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ELECTRA

European Liaison on Electricity Committed Towards long-term Research Activities for Smart Grids

WP 10

Actions on International Cooperation

Deliverable D10.1

List of mutually interesting R&D topics and prioritization by country of R&D topics to be jointly addressed – Phase I (M16)

26/06/2015

ID&Title	**D10.1** List of mutually interesting R&D topics and prioritization by country of R&D topics to be jointly addressed – Phase I (M16)	**Number of pages:**	49

Short description (Max. 50 words):

This document presents a preliminary list of Smart Grids topics potentially useful for future INCO activities with extra-European institutions. On-going agreements between ELECTRA Partners and extra-European Institutions which could be useful for this purpose are also reported.

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V0.1	04/06/2015	First Draft
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Executive summary

This document provides a list of mutually interesting R&D topics for International Cooperation (INCO) activities differentiated by country and linked to the on-going agreements the ELECTRA Partners have outside Europe.

The list has been defined through a series of meeting, workshops and conferences with the AB, ICB, research centres and other institutions. The support provided by ISGAN allowed ELECTRA to establish contacts, find topics of common interest and share results with new realities.

In the Smart Grids and energy areas, the ELECTRA Partners have sixty-four agreements with extra-EU countries – mainly Memorandum of Understanding – of which eleven explicitly related to Smart Grids. USA (13), China (8), Japan (7) and Korea (5) cover 90% of the total agreements, highlighting the thick collaboration the ELECTRA Partners have with the American and the Asian continents. A small number of agreements are with institutions from the other continents (i.e. Africa and Oceania) or with international programs (i.e. ISGAN or Global E^3).

USA is well connected to the ELECTRA and the EERA JP SG activities thanks to the presence of different agreements specifically related to the identified topics. The same applies to Korea and China that are focused on topics classified as of mid-high importance.

Moreover, ELECTRA Partners have agreements with countries (such as in the Middle-East region) not yet directly contacted and, therefore, not mentioned in the topics list. These agreements can be used as a starting point to establish further contacts in order to lead to a more shared view on Smart Grids.

In summary the list presented in this document will act as a basis for future INCO activities, establishing long-term relationships, fostering closer interaction with extra-EU institutes and joint research initiatives on selected Smart Grids topics of mutual interest.

Finally, given that new agreements and new common topics can be found at any moment, this document can be updated during the project life.

Terminologies

Acronyms

ELECTRA	European Liaison on Electricity Committed Towards long-term Research Activity
AB	Advisory Board
AIST	National Institute of Advanced Industrial Science and Technology
ANL	Argonne national Laboratory
AMI	Advanced Metering Infrastructure
BNL	Brookhaven National Laboratory
B.R.I.C.S.	Brazil, Russia, India, China, South Africa
CA	Consortium Agreement
CEPRI	China Electric Power Research Institute
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CNPq	National Counsel of Technological and Scientific Development
DOE	Department of Energy
DoW	Description of Work
DSO	Distribution System Operator
EC	European Commission
EERA	European Energy Research Alliance
EERA JP SG	European Energy Research Alliance Joint Program on Smart Grids
EPRI	Electric Power Research Institute
ERI	Energy Research Institute
ESKOM	Electricity Supply Commission
EU	European Union
FREA	Fukushima Renewable Energy Institute
FP7	Framework Program 7
GA	Grant Agreement
GSGF	Global Smart Grids Federation
ICB	International Coordination Board
ICT	Information and Communication Technology
INCO	International Cooperation
INCT	Instituto Nacional de Ciência e Tecnologia
INERGE	Brazilian Science and Technology Institute
IRP	Integrated Research Programme
ISGAN	International Smart Grid Action Network
ISGF	Indian Smart Grids Forum
ITU	International Telecommunication Union
JP	Joint Programme
JPoSG	EERA Joint Programme on Smart Grids
KACST	King Abdulaziz City for Science and Technology
KEPCO	Korea Electric Power Corporation
KEPRI	Korea Electric Power Research Institute
KERI	Korea Electrotechnology Research Institute
KSGI	Korea Smart Grid Institute
KETEP	Korea Institute of Energy Technology Evaluation and Planning
NA	Not Available

NDA	Non-Disclosure Agreement
NEDO	New Energy and Industrial Technology Development Organization
NERC	National Energy Research Centre
NETL	National Energy Technology Laboratory
NREL	National Renewable Energy Laboratory
PNNL	Pacific Northwest National Laboratory
PMU	Phasor Monitoring Unit
PGCI	Power Grid Corporation of India
RES	Renewable Energy Sources
REX	Researcher Exchange
SANDIA	SANDIA National Laboratory
SANEDI	South African National Energy Development Institute
SJTU	Shanghai Jiao Tong University
SP	Sub Program
TC	Technical Committee
TSO	Transmission System Operator
WAMS	Wide Area Monitoring System
WP	Work Package

Abbreviations

D	Deliverable
MS	Milestone
R	Internal Report

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List of figures and tables

1 Introduction

One of the main objectives of WP10, as described in the ELECTRA IRP DoW [1], is to define the R&D topics of mutual interest for International Cooperation (INCO) with respect to some of the most active countries in the field of Smart Grids and to coordinate these with the programmes of work of the IRP and the JP.

Specifically, the aim of Task T10.1 is to foster information exchange, collation, analyses and selection of R&D topics of mutual interest for INCO activities on Smart Grids with extra-EU Institutions.

D10.1 shows how the foreseen WP10 activity has been carried out, listing all the relevant interactions that the ELECTRA Partners experienced with extra-EU potential Partners.

The approach identified in the DoW [1] foresees a step-by-step process towards an increased level of collaborative interaction, that comprises:

- Initial exchange of information about ongoing Smart Grids programs and projects;
- Sharing of national vision, strategy and priorities;
- Selection of R&D topics of mutual interest;
- Exchange of publicly available data and results;
- Selection of areas/topics for potential joint R&D collaborative projects;
- Definition and launching of joint R&D tasks;
- Execution of joint R&D activities involving the use of research infrastructures and researchers exchange;
- Additional INCO activities of mutual interest.

This will be made possible through:

- A close interaction with the ICB members;
- Enlargement of ICB membership;
- Exchanges and interactions with the ELECTRA Advisory Board;
- Organisation of technical meetings and workshops.

This report is structured in six main chapters.

Chapter 2 refers to the approach to INCO activities, showing how the consortium has approached international organisations, how the ICB has been settled and enlarged with one additional member as well as the relative ICB initial activity for the first year of the project.

Chapter 3 gives detailed information on the activities carried out within ELECTRA with extra-EU organisations. All relevant interactions are summarized in tables organised by country and provide a punctual specification on the possible R&D topics to be addressed between ELECTRA and the relevant organisation having active programs on Smart Grids in their own country.

Chapter 4 provides a preliminary list of mutually interesting R&D topics for each country that has been addressed. The list represents an important outcome of the activity of WP10, suggesting possible actions for the future towards targeted relevant extra-EU organisations.

Chapter 5 presents the ongoing agreements between the ELECTRA partners and extra-EU Organizations in the Smart Grids and energy fields. An analysis of the geographical distribution and of the most used types of agreements is presented, together with a focus on the ones explicitly related to Smart Grids.

Finally, in Chapter 6 the “preliminary list of mutually interesting R&D topics” is linked to the ongoing agreements presented in Chapter 5 and to specific activities carried on in RTD ELECTRA WPs and EERA SPs.

2 Approach to INCO activities

The ELECTRA Consortium aims to promote a broad and efficient collaboration with extra-European research Institutions and international Organisations to disseminate the European vision on the Smart Grids field, to highlight the European leading technology in the electrical industry and to ensure that technology developed within EU are fit for much broader scopes of application under different conditions. In this framework, actions towards INCO activities aims at establishing long-term collaborations between the EU and the other countries interested in researching and developing new technical solutions for the future Smart Grids. Major leading countries such as USA, Japan, Korea and Australia, are targeted, considering their respective level of excellence in high-tech solutions and a wide and consolidated experience in collaboration and knowledge sharing with European countries. The overwhelming development of emerging countries such as China and India dictates to give them special attention and to ensure a strong and fruitful cooperation also in the research field. In a broader sense, our INCO activities on Smart Grids aims at creating a channel for present and future long-term wide collaboration of the European countries, seen as a single entity represented by the EERA JP on Smart Grids, and extra-European countries in R&D activities on Smart Grids, which constitutes a fundamental activity for the strategic energy targets set by each country.

The ambitious goal of WP10 can be reached through a number of initiatives which constitutes a step-by-step approach to interact with international Organisations, to gain knowledge about their activities and their research objectives. Technical workshops, webinars, online as well as physical meetings, represent common practice within the Consortium and are used to interacts with member representatives of the targeted extra-European Organisations.

2.1 The International Coordination Board (ICB)

An important body the ELECTRA Consortium has established is the International Coordination Board (ICB). The ICB gathers “representatives from research institutions and other stakeholders in the field of Smart Grids from outside the boundaries of the EU” [1]. The Board serves as appropriate entity where international scientists, experts and industry representatives can provide their input, feedback and advice on the ELECTRA activities. It is of outmost importance that the research efforts envisaged within the ELECTRA IRP are aligned with the industry expectations and the state of the art of the most advanced achievements worldwide. Thus, the ICB represents the cornerstone of the INCO activities, also ensuring that the main messages from the EU research community reach a wider audience and a broad consensus as well as the leadership of the EU industry in Smart Grids technologies is properly highlighted and promoted.
The setting of the ICB is also motivated to coordinate and encourage joint research activities among European countries and extra-EU Organisations worldwide to bundle research capacities to achieve a common goal and to create an international community of Smart Grids experts where Europe is properly represented.

The present ICB Members are listed in Table 1, showing a wide international support from research centres, technical universities, standardisation bodies and international associations.

The first year of activity has seen an enlargement of the ICB thanks to the Letter of Support (LoS) received by the Japanese public research institute Advanced Industrial Science and Technology (AIST) and the related recently-established Fukushima Renewable Energy Institute (FREA). The commitment towards an effective international collaboration passes through an additional enlargement of the Board and the involvement of few other main countries to be addressed.

Table 1 – List of ICB members (December 2014)

ID#	Country (*)	ELECTRA Involved Partners		Organization	Contact Person(s)
01	**Australia**	TEC	A. Diaz	**CSIRO**	Glenn Platt M. Paterson
02	**ITU**	RSE	C. Tornelli	**ITU**	F. Cucchietti C. Bueti
03	**ISGAN**	RSE AIT	L. Martini H. Brunner	**ISGAN**	M. De Nigris R. Conklin
04	**USA**	RSE	L. Martini	**EPRI**	Tom Key M. Wakefield M. F. Granaghan S. Simon
05	**China**	JRC RSE	E. Bompard L. Martini	**SJTU**	Zheng Yan
06	**China**	JRC DTU	E. Bompard H. Bindner	**ERI**	Wang Zhongying
07	**Japan**	RSE	L. Martini	**AIST / FREA**	Yoshiro Owadano Kenji Otani

2.1.1 The ICB initial activity

During the first year of activity, the ICB Members met twice through one online meeting and one physical interaction thanks to the opportunity given by the IRED2014 conference organised in Kyoto, Japan.

Following the first interactions via email, an online meeting was organised in October 2014 to promote and to start a more direct discussion with the ICB Members and external observers on the ELECTRA IRP and the Smart Grids activities envisaged within the EERA JP on Smart Grids. The event constituted the chance to present the ELECTRA IRP to ICB members and to start a fruitful discussion on possible collaboration on specific R&D topics of mutual interest. It was also the opportunity to invite international Organisations to the international workshop that ELECTRA organized as a side-event of the IRED2014 conference held in Kyoto, Japan in November 2014. IRED2014 represents an important forum focusing on the Integration of Renewable and Distributed Energy Resources that involved participants form Europe, America and Asia. In that context, the IRP organised also the first ICB physical meeting, allowing ICB Members to know each other and have a face-to-face conversation and discussion. Both ICB events experienced a very good participation and put the basis for future cooperation on research activities, considering the high interest shown for the ELECTRA topics.

