KPIs/Benefits proposed by JRC) that smart solutions could provide to the system, such as the deferment of distribution capacity investments or a lower environmental impact of electricity grid infrastructure.

Step 7: Identification of main benefits

In this step the potential main benefits of the solution have to be identified. This task is done in cooperation between the partners, as long as reliable benefit identification is pursued.

In this step within the CA&BA methodology of the IGREENGrid project, with the aim of identifying benefits, the solutions under study are considered as a whole. This assumption means:

1) Only those JRC-functionalities and services related to the overall solution will be considered instead of taking into account the whole set of JRC-functionalities / services associated to each asset.
2) Only those expected benefits resulting directly from the solution will be identified, ignoring partial effects related just to an asset or a JRC-functionality.

There are two main reasons to undertake this task in this way:

- Direct relationship between the objective of the solution and the benefits provided by it: it is conceptually easier to understand the benefits of the whole solution through the problems it is considered to solve rather than evaluating the side benefits or impacts procured by each single asset being part of the solution.
- Different JRC-functionalities can have side effects on the same benefit but in opposite directions, so that the resulting net benefit could be insignificant and yet require a complex analysis.

The main benefits are identified from the list of 22 potential benefits of smart grids projects (put forward by the EPRI methodology.

It is important to understand why each identified benefit actually occurs or is provided by the solution (or the kind of solution within the “solution group”). So that, an explanation of the reasons or causes of each main benefit is provided, thanks to the cooperation of all the partners within the IGREENGrid project.

Step 8: Formulation of main benefit

Once main benefits are identified, formulas to potentially calculate the monetised value of these main benefits will be proposed, as visualising how to monetise or valuate benefits may help to better understand their causes. It is important to clarify that these formulas will just be exposed for information purposes but not actually used, i.e. no value will be given to benefits.

Step 9: Identification of other benefits

The identification of main benefits is complemented by the identification of additional benefits brought by the project towards the achievement of the smart grids and of the policy goals behind it. These benefits are selected from the list of KPIs/Benefits defined by EC Task Force for smart grids 2010C.

Part 4: Overall Assessment

Step 10: Assessment of costs analysis and benefit analysis

In this last point costs analysis and benefits analysis are already carried out and the two results or assessments are obtained for each solution. So, finally, these two analyses are combined with the aim of obtaining an overall assessment of the smart grids solutions proposed within the IGREENGrid project.

The combination implies fulfilling a form that summarizes the main results of the costs analysis (CA) and the aimed benefits identification (BA).

10 References

10.1 Project Documents

List of reference document produced in the project or part of the grant agreement

[DOW] – Description of Work.
[GA] – Grant Agreement.
[CA] – Consortium Agreement.
[D1.5] - Report I: coordination with SINGULAR & SUSTAINABLE Project.
[D1.6] - Report II: coordination with SINGULAR & SusTAINABLE Projects.
[D1.7] – IGREENGrid-SINGULAR- SuSTAINABLE. Modalities for interaction during the course of the project.
[D4.2] - List of reference targets (country-specific & EU-wide) for grid integration of DER based on selected: Identification of effective solutions for DRES integration in distribution grids that could be scaled and replicated.
[D5.1] - Technical and economic evaluation of replicability and scalability of solutions to increase the DER: Identification of opportunities to scale and replicate most promising solutions.
[D7.1] – Dissemination Plan.
[D7.3] - IGREENGrid Newsletter 1.
[D7.4] - IGREENGrid Newsletter 2.
[D7.5] - IGREENGrid Newsletter 3.
[D.7.6] - IGREENGrid Workshop 1.
[D.7.7] - IGREENGrid Workshop 2.
[D.7.8] - IGREENGrid Workshop 3.
[D.7.9] - IGREENGrid Workshop 4.
[D.7.11] - Articles in prestigious publications to present IGREENGrid results.
[D7.12] - DISSEMINATION: IGREENGrid website.