2.2 Main interaction means and tools

The main interactions means to be used to establish an efficient and continuous interaction with extra-EU Organizations to get information about ongoing Smart Grids projects and activities are listed in the following:

- Direct interaction based on past bilateral contacts and agreements;
- International meetings, workshops and conferences;
- Research facilities and researcher exchanges;
- ICB online and physical meetings.

2.2.1 Direct interaction based on past bilateral contacts and agreements

In the past few years the EERA JP on Smart Grids succeeded in interacting with several relevant extra-EU Organizations and research centres. Multiple interactions and effective exchange of information took place with DoE and National Laboratories (USA), with NEDO (Japan), KETEP and KSGI (Korea), and Others. Specific meetings and workshops have been organized both in Europe and abroad opening the possibility of closer collaborations. Moreover, individual research organization members of ELECTRA and of the EERA JP on Smart Grids were key in opening effective communication channels with targeted extra-EU Organizations owing to their past bilateral contacts and agreements. All the above was instrumental to put the basis for the future ELECTRA INCO activity. ELECTRA plans to first stabilize the present interactions and then to reach out additional contacts by leveraging its members broad connections.

2.2.2 International meetings workshops, conferences, and technical visits

International meetings, workshops and conferences are suitable and very effective tools to exchange technical information on key topics with researchers and scientists around the world on a specific research field. In the past few years the EERA JP on Smart Grids organized several of such events in Europe and invited some extra-EU colleagues to attend and contribute. In one specific case the JP Smart Grids co-organized an international workshop with US DoE involving four different National Labs (NREL, ORNL, SANDIA and PNNL) and representatives from research centres and industry. After this workshop, technical visits to the above mentioned four National labs have been organized thus better understanding ongoing research activities and available research infrastructures.

Likewise, apart from a workshop organized in Glasgow (UK) in June 2014, ELECTRA organized an international workshop as side-event of the IRED2014 conference in Kyoto, Japan. A specific meeting with key representatives form AIST FREA (Director-General and senior researchers) took place the following week along with an extremely interesting visit to the available research laboratories and facilities.

2.2.3 Research facilities and researcher exchanges

The common use of research facilities and the possibility for researcher exchange could also be very effective means to establish fruitful interactions and collaborations with EU and extra-EU research organizations. Bearing this in mind, WP 10 INCO activities will foster the possibility to promote closer interactions with research organizations by specific actions linking other ELECTRA ongoing activities performed within other work packages as WP2 and WP9. For example, the international exchanges offered and managed by WP9 are already proving a valuable and attractive proposition in the open dialogue with international organisations.

2.2.4 ICB online and physical meetings

As described in Chapter 2.1.1, the ICB gathered together twice in the first year of activity. The two meetings were organised in the second part of the year, following a preliminary phase dedicated to initial interactions.

The first meeting was organised online and constituted the opportunity to gather together and know each other. In this first occurrence, priority was given to individual presentation of the ICB members and the observers as well as of the ELECTRA Partners and the IRP Project Officer (PO)

as representative of the European Commission (EC). The ELECTRA IRP and the strong relationship and interdependence with the EERA JP on Smart Grids was presented by the Program Coordinator (PC) and the Technical Program Coordinator (TPC), showing general information on the IRP, its structure and the main technical aspects to be addressed in the project. The commitment of the EU in the Smart Grids research through EERA and the many other European initiatives was also stressed, underlining the long-term vision of the EERA JPs and their long-lasting activity in order to fully integrate the research activity in Europe and to create a unique organisation at the EU level to be seen as reference worldwide. More information can be found in Annex I, where the minutes of the meeting report the list of participants (ICB and ELECTRA Members and Observers) and summarize the discussion that took place for each agenda topic.

The second meeting was organised at the same time as the IRED conference in Kyoto, Japan. The event constituted the chance for the ICB members to gather together physically and enhance the interactions in a more direct way.

This meeting was organized afterwards the ELECTRA workshop and devoted to a live presentation of the ICB members and their respective organisations, and to have an open discussion on Smart Grids research topics in each country, debating on the most important topics and drivers for the research in this field. The ultimate goal of the discussion was recognised in sharing information on the main challenges being faced by the Smart Grids research community worldwide, the commitment of the leading countries in financing specific research projects on Smart Grids and the identification of possible R&D topics of mutual interest for joint research activities.

3 First interactions on R&D topics by country

In this Chapter a list of the main interactions that took place to preliminary select R&D topics suitable for each country needs is presented. Countries are ordered to emphasize leading countries in the Smart Grids area, followed by BRICS countries and other developing countries.

3.1 USA

The long tradition of the USA in cutting-edge technology imposes to give special attention to American organisations and their respective initiatives. The past actions as well as the established long-term collaboration which links Europe and the US facilitates the interactions and the fostering of new joint activities as well as encourages its continuance. The good relationship with American organisations demonstrates the effective high number of interactions with many different entities through various initiatives involving ELECTRA members. Table 2 summarizes the relevant American organisations an effective interaction has been established with.

Table 2 – Target organisations within the USA and list of interactions

	ELECTRA Involved Partners		Organization	Contact Person(s)
USA	RSE	L. Martini	EPRI	T. Key, M. Wakefield, M. McGranaghan
	RSE	L. Martini	DOE DOE/NETL	Dan Ton (Paul Wang) Mario Sciulli
	RSE	L. Martini	PNNL	Steve Widergren
	DTU	H. Bindner	NREL	Ben Kroposki David Corbus
	RSE	L. Martini	BNL	Stephanie Hamilton
	USTRATH	G. Burt	DoE	Jim Reilly

ELECTRA involved Participant	Contact Person(s)		Interaction "tool"	Date and Place	R&D Topics	Main Outcomes
RSE L. Martini	DOE	Dan Ton	e-mail – ELECTRA info	05/2014	-	ELECTRA main information circulated
RSE L. Martini	DOE NETL	Dan Ton (Paul Wang) Mario Sciulli	DOE Peer Review, info on ongoing SG projects	10-12/ 06/2014 USA	Microgrids, System Resiliency, Test beds	Gain of specific knowledge about US R&D priorities
RSE L. Martini	NREL	David Corbus	e-mail – ELECTRA info	11/06/2014 USA	-	ELECTRA main information circulated
RSE L. Martini	PNNL	Steve Widergren	Meeting + e-mail ELECTRA info	11/06/2014 USA	US DOE related topics	ELECTRA main information circulated
RSE L. Martini	BNL	Stephanie Hamilton	e-mail – ELECTRA info	11/06/2014 USA	BNL test facilities	ELECTRA main information circulated
INESC J. Sumaili	ANL	Audun Botterud	Physical meeting	Porto 2014	Solar production forecasting	Beginning of project collaboration

ELECTRA involved Participant	Contact Person(s)		Interaction "tool"	Date and Place	R&D Topics	Main Outcomes
INESC J. Sumaili	ANL	Audun Botterud	Email – preparation of a new project	2014	Energy storage for distribution systems	Draft for project application
INESC N. Fidalgo	ANL	Audun Botterud	email	January 2015	-	ELECTRA main information circulated
RSE L. Martini M. de Nigris	DOE E2RG	Dan Ton M.A. Biviji	e-mail and Phone calls	April-Sept. 2014	Smart Grids drivers in EU, USA and Asia	Smart Grids Chapter for Wiley Handbook
RSE L. Martini	DOE	Dan Ton Merrill Smith Russell Conklin	e-mail – ELECTRA ICB online meeting invitation	28/10/2014	Kick-off ICB online meeting	Participation to the ICB online meeting
RSE L. Martini	EPRI	Matt Wakefield	e-mail – ELECTRA ICB online meeting invitation	28/10/2014	Kick-off ICB online meeting	Participation to the ICB online meeting
RSE L. Martini	PNNL	Steve Widergren	e-mail – ELECTRA ICB online meeting invitation	28/10/2014	Kick-off ICB online meeting	Participation to the ICB online meeting
WP10 Members	EPRI	Gale Horst	ELECTRA ICB physical meeting	17/11/2014	Meeting minutes available	Participation to the ICB physical meeting
G. Burt	DoE	Jim Reilly	ELECTRA International Workshop	17/11/2014	Meeting minutes available	Participation in the ELECTRA International Workshop
G.Burt	DoE	Jim Reilly	e-mails - ELECTRA REX	10/01/2014	Hardware in the loop testing	Plan to coordinate proposed exchanges
DTU H. Bindner	NREL	Ben Kroposki	Physical meeting	26/05/14	Control of DER in LV grids	Continuation of lab collaboration

As the US research activity on Smart Grids is focusing on microgrids, grid resiliency and renewable energy, the point of contact with the IRP is reached by the innovative solutions for the grid control to be developed in the ELECTRA framework. Thus, the high interest shown for the IRP can lead to future R&D collaboration on microgrids, and the related new concept of "cell" [2], new solutions for frequency and voltage control as well as ICT innovation.

In this respect, the mutual sharing of knowledge on Smart Grids, the joint use of research laboratories and the researcher exchange programme envisaged in WP9 can further strengthen the collaboration of the European research community with the US.

The ELECTRA IRP has established initial relationships with the following US institutions: the US Department of Energy (DOE) [3], the National Energy Technology Laboratory (NETL) [4], the National Renewable Energy Laboratory (NREL) [5], the Pacific Northwest National Laboratory (PNNL) [6], the Brookhaven National Laboratory (BNL) [7], the Argonne National Laboratory (ANL) [8] and the Electric Power Research Institute (EPRI) [9].

3.2 Japan

A strong collaboration with Japanese institutions links Europe with the major research centres of the country, NEDO and AIST/FREA. The long-term and proficient communication established between Japan and the various European countries is expected to be leveraged at the European level by ELECTRA and the EERA JP on Smart Grids. So far, the activities towards Japan have raised interest in the IRP and the good relationships with AIST led to a formal Letter of Support (LoS) from the Japanese organisation. With the establishment of FREA in 2011 after the earthquake disaster, Japan has started effective R&D activities in renewable energy and green technologies, also in view of helping in the reconstruction of the areas devastated by the disaster. Table 3 shows the contacts within the Japanese organisations NEDO and FREA, which is under the control of AIST.

Table 3 – Target organisations within Japan and list of interactions

	ELECTRA Involved Partners		Organization	Contact Person(s)
Japan	RSE	L. Martini	NEDO	T. Yoshida, S. Morishima Y. Matsuzaka, K. Takada
	RSE	L. Martini	AIST	Kenji Otani, Hirohisa AKI
	USTRATH	P. Crolla	AIST	Kenji Otani, Hirohisa AKI

ELECTRA involved Participant	Contact Person(s)		Interaction "tool"	Date and Place	R&D Topics	Main Outcomes
RSE L. Martini	NEDO	T. Yoshida S. Morishima Y. Matsuzaka K. Takada	Email – Invitation to ICB	08/09/2014	-	ELECTRA main information circulated
RSE L. Martini	AIST	Kenji Otani Hirohisa Aki	Email – Formal support to ELECTRA	19/09/2014	Received Letter of Support AIST / FREA	AIST joins the ICB
RSE L. Martini	NEDO	M. Yamamoto Y. Matsuzaka	ISGAN ExCo Meeting	1-3 Oct. 2014 Montreal	-	Information about ELECTRA circulated
RSE L. Martini	AIST	Kenji Otani Hirohisa AKI	e-mail – ELECTRA ICB online meeting	28/10/2014	ELECTRA Kick-off ICB online meeting	Participation to the ICB online meeting
RSE L. Martini	NEDO	T. Yoshida S. Morishima Y. Matsuzaka K. Takada	e-mail – ELECTRA ICB online meeting invitation	28/10/2014	ELECTRA Kick-off ICB online meeting	Participation to the ICB online meeting
WP10 Members	AIST	Y. Owadano K. Sakanishi J. Watanabe	ELECTRA ICB physical meeting	17/11/2014 Kyoto (JP)	Meeting minutes available	Participation to the ICB physical meeting
WP10 Members	NEDO	Y. Matsuzaka	ELECTRA ICB physical meeting	17/11/2014 Kyoto (JP)	Meeting minutes available	Participation to the ICB physical meeting
RSE L. Martini USTRATH P. Crolla	AIST - FREA	Kenji Otani Y. Owadano, J. Wanatabe	Technical visit & Meeting at FREA	25/11/2014 Fukushima Prefecture	Meeting minutes available	Basis for Researchers Exchange

Two main Japanese organisations have been addressed: NEDO and AIST. The New Energy and Industrial Technology Development Organisation (NEDO) actively undertakes the development of renewable energy and energy conservation technologies, verification of technical results, and introduction and dissemination of new technologies [10].

The National Institute of Advanced Industrial Science and Technology (AIST) is a public research institution funded by the Japanese government to a large extent and is strongly committed in developing new technologies for building a sustainable society [11].

The IRED conference constituted an excellent opportunity to enhance the collaboration between Europe and Japan, and a chance to visit the recently inaugurated FREA premises located in Fukushima. The Fukushima Renewable Energy Institute (FREA) has the mission of promoting R&D in renewable energy in Japan and of contributing to industrial clusters and reconstruction, after the disaster of the Great East Japan earthquake. Japanese representatives showed interest in Smart Grids technologies to be developed within the ELECTRA IRP and possible points of contact in the R&D activities can be identified in power system operation with a high share of RES, TSO-DSO interaction and local control schemes for frequency and voltage control. The global launch of the ELECTRA REX (Researcher Exchange) scheme at the ELECTRA side-event at IRED was an important occasion to properly highlight the opportunities to effectively enhance the collaboration between the EU and Japan.

3.3 Korea

The Korean government is pursuing sustainable development while dealing with climate change, aiming at shifting towards a low carbon economy by reducing 30% of CO_2 emissions by 2020. In this framework, Korea launched a Smart Grid national project to achieve the ambitious goals which have been set, laying the foundation for a low carbon, green-growth economy by building a Smart Grid. Relevant investments have been made, leading to the ambitious plan to build a Smart Grid Test-bed on the Jeju Island. Thus, Korea has started a number of research activities in the field of Smart Grids and represents a target nation to be addressed by the ELECTRA Consortium.

Table 4 – Target organisations within Korea and list of interactions

	ELECTRA Involved Partners		Organization	Contact Person(s)
Korea	RSE	L. Martini	KETEP	Gyun Choi, Dae-Kyung Kim
	RSE	L. Martini	KSGI	Bruce Lee, Aram An, Bonnie Jang
			KERI	Sangsoo Seo
	USTRATH	G. Burt	KEPRI	Il-Keun Song

ELECTRA involved Participant	Contact Person(s)		Interaction "tool"	Date and Place	R&D Topics	Main Outcomes
RSE L. Martini	KETEP	Dae Kyeong Kim	e-mail and Phone calls	April-Sept. 2014	Smart Grids drivers in EU, USA and Asia	Smart Grids Chapter for Wiley Handbook
RSE L. Martini AIT H. Brunner	KSGI	Bruce Lee Aram An Bonnie Jang	ISGAN ExCo Meeting	1-3 Oct. 2014 Montreal	-	Information about ELECTRA circulated

ELECTRA involved Participant	Contact Person(s)		Interaction "tool"	Date and Place	R&D Topics	Main Outcomes
VTT K. Maki	KEPRI	Juyong Kim	E-mails and workshops; Interested to join IRED2014 workshop	Nov 2014	Smart Grid, Microgrid systems	Invited to join IRED 2014 workshop; ELECTRA information shared
WP10 Members	KERI	Sangsoo Seo	ELECTRA ICB physical meeting	17/11/2014 Kyoto (JP)	Meeting minutes	Participation to the ICB physical meeting
USTRATH G. Burt	KEPRI	Il-Keun Song Jintae Cho	E-mail and workshops	Apr-Nov 2014	Smart Grid & wind integration	Invited to join IRED 2014 workshop

The Korea Institute of Energy Technology Evaluation and Planning (KETEP) is a government organization under the authority of the Ministry of Knowledge Economy. It undertakes planning, evaluating and managing national energy R&D projects for the objective of contributing to three targets set by Korean government: 10% market share in global green energy market, 12% increase in national energy efficiency, 15% reduction of greenhouse gas emission compared to BAU (Business As Usual) [12]. KETEP is committed to carry forward energy technology development for the purpose of enhancing the future national competitiveness of Korea. Engagement with KETEP was further complemented by an invited USTRATH contribution to the KETEP energy roadshow in Korea on 28th-29th August 2014.

The Korea Electric Power Corporation (KEPCO) was founded with the objective to facilitate the development of electric power supply in Korea, meet the country's power supply and demands needs, and contribute to the national economy in accordance with the Korea Electric Power Corporation Act [13]. KEPCO is classified as a market-oriented public corporation under the Act on the Management of Public Institutions. KEPCO's areas of business are based on the aforementioned objectives and include the development of electric power resources, electric power generation, transmission, transformation, and distribution, as well as related marketing, research, technological development, overseas business, investment, corporate social responsibility and use of its property.

3.4 Australia

Australia has assumed international leadership with its Smart Grid-Smart City project, funded with $100 million by the Australian government and launched in 2010. The project tested a range of Smart Grid technologies, gathering information about the benefits and costs of implementing these technologies in an Australian setting [14].

In Table 5 the contacts and the interactions with Australian organisations are reported.

Table 5 – Target organisations within Australia and list of interactions

	ELECTRA Involved Partners		Organization	Contact Person(s)
Australia	RSE	L. Martini	CSIRO	Glen Platt
	TEC	A. Diaz		
	USTRATH	G. Burt	CSIRO	Adam Berry

ELECTRA involved Participant	Contact Person(s)		Interaction "tool"	Date and Place	R&D Topics	Main Outcomes
WP10 Members	CSIRO	Glenn Platt	e-mail – ELECTRA ICB online meeting invitation	28/10/2014	ELECTRA Kick-off ICB online meeting	Participation to the ICB online meeting
WP10 Members	CSIRO	Glenn Platt	ELECTRA ICB physical meeting	17/11/2014 Kyoto (JP)	Meeting minutes	Participation to the ICB physical meeting
USTRATH G. Burt	CSIRO	Adam Berry	Email – ELECTRA REX	08/01/2015	Researcher exchange from CSIRO to EU	Basis for Researcher Exchange

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is Australia's national science agency [15]. Among the different R&D activities, the Energy Flagship helps unlock in-situ value from our energy resources to enhance Australia's economic competitiveness and regional energy security. It is also enabling the transition to a lower emissions energy future and helping achieve greenhouse gas abatements.

3.5 China

The overwhelming economic growth of China has brought the country to develop a high quality research activity in the Smart Grids technologies. Also, the significant increase in the yearly electricity consumption requires China to adapt the grid and generation expansion to the most modern technologies to ensure an optimised allocation of funds and the necessary quality of investments. In this sense, it constitutes a very interesting opportunity to design and implement Smart Grids technology solutions from scratch, avoiding the constraints of a previous-planned electrical grid. This is true for all developing countries and in particular to the two major emerging countries, China and India.

Two Chinese organisations, SJTU and ERI, were addressed at the project submission phase, receiving the respective letters of support.

The Shanghai Jiao Tong University (SJTU), as one of the higher education institutions which enjoy a long history and a world-renowned reputation in China, is a key university directly under the administration of the Ministry of Education (MOE) of China [16].
The Energy Research Institute (ERI) of the National Development and Reform Commission (NDRC) was established in 1980. It is a national research organization conducting comprehensive studies on China's energy issues. The scope of research conducted by ERI covers the fields of energy production, distribution, and consumption. The main focus is on soft scientific studies in the fields of energy economy, energy efficiency, energy and the environment, and renewable energy [17].

Table 6 lists the organisations targeted during the first phase of WP10 activity and the related interactions.

Table 6 – Target organisations within China and list of interactions

	ELECTRA Involved Partners		Organization	Contact Person(s)
China	JRC RSE	E. Bompard L. Martini	SJTU	Zheng Yan
	JRC	E. Bompard	ERI	LIU Xiaoli
	USTRATH	G. Burt / P. Crolla	CEPRI	Liangzhong Yao

ELECTRA involved Participant	Contact Person(s)		Interaction "tool"	Date and Place	R&D Topics	Main Outcomes
JRC E. Bompard	SJTU	Zheng Yan	e-mail exchange	Jan.-July 2014	-	Information about ELECTRA circulated
JRC E. Bompard	ERI	LIU Xiaoli	e-mail exchange	Jan.-July 2014	-	Information about ELECTRA circulated
DTU H. Bindner	Tsinghua Univ.	Yonghua Song	Workshop	03/03/14	Active distribution grids	Project collaboration
RSE L. Martini M. de Nigris	SJTU	Zheng Yan Lingyu Cao	ISGAN ExCo Meeting	1-3 Oct. 2014 Montreal	-	Information about ELECTRA circulated
USTRATH G Burt	CEPRI	Liangzhong Yao	e-mail exchange & committee meeting	25 Feb 2014 Beijing	Smart Grid & wind integration	Invitation to IRED event

China is experiencing two major drivers in the national electrical industry: the extraordinary electricity consumption growth and the introduction of high shares of RES into the system. For these reasons, possible R&D topics of mutual interest are referred to the grid control schemes and applications of innovative technologies such as Phasor Measurement Units (PMUs) and Wide Area Measurement Systems (WAMS) to increase the network observability and control. Further interactions will be focused on establishing long-lasting activities to enhance the cooperation between Europe and this important country.

3.6 Brazil

Brazil is one of the BRICS countries, the new emerging countries that are assuming great relevance worldwide due to their impetuous economic growth of the last years and the high potentialities. An important synergy that is being deployed by the IRP is the very good relationships already in place between Portugal and Brazil, considering the obvious facilitations given by the historical interdependencies of the two countries and the common language. The ELECTRA Partner INESC_P is opening the way for establishing an effective and fruitful collaboration of the EU with Brazil, counting also on the physical presence of the institution with the INESC P&D Brasil premises in São Paulo.

Table 7 shows the contact persons within the Brazilian institutions and interactions undertaken in this first phase of the WP10 activity.

Table 7 – Target organisations within Brazil and list of interactions

	ELECTRA Involved Partners		Organization	Contact Person(s)
Brazil	INESC	N. Fidalgo	INESC P&D Brazil	Mauro Rosa
	INESC	N. Fidalgo	INERGE	José Pereira

ELECTRA involved Participant	Contact Person(s)		Interaction "tool"	Date and Place	R&D Topics	Main Outcomes
INESC N. Fidalgo	INESC P&D Brasil	Mauro Rosa	e-mail and Phone calls	May-July 2014	-	Information about ELECTRA circulated
INESC N. Fidalgo	INESC P&D Brasil	Mauro Rosa	Physical meeting	November 2014 Porto	Smart Grids	First steps of organization of a workshop in Brazil
INESC N. Fidalgo	INERGE	José Pereira	e-mail	2014	Smart Grids	Additional contacts

INESC P&D Brazil [18] is part of the INESC Porto R&D institute and is located in São Paulo, Brazil. It coordinates a network of several Brazilian Universities and has contacts with several companies. INERGE is an INCT (Instituto Nacional de Ciência e Tecnologia) - consortium of R&D groups devoted to research in power systems, approved by CNPq (Ministry of Science) as an organization of excellence [19]. INESC TEC is an external international Partner located in Porto and its surroundings as well as the abovementioned premises in São Paulo, Brazil.
Main areas of interest in R&D topics on Smart Grids are those related to RES technologies and their introduction in the electrical network. The ELECTRA Consortium foresees close collaboration with the Brazilian institutions, relying on the strong link with the Portuguese Partner.

3.7 Russia

Relationships with Russia on Smart Grids are being established mainly through preferred channels. In Table 8 the event that constituted an important step towards cooperation with Russian institutions is reported. In July 2014 the conference in St. Petersburg gave the chance to IPE representatives to communicate effectively with Russian universities and institutions. It also constituted the chance of presenting the ELECTRA IRP to Russian stakeholders and raise their interest in EU initiatives on Smart Grids. For the occasion, the first ELECTRA paper was released, describing the innovative technical solutions for frequency and voltage control to be developed within the IRP.

Table 8 – Target organisations within Russia and list of interactions

	ELECTRA Involved Partners		Organization	Contact Person(s)
Russia	IPE	I. Oleinikova	various	Conference participants
	RSE	L. Martini	Russian Energy Agency	Iya Bordyuzhenko

ELECTRA involved Participant	Contact Person(s)		Interaction "tool"	Date and Place	R&D Topics	Main Outcomes
IPE I. Oleinikova	-	-	Conference	1-4 July 2014 St. Petersburg	Smart Grid Terminology	Published paper (in Russian)
RSE L. Martini	REA	I. Bordyuzhenko	ISGAN ExCo Meeting	1-3 Oct. 2014 Montreal	Smart Grid Terminology	Information about ELECTRA circulated
RSE L. Martini	REA	I. Bordyuzhenko	e-mail	20/10/2014	-	Contact details and interaction

Founded in 2009, the Russian Energy Agency (REA) main goal is "the enhancement of the state policy on energy efficiency and saving, the establishment of a unified platform for interaction among all market participants, and the promotion of the investment interest in the electric power sector of the economy" [20]. REA implements the state strategy of Russia in the field of energy efficiency development, energy saving and RES

3.8 India

Initial relationships with India on Smart Grids are being established mainly through the IEA ISGAN preferred channels. In Table 9 the events that constituted an important step towards cooperation with Indian institutions are reported. In particular the main actors of the Indian Smart Grids landscape were the Indian Smart Grids association and the transmission system operator (PGCI).

The India Smart Grid Forum (ISGF) is a public private Partnership initiative of Ministry of Power (MoP), Government of India for accelerated development of Smart Grids technologies in the Indian power sector. ISGF was set up in 2010 to provide a mechanism through which academia, industry, utilities and other stakeholders could participate in the development of Indian Smart Grid systems and provide relevant inputs to the government's decision-making.

The ISGF Mission:

- To help the Indian power sector deploy Smart Grid technologies in an efficient, cost effective, innovative and scalable manner by bringing together all key stakeholders and enabling technologies;
- To create a platform for public and private stakeholder members, research institutions and power utilities to exchange ideas and information on Smart Grids and develop use case scenarios for India;
- To bring together experts from regulation, policy, and the corporate sector to build support for Smart Grid policies;
- To conduct research on the capabilities of Smart Grids in the Indian context through case studies, cost-benefit analysis, study of technical advancements in renewable energy sources and other ancillary activities;
- To make recommendations to the government, regulators, utilities and consumers through reports, white papers, technical seminars etc.

Mandate of ISGF is to advise government on policies and programs for promotion of Smart Grids in India, work with national and international agencies in standards development and to help utilities, regulators and the Industry in technology selection, training and capacity building.

ISGF has over 100 members covering ministries, government institutions, regulators, utilities and private companies from the industry, non-profit organisations, educational and research entities and students from renowned institutions. ISGF has constituted 10 working groups examining different aspects of Smart Grids – WG1: Advanced Transmission; WG2: Advanced Distribution; WG3: Communications for Smart Grids; WG4: Metering; WG5: Consumption and Load Control; WG6: Policy and Regulations; WG7: Architecture and Design; WG8: Pilots and Business Models; WG9: Renewables and Microgrids; and WG – 10: Cyber Security.

The members of ISGF participate in focused working groups to develop required use cases, standards, technology recommendations and guidelines. ISGF has been actively providing advisory services to MoP on matters related to Smart Grids in India and conducting monthly technology workshops.

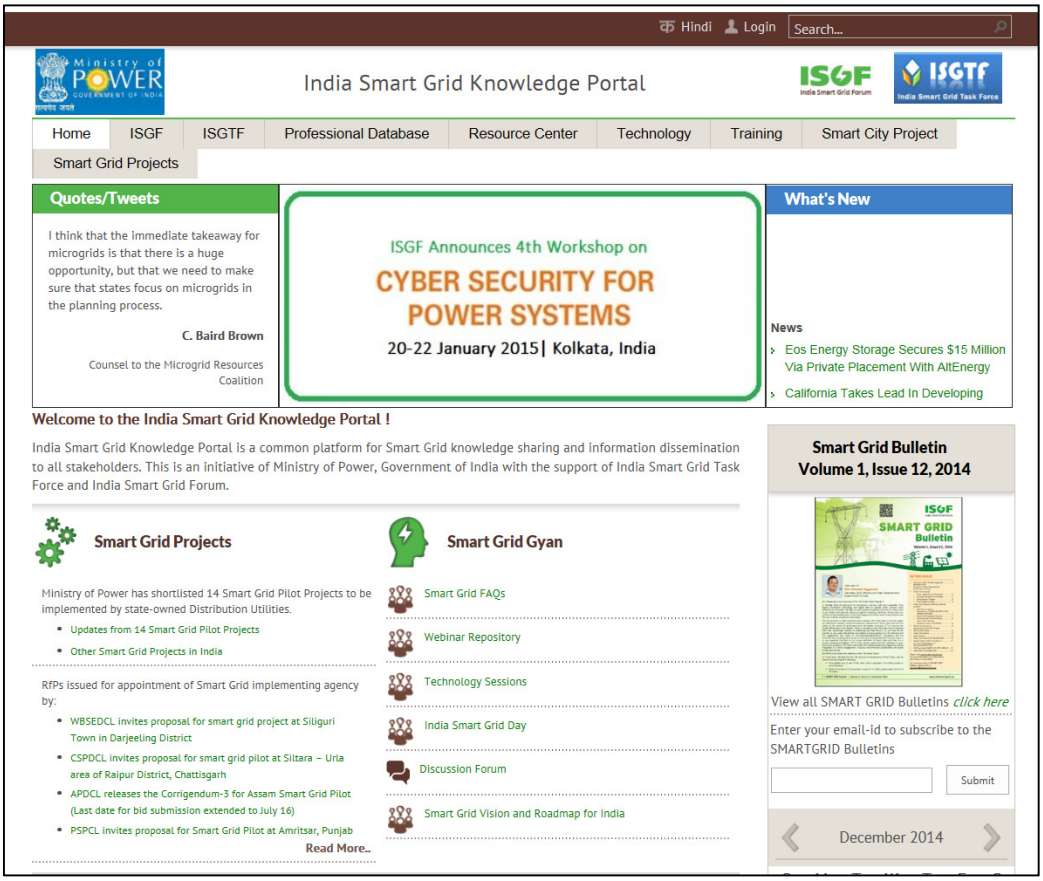

Figure 1 – India Smart Grids Knowledge Portal

Moreover, contacts were taken with the PGCI (Power Grid Corporation of India), the Government of India company devoted to the management and development of the transmission grid. Contacts were takes at the highest level, involving Dr.N.S. Sodha, Executive Director and Head of the India Smart Grid Task Force.

Table 9 – Target organisations within India and list of interactions

	ELECTRA Involved Partners		Organization	Contact Person(s)
India	RSE	L. Martini	PGCI	N. Singh Sodha
			ISGF	Reji Kumar Pillai

ELECTRA involved Participant	Contact Person(s)		Interaction "tool"	Date and Place	R&D Topics	Main Outcomes
RSE L. Martini	PGCI	N. Singh Sodha	ISGAN ExCo Meeting	1-3 Oct. 2014 Montreal	-	Information about ELECTRA circulated
RSE L. Martini	ISGF	Reji Kumar Pillai	ISGAN ExCo Meeting	1-3 Oct. 2014 Montreal	-	Information about ELECTRA circulated

3.9 South Africa

In Table 10 the event that constituted an important step towards cooperation with South African institutions is reported.

Table 10 – Target organisations within South Africa and list of interactions

South Africa	ELECTRA Involved Partners		Organization	Contact Person(s)
	RSE	L. Martini	SANEDI	Minnesh Bipath
	RSE	L. Martini	ESKOM	Nick Singh

ELECTRA involved Participant	Contact Person(s)	Interaction "tool"	Date and Place	R&D Topics	Main Outcomes
RSE L. Martini M. de Nigris	SANEDI Minnesh Bipath	ISGAN ExCo Meeting	1-3 Oct. 2014 Montreal	-	Information about ELECTRA circulated
RSE L. Martini M. de Nigris	ESKOM Nick Singh	ISGAN ExCo Meeting	1-3 Oct. 2014 Montreal	-	Information about ELECTRA circulated

3.10 Jordan

The National Energy Research Centre (NERC) of Jordan, is intended to perform studies, research, and experimental projects in the use of the local new and renewable energy sources to increase their contribution to satisfy the energy needs of the country as well as to improve methods, incentives and advisory services of efficient energy use to decrease total energy cost on the national level and to protect the environment [21].

On the 24th April 2012 the launch of a series of studies to prepare for the biggest upgrade of the Jordan Kingdom's electricity infrastructure in over 30 years was announced.

Under an agreement signed by the US Trade and Development Agency (USTDA) and the Electricity Regulatory Commission (ERC) of Jordan, the US government agreed to extend $1.15 million to Jordan to explore implementing "Smart Grids" in the three largest electricity distributors in the country. The studies examine ways Smart Grids can increase safety, reliability and load management capacity for the electricity distribution company, the Irbid electric power company and the Jordanian electric power company.

The studies are 90% funded by the USTDA grant. The introduction of "smart meters" will be explored to provide up-to-date data on capacity loads for providers and accurate billing information for consumers. So far, following the USTDA grant, some feasibility studies were completed by the Irbid district electricity company and possibly by the other distribution companies in the country.

One of the leading projects in Jordan for studying Smart Grids application can be found in the Tafila region. The Tafila distributed Smart Grid will be the first in Jordanian region to deploy smart solar technology — highly distributed solar energy generation coupled with Smart Grid technology — for every electric utility subscriber throughout an entire region. In this project 20,000 Smart solar systems will be installed on rooftops in the Governorate of Tafila. The project is led by Petra Solar from USA. Each system includes an intelligent monitoring system that keeps track of all electricity flowing in the system. Currently, there are 1,000 smart photovoltaic panels installed in the Tafila region forming a small Smart Grid suitable for studies.

Following that progress, a study by the Tafila Technical University titled "Smart Grid Law and Regulation — Case Study of Tafila Smart Grid" was published online on May 2014 by the SciRes Journal [22]. The study presents the Smart Grid policy and law in Jordan by studying Tafila Smart Grid as a case study. A variety of problems and challenges in the field of Smart Grid were found that should be addressed in the country.

Table 11 – Target organisations within Jordan and list of interactions

Jordan	ELECTRA Involved Partners		Organization	Contact Person(s)
	CRES	S. Tselepis	NERC	Walid Shahin / Firas Alawneh

ELECTRA involved Participant	Contact Person(s)		Interaction "tool"	Date and Place	R&D Topics	Main Outcomes
CRES S. Tselepis	NERC	Director Walid Shahin and Firas Alawneh	e-mail – ELECTRA info	29/6/2014	ELECTRA main information circulated, contact list of persons for inquiry received on 15/7/2014	Activities in Jordan, next steps to follow according to information received
CRES S. Tselepis	NERC	Director Walid Shahin and Firas Alawneh	e-mail requesting activities status	15/7/2014	Request of Smart Grid activities in Jordan	Received more contact persons
CRES S. Tselepis	NERC/ RSS	Diala al-Haddad Royal Scientific Society (RSS)	e-mail requesting activities status	17/7/2014	Request of Smart Grid activities in Jordan	Review of Smart Grids activities and projects in Jordan

3.11 Saudi Arabia

In Saudi Arabia, King Abdulaziz City for Science and Technology (KACST) is an independent scientific organization administratively reporting to the Prime Minister of the country [23]. KACST is both the Saudi Arabian national science agency and its national laboratories. The science agency function involves science and technology policy making, data collection, funding of external research, and services such as the patent office. KACST developed detailed courses for fifteen strategic research fields, involving universities, government bodies as well as the private sector. Among the fifteen research fields, a specific commitment on energy issues, green generation and integration of renewables can be found.

Table 12 – Target organisations within Saudi Arabia and list of interactions

Saudi Arabia	ELECTRA Involved Partners		Organization	Contact Person(s)
	TUBITAK	A. Nadar	KACST	Mohammed ibn Ibrahim Al-Suwaiyel

ELECTRA involved Participant	Contact Person(s)		Interaction "tool"	Date and Place	R&D Topics	Main Outcomes
TUBITAK A. Nadar	KACST	M. Al-Suwaiyel	e-mail	July 2014	Smart Grids R&D	Expression of interest
Project Coordinator	KACST	M. Al-Suwaiyel	Invitation Letter	January 2015	Smart Grids R&D	Specific Dept. involvement

4 ELECTRA agreed approach to extra-EU organizations

ELECTRA has established a very wide network of contacts and collaboration that allows to discuss with research organizations, institutions and funding agency representatives from countries their potential interest to collaborate with Europe in the field of Smart Grids.

Of particular relevance is the fruitful collaboration with ISGAN (International Smart Grids Action Network) gathering 25 countries in an overall governmental collaboration on Smart Grids. ISGAN was instrumental not only to connect to specific countries, especially B.R.I.C.S., but also by sharing the results of an extensive survey of Smart Grids development drivers and technologies for different geographical areas and countries.

A summary of main trends and drivers for Asia, Europe and America resulting from ISGAN Annex I activity has been prepared in summer 2014 by representatives from US DOE, RSE and KETEP, as part of a contribution to a chapter on Smart Grids for a new Wiley Handbook, see Annex I .

On the basis of the results of the initial interactions, the performed activity, and the relevant information shared with ISGAN, a preliminary list of R&D topics of interest in different extra-European countries could be delineated.

Table 13 reports a summary of the R&D topics of interest for specific organizations in different extra-European countries, and an indication about the possible matching with ongoing activities within EERA JP SG sub-programmes and/or ELECTRA work packages. Each topics is identified with the geographical location, the importance level (H stands for “High”, A stands for “Average” and L for “Low”) and the possible links with the ELECTRA and/or EERA JP on Smart Grids activities.

Table 13 – Preliminary list of Smart Grids R&D topics of interest in specific extra-European countries

Country	Smart Grids R&D Topics	Importance	Notes / Possible links to EERA JP SG ELECTRA activities
USA	Distribution network reliability and implementation of Distribution Management systems	H	SP2 WP5 - WP6
USA	System efficiency and impact of Information and communication technologies	H	SP3 WP4
USA	OPEX reduction and asset management including the fault and outage management and the service restoration	A	(SP5) (WP6)
Japan	System reliability as seen by the user and building energy management	H	-
Japan	Generation adequacy and its impact on network management (network integration of variable sources)	A	SP2
Japan	Power quality and its impact for the final consumer, with special reference to advanced smart home applications	A	SP2
Korea	Customer services and advanced metering infrastructure	A	SP3

Country	Smart Grids R&D Topics	Importance	Notes / Possible links to EERA JP SG ELECTRA activities
Korea	Energy efficiency and impact of storage	H	SP4 (WP6)
Korea	System efficiency and the potential offered by microgrids	H	SP1 WP6
Australia	System reliability, fault detection and system restoration	A	-
Australia	System efficiency and impacts of the AMI	A	SP3
China	Transmission adequacy and impact of HVDC	H	SP5
China	National security issues and transmission system management	H	SP5
China	Renewables integration targets with special reference to wind integration	H	SP5 WP5 - WP6
Brazil	Reduction of T&D losses: smart metering and AMI	A	(SP5)
Brazil	T&D system efficiency and use of advanced technologies (PMUs, voltage control, network automation)	H	SP5 WP5 – WP6
Russia	Electricity end-user market involvement and economical advantages: AMI	H	SP2 – SP3 WP3
Russia	Network reliability and fault detection and clearing	A	-
India	Revenue collection and system efficiency: AMI	L	-
India	System reliability and use of Distribution management systems	H	SP2
South Africa	Generation adequacy and bulk renewables integration: use of PMUs to enhance system stability	A	SP2 – SP5 WP5
South Africa	Revenue collection and different solutions: AMI and pre-paid contracts	L	-

5 Existing agreements between ELECTRA partners and extra-EU institutions

In this Chapter the ongoing agreements related to Smart Grids and/or energy studies between the ELECTRA partners and the extra-EU institutions are presented. For each partner the main information are the name and nation of the organization, the type of agreement and the topics analysed within the agreement.

Table 14 - Agreements between ELECTRA partner and extra-EU organization

Partner	Extra-EU organization	Nation	Agreement type	Topics
RSE	University Corporation for Atmospheric Research, UCAR	USA	NDA	Advanced forecasting tools
RSE	National Oceanic and Atmospheric Administration, Earth System Research Laboratory, NOAA	USA	NDA	Modelling system for evaluating the effect of the different energy scenarios on earth quality over Italy
RSE	The New Energy and Industrial Technology Development, NEDO	Japan	MOU	Cable safety issues
AIT	University of California	USA	MOU	Cyber security
AIT	Nanchang University	China	MOU	Smart cities
VITO	University of Texas	USA	MOU	Smart Grids, smart cities
VITO	National Renewable Energy Laboratory, NREL	USA	MOU	Smart Grids, Smart cities
VITO	Gulf Organization for Research and Development, GORD	Qatar	MOU	Sustainable buildings
LABORELEC	CORporación de FOmento de la Producción de Chile, CORFO	Chile	Other	Energy competitiveness and sustainability
LABORELEC	Hydro-Québec's Research Institute, IREQ	Canada	Other	Production, transport, distribution, storage, use of electricity
LABORELEC	Nanyang Technological University, NTU	Singapore	MOU	Sustainable powering off-grid regions, participation in the renewable energy integration demonstrator at Singapore
LABORELEC	Massachusetts Institute of Technology, MIT	USA	Other	Definition of the ideal international marketing strategy of the product "Smart local energy management" in Europe and USA. "Clean Energy Prize" project
DTU	Global E^3 (Engineering Education Exchange)	Worldwide	Other	Engineering and computer science

Partner	Extra-EU organization	Nation	Agreement type	Topics
DTU	Chinese universities	China	Other	Sustainable energy (bio energy thermal, bio energy biological, solar, wind, fusion, energy systems), water and environment, nano-science, social science, life sciences
VTT	Nanyang Technological University, NTU	Singapore	CA	Microgrids
VTT	Korea Electric Power Corporation, KEPCO Research Institute	Korea	MOU	Smart Grids, smart cities and electricity distribution systems
VTT	Industrial and Energy Ministry of Uruguay	Uruguay	MOU	Energy and environment focusing on bio-economy and monitoring of environment
VTT	Kuwait Institute for Scientific Research, KISR	Kuwait	CA	Material research including environmental technology, smart built environment, energy efficiency and industrial biotechnology
VTT	McGill University	Canada	MOU	Material technology, minimization of environmental impact. Energy conservation, product differentiation and the demand for more user friendly products
VTT	Korea Institute of Science and Technology Information, KISTI	Korea	MOU	Exchanging scientific, technical and market information and related technologies, and service development
VTT	Korea Institute for the Advancement of Technology, KIAT	Korea	MOU	Strategic cooperation in the fields of ICT, electronics and bio- technologies and manufacturing technologies
VTT	Mitsui & Co., Ltd	Japan	MOU	Technology evaluation and foresight
CEA	NA			
IWES	Electric Power Research Institute, Inc., EPRI	USA	MOU	Integrated grid
IWES	Jiangxi Electric Power Research Institute, JXEPRI	China	MOU	Active load management Technology and Application
IWES	Fraunhofer Centre for Sustainable Energy Systems	USA	MOU	Non-inclusive load monitoring
IWES	IEA Task ISGAN (SIRFN Network)	Worldwide	Other	Development of testing facilities
CRES	Royal Scientific Society - National Energy Research Centre	Jordan	CA	RES Microgrids, RES Desalination and Energy Efficient interventions in

Partner	Extra-EU organization	Nation	Agreement type	Topics
CRES	Universite Abdelmalek Essaadi, UAE	Morocco	CA	buildings RES Microgrids, RES desalination and energy efficient interventions in buildings
CRES	National Research Centre Egypt, NRC	Egypt	CA	RES Microgrids, RES desalination and energy efficient interventions in buildings
CRES	New and Renewable Energy Authority of Egypt, NREA	Egypt	MOU	Renewable energy and other subjects
ENEA	Italian-South American Institute, IILA	South America	MOU	RES, environment, climate, innovation technologies, safety and health, cultural heritage
ENEA	Fundação Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, CAPES/MEC Conselho Nacional de Desenvolvimento Cientifico e Tecnológico, CNPq/MCTI	Brazil	MOU	Cooperation with Brazilian Institution of Education and Research with the involvement of students, professors and researchers
ENEA	The Hefei Institutes of Physical Science, Chinese Academy of Sciences, CASHIPS	China	MOU	Technologies for nuclear application of heavy liquid metals
ENEA	China Science and Technology Exchange Centre, CSTEC	China	MOU	Innovation technology and industrial cooperation in the area of new materials, energy and biotechnologies
ENEA	Korea Institute of Energy Research, KIER	Korea	MOU	RES and energy efficiency
ENEA	Toshiba T&D Europe S.p.A.	Japan	Other	Storage, RES, sustainable mobility, Smart Grids
ENEA	The Energy and Resources Institute, TERI	India	MOU	RES, Smart Grids, I & II generation biofuels, materials for energy efficiency
ENEA	University Ben Gurion of Negev	Israel	MOU	Joint laboratory on solar energy sources and RES
ENEA	Technion – Israel Institute of Technology	Israel	MOU	I-CORE Program on alternative energy sources, in particular on solar fuel
ENEA	Industrial Technologies Research Institute of Taiwan, ITRI	Taiwan	MOU	Energy, in particular RES, low carbon technologies, sustainable development
ENEA	Battelle Energy Alliance/Idaho National Laboratory, BEA/INL	USA	MOU	Nuclear fission - R&D on nuclear technologies

Partner	Extra-EU organization	Nation	Agreement type	Topics
ENEA	Shanghai Institute of Optics and Fine Mechanics	China	Other	Plasmonics for optical filtering
IPE	ENERGOSTAT	Russia	Other	Operation system in energy sector
IPE	SICON	Russia	Other	Power systems and ICT
IPE	Energy System Institute	Russia	Other	Power system operation and security
SINTEF	Advanced Industrial Science and Technology, AIST	Japan	MOU	Combustion
SINTEF	University of Kathmandu	Nepal	Other	Renewable energy
SINTEF	Sandia National Lab.	USA	MOU	Combustion
IEn	No bilateral agreements with extra-EU organizations			
INESC Porto	Argonne National Laboratory, ANL	USA	CA	Microgrids, demand; response power system operation and control, cybersecurity, distribution automation and management
TECNALIA	Commonwealth Scientific and Industrial Research Organization, CSIRO	Australia	NDA, LoI	Smart grids, integration of renewables
TECNALIA	Laboratorio de Pruebas de Equipos y Materiales, LAPEM	Mexico	CA	T&D equipment testing
TECNALIA	Universidad de Antofagasta, UA	Chile	CA	Solar energy
TECNALIA	Kyosemi/Sphelar Solar Power	Japan	CA	Solar energy
TECNALIA	National Ocean Technology Centre, NOTC	China	CA	Marine energies
JRC	Israel Ministry for Energy and Water	Israel	MOU	Renewables, Smart Grids, e-mobility, energy efficiency, oil fuels alternatives
JRC	Ministry of Science and Technology	Brazil	LoI	Renewables, Smart Grids, e-mobility, energy efficiency, oil fuels alternatives
JRC	Department of Energy, DoE	USA	LoI	Electric vehicle, Smart Grids interoperability
TNO	NA			
TUBITAK	King Abdulaziz City for Science and Technology, KACST	Kingdom of Saudi Arabia	Other	Development of Smart Grids controller for PV network
USTRATH	China Electrical Power Research Institute,	China	Other	Large wind power

Partner	Extra-EU organization	Nation	Agreement type	Topics
	CEPRI			
USTRATH	New York University, NYU	USA	MOU	Sustainable and future cities; bio-medical engineering; Energy and power systems; Policy development and engagement; Incubators and innovation
USTRATH	Korean Institute of Energy Technology Planning and Evaluation, KETEP	Korea	MOU	Energy efficiency; Renewable energy; Smart Grids; Green transportation; Carbon capture and storage
USTRATH	Korean Institute for Advancement of Technology, KIAT	Korea	MOU	Mechanics and materials; Chemistry; Bio and medical IT; Electrics and electronics; Knowledge services
USTRATH	Korean Institute for Advancement of Technology, KIAT	Korea	Other	Energy resources and materials
USTRATH	Nanyang Technological University, NTU	Singapore	MOU	Renewable energy; Continuous manufacturing and crystallization; Electrical systems; Organizational effectiveness and transformation; Sharing operational experiences in working with partners
DERlab	NA			
OFFIS	No bilateral agreements with extra-EU organizations			

5.1 Analysis of the ongoing agreements

In this Section the ongoing agreements between the ELECTRA Partners and extra-EU Institutions are analysed. The main focus is on the geographical distribution and the most used types of agreements. Finally, the agreements explicitly related to Smart Grids aspects are presented.

5.1.1 Geographical distribution of the ongoing agreements

Figure 2 highlights that the ELECTRA Partners are very much linked with the American and Asian continents, where 90% of the agreements are concentrated. Few agreements are located in the other continents (i.e. Africa and Oceania) and with international Programs, such as ISGAN, that cannot be specifically located at geographical level for their intrinsic nature.

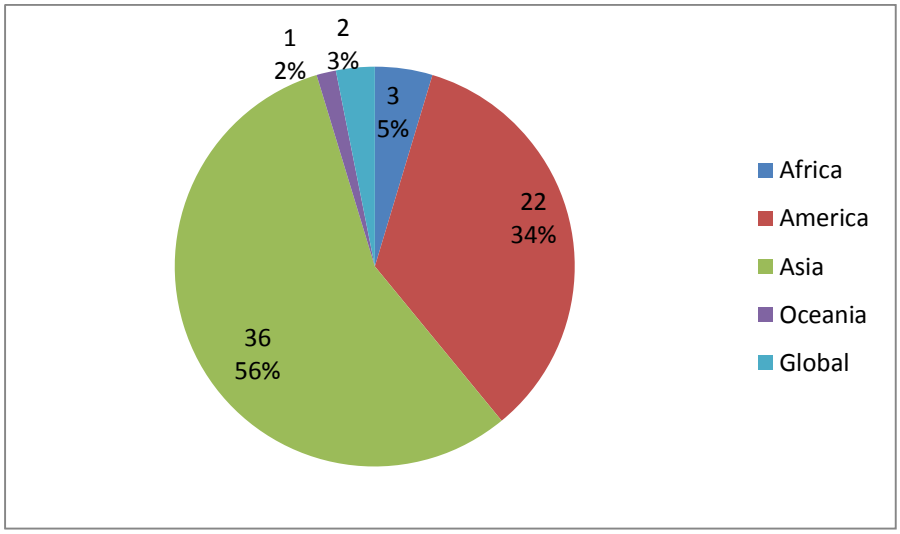

Figure 2 – Agreements between ELECTRA Partner and extra-EU Organization

From Figure 3, the nations with the highest number of agreements are USA (13), China (8), Japan (7) and Korea (5), covering more than half of the total agreements.

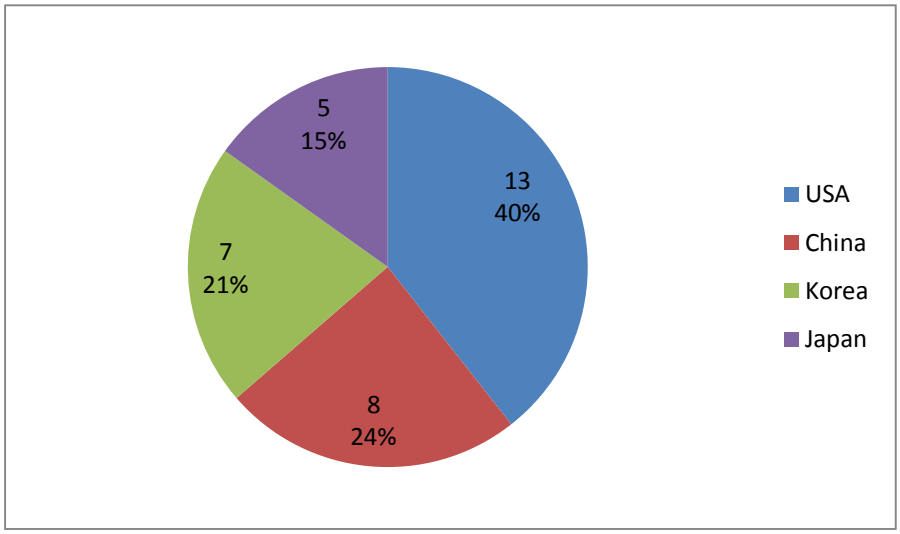

Figure 3 – Nations with the highest number of agreements (i.e. >4)

The large number of types of agreements collected led to the definition of five main categories:

- Collaboration Agreements (CA);
- Letter of Intent (LoI);
- Non-Disclosure Agreements (NDA);
- Memorandum of Understanding (MOU);
- Other (e.g. Protocol Agreement, Cooperation Agreement etc.).

shows that the most used type of agreement is MOU, with a share of 53% (34 agreements). Collaboration Agreements are adopted in 15% of the cases while Letter of Intent and Non-Disclosure Agreements are less frequently used, covering 5% each. Finally, the “Other” category takes 22%.

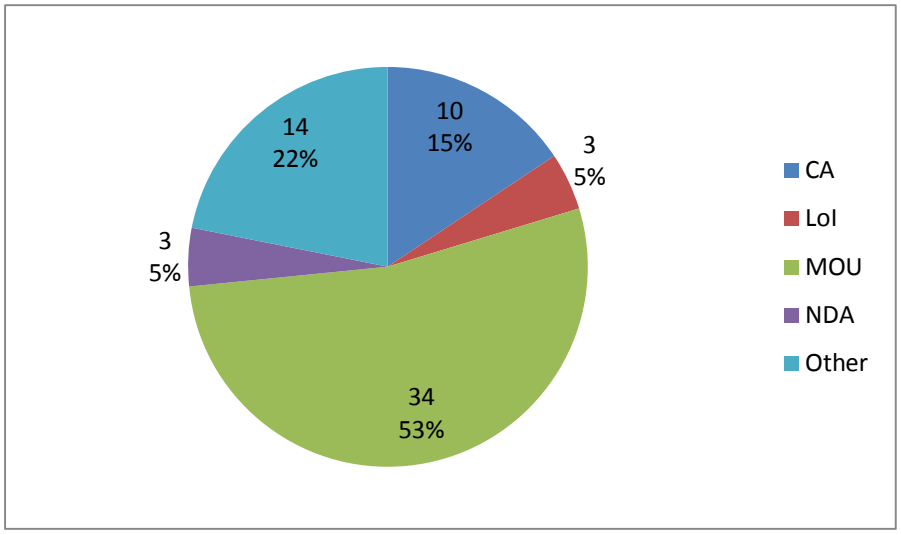

Figure 4 – Types of agreement between ELECTRA Partner and extra-EU Organizations

Among the sixty-four agreements, eleven are explicitly related to Smart Grids. Other agreements could be included in this group due to the related Smart Grids activities, however these are the ones with an explicit reference to Smart Grids.

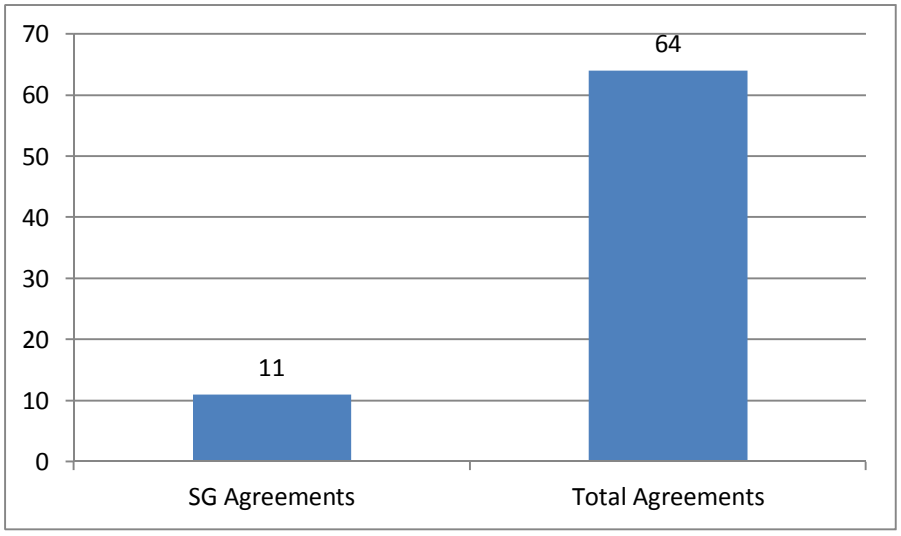

Figure 5 – Agreements explicitly mentioning Smart Grids

6 Link between the research topics and the existing bilateral agreements with Extra-EU countries

Chapter 6 has the objective to link the “Smart Grids R&D topics of interest in specific extra-European countries” to the ELECTRA EERA activities (see Chapter 4) and to the ongoing agreements the ELECTRA Partners have outside Europe (see Chapter 5). Information summarized in Table 13 and Table 14 have been used for this purpose.

As a result, Table 15 has been generated, where, for each country, the priority R&D topics are linked to the ELECTRA WPs, the EERA JP SG SPs and the agreements the ELECTRA Partners have outside Europe. Given the different description level of the agreements, they can be specifically or generally related to the considered topic.

It can be noted that most of R&D topics of interest are connected to the activities carried on in some of the RTD ELECTRA WPs (i.e. from WP3 to WP6) and EERA SPs (i.e. from SP1 to SP6).

The three topics identified with USA – of mid-high importance - are either specifically or generally linked with some agreements the ELECTRA Partners have in the USA itself.

The agreement ENEA has with Toshiba S.p.A. allows to analyze the generation adequacy and its impact on network management, which is a topic of interest for Japan. Moreover, a couple of agreements can be exploited to investigate customer services and AMI aspects, that are of interest for Korea and part of the activities carried on in the SP3.

The agreement TECNALIA has with the Australian CSIRO allows to analyze the system efficiency and the impact of AMI in Smart Grids. Moreover, in the frame of the EERA JP SG SP5, the agreement IWES has with JXEPRI can be used to analyze security issues and transmission system management aspects.

Two agreements can be exploited for investigations on wind integration, one of the highly important topics in common with China and considered in the ELECTRA WP5 and WP6 and in the SP5 of the EERA JP on Smart Grids. The agreement JRC has with the Brazilian Ministry of Science and Technology can be specifically exploited for investigating T&D system efficiency – included losses reduction - and the use of advanced technologies for Smart Grids.

The agreement ENEA has with the Indian TERI can be exploited to study system reliability and the use of distribution management systems in the network.

On the other hand, the topics identified with some countries, such as Japan, China, Russia and South Africa, even if well linked with some ELECTRA WPs and/or EERA JP SG SPs, are not linked to any specific agreement. However, the dynamic nature of the relationships the ELECTRA Partners have with other Institutions leave room for finding new agreements in these countries also related to those topics.

Table 15 – List of Smart Grids R&D topics of interest in specific extra-European countries: link with ELECTRA/ EERA JP SG and on-going agreements

Country	Smart Grids R&D Topics	Importance	Links with ELECTRA	Links with EERA JP SG	Specific agreements	General agreements
USA	Distribution network reliability and implementation of Distribution Management systems	H	WP5, WP6	SP2	INESC/ANL IWES/ Fraunhofer USA	VITO/ Un. Texas VITO/NREL
USA	System efficiency and impact of Information and communication technologies	H	WP4	SP3	AIT/ Un. California INESC/ ANL	IWES/EPRI INESC/ANL USTRATH/NYU
USA	OPEX reduction and asset management including the fault and outage management and the service restoration	A	WP6	SP5	LABORELEC/MIT INESC/ANL	JRC/DoE USTRATH/NYU
Japan	Generation adequacy and its impact on network management (network integration of variable sources)	A		SP2		ENEA/ Toshiba
Japan	Power quality and its impact for the final consumer, with special reference to advanced smart home applications	A		SP2		
Korea	Customer services and advanced metering infrastructure	A		SP3		VTT/KEPCO USRATH/KETEP
Korea	Energy efficiency and impact of storage	H	WP6	SP4	ENEA/KIER USTRATH/KETEP	VTT/KEPKO
Korea	System efficiency and the potential offered by microgrids	H	WP6	SP1	ENEA/KIER USTRATH/KETEP	VTT/KEPKO
Australia	System efficiency and impacts of the AMI	A		SP3		TECNALIA/ CSIRO
China	Transmission adequacy and impact of HVDC	H		SP5		
China	National security issues and transmission system management	H		SP5	IWES/ JXEPRI	
China	Renewables integration targets with special reference to wind integration	H	WP5, WP6	SP5	DTU/Chinese Universities USTRATH/CEPRI	

Country	Smart Grids R&D Topics	Importance	Links with ELECTRA	Links with EERA JP SG	Specific agreements	General agreements
Brazil	Reduction of T&D losses: smart metering and AMI	A		SP5		JRC/ Ministry of Science & Technology
Brazil	T&D system efficiency and use of advanced technologies (PMUs, voltage control, network automation)	H	WP5, WP6	SP5	JRC/Ministry of Science and Technology	
Russia	Electricity end-user market involvement and economical advantages: AMI	H	WP3	SP2, SP3		
India	System reliability and use of Distribution management systems	H		SP2		ENEA/TERI
South Africa	Generation adequacy and bulk renewables integration: use of PMUs to enhance system stability	A	WP5	SP2, SP5		

Moreover, as shown in Table 16, Electra Partners have agreements with some countries not yet contacted and/or on topic not included in Table 15.

These agreements are mainly focused on renewable integration, micro-grids, system efficiency and ICT. Of particular importance are connections of CRES with Middle-East countries and of IPE with Russia.

These agreements could be used as a starting point for r the identification of common R&D topics between the ELECTRA and/or EERA JP SG with these countries, in order to enlarge the cooperation network and lead to a shared view on Smart Grids.

Table 16 – Agreements between ELECTRA partners and extra-EU organizations to be used to identify further R&D common topics

Partner	Extra-EU organization	Nation	Agreement type	Topics
IWES	IEA Task ISGAN (SIRFN Network)	Worldwide	Other	Development of testing facilities
LABORELEC	Nanyang Technological University, NTU	Singapore	MOU	Sustainable powering off-grid regions, participation in the renewable energy integration demonstrator at Singapore
VTT	Nanyang Technological University, NTU	Singapore	CA	Microgrids
CRES	Royal Scientific Society - National Energy	Jordan	CA	RES Microgrids, RES Desalination and Energy

Partner	Extra-EU organization	Nation	Agreement type	Topics
	Research Centre			Efficient interventions in buildings
CRES	Universite Abdelmalek Essaadi, UAE	Morocco	CA	RES Microgrids, RES desalination and energy efficient interventions in buildings
CRES	National Research Centre Egypt, NRC	Egypt	CA	RES Microgrids, RES desalination and energy efficient interventions in buildings
JRC	Israel Ministry for Energy and Water	Israel	MOU	Renewables, Smart Grids, e-mobility, energy efficiency, oil fuels alternatives
TUBITAK	King Abdulaziz City for Science and Technology, KACST	Kingdom of Saudi Arabia	Other	Development of Smart Grids controller for PV network
IPE	ENERGOSTAT	Russia	Other	Operation system in energy sector
IPE	SICON	Russia	Other	Power systems and ICT
IPE	Energy System Institute	Russia	Other	Power system operation and security
TECNALIA	Laboratorio de Pruebas de Equipos y Materiales, LAPEM	Mexico	CA	T&D equipment testing

7 Conclusions

In the initial phase of the ELECTRA IRP, one of the main goals of WP10 on “Actions on International Cooperation” is the identification of common research topics on smart grids between ELECTRA and other relevant extra-EU organisations.

Accordingly, the activity of WP10 was initially devoted to the establishment of relationships with the AB, the ICB and extra-EU organizations interested in the Smart Grids research. The interaction focused on sharing relevant information on ongoing R&D projects and initiatives, promoting the ELECTRA IRP together with the EERA JP on Smart Grids, organizing meetings, workshops and conferences. An important support was provided by ISGAN which helped in the establishment of contacts and result-sharing, especially B.R.I.C.S countries. The interaction with ISGAN and with other institutions led to the identification of **a preliminary list of Smart Grids topics of common interest in different extra-European countries.**

As a next step, the on-going agreements between the ELECTRA Partners and extra European institutions in the smart grid and energy fields were collected and evaluated. A total of sixty four agreements were collected. Most of them (i.e. 90%) are located in the American and Asian continents. The nations with the highest number of agreements are USA (13), China (8), Japan (7) and Korea (5), covering more than half of the total agreements.

Finally, the agreements the ELECTRA Partners have outside Europe have been linked to the topics of common interest already identified and to specific activities carried on in RTD ELECTRA WPs and EERA SPs.

USA is well connected to the ELECTRA and the EERA JP SG activities thanks to the presence of different agreements specifically related to the identified topics. The same applies to Korea and China that are focused on topics classified as of mid-high importance. Moreover ELECTRA Partners have some agreements with B.R.I.C.S. countries.

On the other hand, the topics identified with Russia and South Africa - even if well connected with some ELECTRA WPs and EERA JP on Smart Grids SPs – are not linked to any specific agreement.

Moreover ELECTRA Partners have agreements with countries (such as in the Middle-East region) not yet directly contacted and, therefore, not mentioned in the topics list; these agreements can be used as a starting point to establish further contacts in order to lead to a more shared view on Smart Grids.

In summary the list presented in this document will act as a basis for future INCO activities, establishing long-term relationships, fostering closer interaction with extra-EU institutes and joint research initiatives on selected smart grids topics of mutual interest.

Finally, given that new agreements and new common topics can be found at any moment, this document can be updated during the project life.

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9 Disclaimer

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The sole responsibility for the content of this publication lies with the authors. It does not necessarily reflect the opinion of the European Commission.

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ANNEX I - GLOBAL SURVEY OF SMART GRID ACTIVITIES

Text extracted from a contribution to
a chapter for a Wiley Handbook on Smart Grids
(to be published in 2015)

Introduction

A survey of global Smart Grid activities provides us trends prevalent in different geographies. Some of these trends are dictated by local/regional electric grid enhancement requirements, while others are influenced by state or national policy goals. The International Smart Grid Action Network (ISGAN) is an initiative of the Clean Energy Ministerial organized as an Implementing Agreement of the International Energy Agency. As a part of its activities, national-level Smart Grid deployment drivers and related technologies were identified by nineteen ISGAN participants, and then used as a criterion for selecting Smart Grid projects as candidates for the ISGAN Global Smart Grid Inventory. The selected projects chose their main application area from one of seven application areas:

1. Smart Metering
2. Smart Network Management
3. Integration of Distributed Energy Resources (DER)
4. Integration of Large Scale Renewable Energy Sources/Systems (RES)
5. Aggregation (Demand Response [DR], VPP [Virtual Power Plant])
6. Smart Customer and Smart Home
7. Electric Vehicles (EV) and Vehicle2Grid (V2G) Applications

This chapter provides us an insight to major drivers and Smart Grid activities by major application areas for the three major continents participating in ISGAN – North America, Europe, and Asia. After a brief introduction to each continent's Smart Grid drivers and overall activities, key Smart Grid projects are described from each continent grouped by the aforementioned seven major application areas.

Asia

The key priority of Smart Grid developments in Asia is to establish a strong power grid infrastructure to supply stable electric energy to rapidly increasing demand in the developing countries. With a fast growing economy, many Asian countries are experiencing shortage of electricity. Furthermore, they experience pressure from the international society to keep in check their CO_2 emissions. To fulfill energy needs under environmental constraints, many renewable energy projects are being developed in connection with Smart Grid technologies. In this context, China, Japan, and Korea, are competing to take an initiative in the Smart Grid market. These northeast Asian countries have strong competences in both manufacturing and software industries, so they want to develop new market opportunities in Smart Grid to keep a sustainable growth. Considering that Asia has both competitive suppliers and big markets, Asia is expected to be the most dynamic market of Smart Grid in the near future.

According to the 2014 ISGAN survey, the top 6 Smart Grid drivers identified for the Asian continent (by China, Japan, India, Republic of Korea, and Singapore ISGAN representatives) are shown in Figure 1. Interestingly, for Asia the top driver is 'Enabling customer choice and participation' because consumers have been more passive in Asia as compared to North America and Europe under strong regulation on the electricity market. Therefore, the survey result reflects accumulated

needs regarding the liberalization and deregulation of the market with Smart Grid technologies. 'System efficiency' and 'Reliability improvements' are the 2nd and 3rd drivers, followed by 'Renewable energy standards and targets' that are essential in meeting increasing energy needs under environmental constraints.

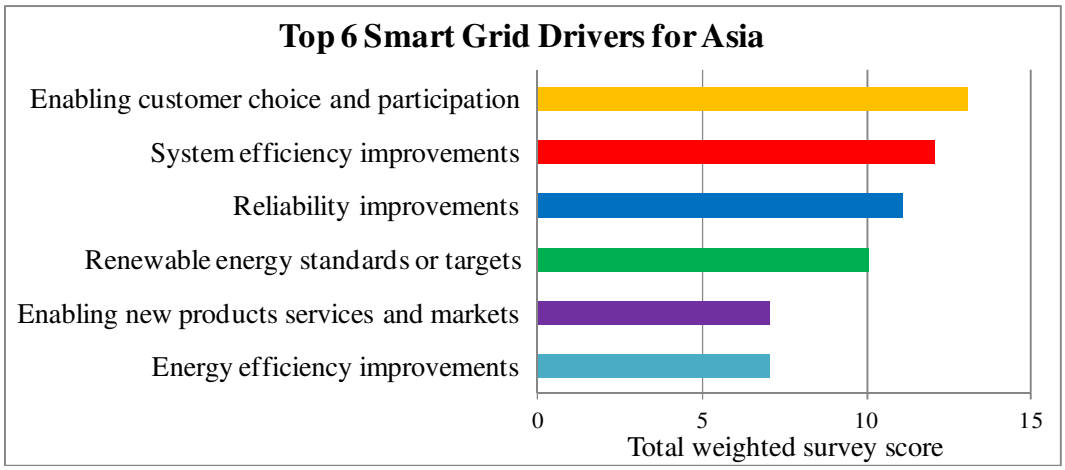

Figure 1. Top 6 Smart Grid Drivers for Asia identified by 2014 ISGAN Annex 1 Survey

Europe

The energy panorama of Europe has dramatically changed in the last 20 years. This transition is due to the ambitious climate goals that Europe has set in the short to medium term, and to the unbundling of vertically integrated structures of the past national electric utilities, in view of the setting up of a single pan-European electricity market. Many European directives dealing with energy matters have come into force to shape such changes, emphasizing electricity as a crucial enabler of sustainable economic growth. These directives support the three European energy policy pillars (security of supply, sustainability, and market efficiency) and the related short term ("20-20-20") energy policy targets. These targets translate into both massive integration of RES into the electricity system and energy efficiency measures – which need networks to be smarter, more flexible and resilient, favouring centralised and decentralised storage and allowing bi-directional power flows while maintaining the system reliability. The drivers guiding the development of the European electricity system towards a profound modernisation are well represented in the second policy survey carried out by ISGAN in 2014, and are shown in the following Figure 2 .

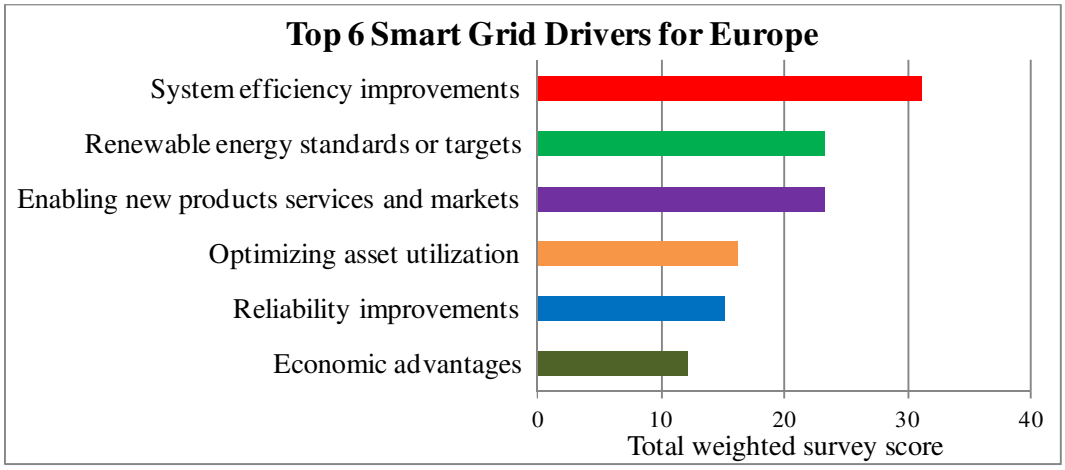

Figure 2. Top 6 Smart Grid Drivers for Europe identified by 2014 ISGAN Annex 1 Survey

As it can be seen in the figure, the most important driver is linked with the improvement of system efficiency, followed by the integration of RES and a number of parameters linked with the pan-European market (i.e., new products, services and markets) and operational costs optimisation (operating and maintenance costs reduction, asset utilisation).

To meet the target of ensuring the availability of Smart Grid to enable the achievement of the electricity system development drivers, all European countries acknowledge the necessity to complement technological research with field demonstration of solutions in actual environments, with real networks, customers, and regulatory constraints. The European Electricity Grid Initiative (EEGI), gathering the major stakeholders of the electricity system (i.e., country representatives, network operators, technology providers, retailers associations, and the European Commission) has published a research and demonstration roadmap to highlight the activities deemed necessary to demonstrate the viability of Smart Grid solutions at transmission and distribution levels considering a time span ranging from 2012 to 2020. Implementation plans focus on immediate needs during the next two-year period; a longer term view (towards 2035) is adopted by the European Smart Grid Technology Platform in its Strategic Research Agenda.

The European Joint Research Centre for Energy and Transport (JRC-IET), in its recently published updated report, has collected information about nearly 450 Smart Grid projects, accounting for a total investment of 3.15 billion €. A rough outline of the European Smart Grid project scene is reported in

Figure 3, showing the number of Smart Grid projects and the related allocated budgets for the different European countries. This figure shows that the so-called EU15 countries[1] are the most engaged in Smart Grid. In terms of funding, as expressed in Figure 4, more than 70% of the total budget is allocated for demonstration and deployment, where private capitals play a very important role.

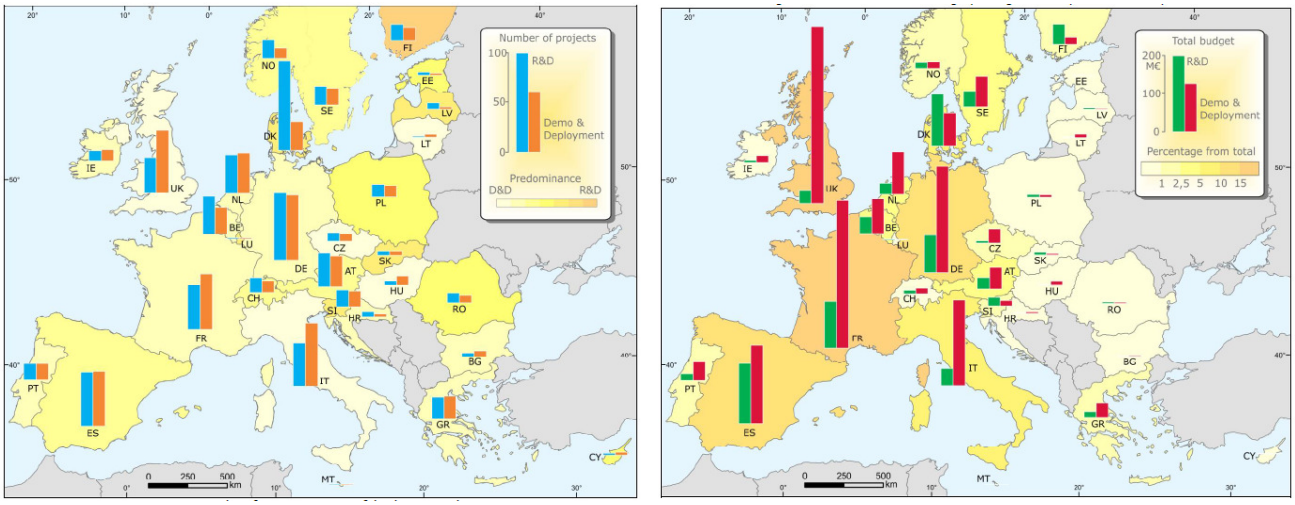

Figure 3. JRC-IET survey on Smart Grid projects in Europe (2014), expressed in number of projects developed (left) and budget allocated (right) in the different countries, distinguishing between R&D Projects and Demonstration & Deployment initiatives

[1] EU15 countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the United Kingdom

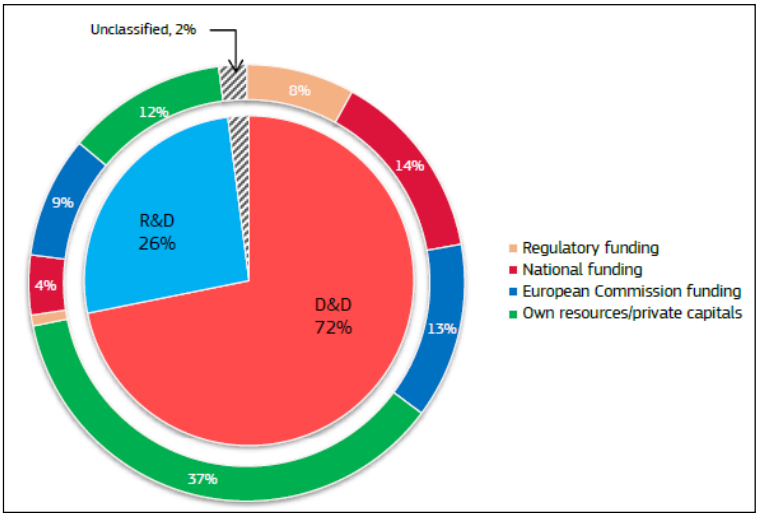

Figure 4. Funding of Smart Grid projects per type of project (R&D or Demonstration) and per category of funding source

North America

The US Smart Grid activities were kick started by the American Recovery and Reinvestment Act of 2009 (Recovery Act) with the help of $4.5 billion provided to the U.S. Department of Energy to modernize the electric power grid and implement Title XIII of the Energy Independence and Security Act of 2007. The two largest initiatives are the Smart Grid Investment Grant (SGIG) program and the Smart Grid Demonstration Program (SGDP). The SGIG focuses on deploying existing Smart Grid technologies, tools, and techniques to improve grid performance today. The SGDP explores advanced Smart Grid and energy storage systems and evaluates performance for future applications.

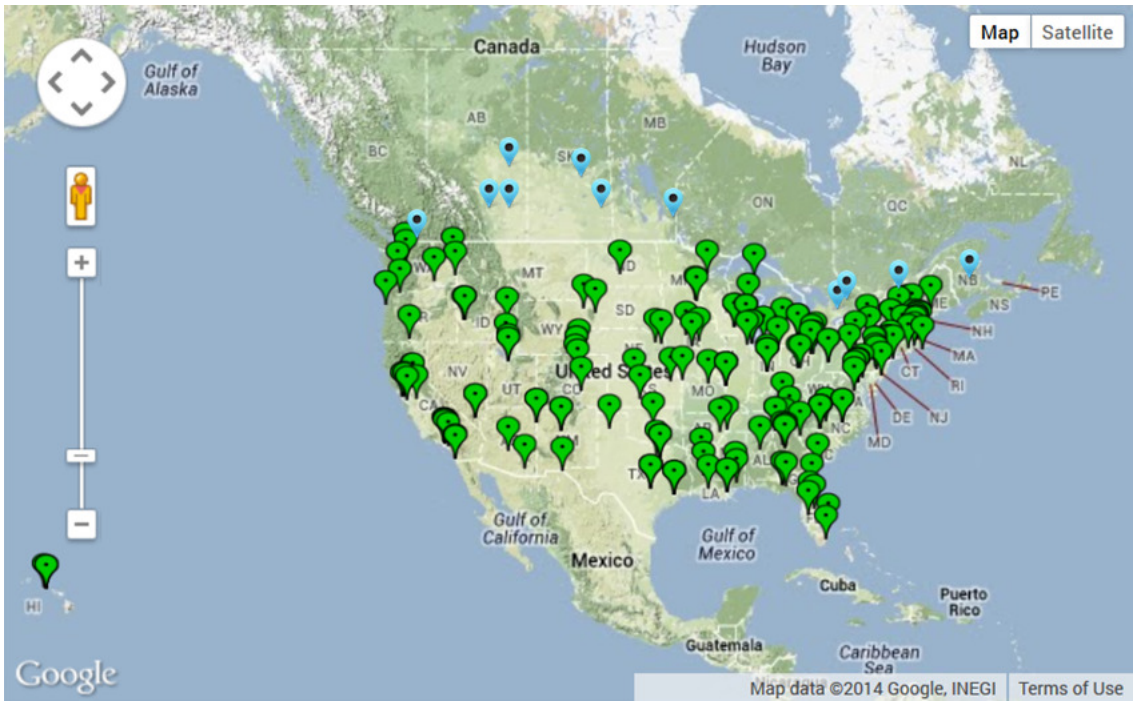

Figure 5. Map showing US Recovery Act and Canadian Smart Grid projects

The Canadian Smart Grid efforts at the federal level are led by the Smart Grid Technology and Standardization Task Force, which was established by the Natural Resources Canada agency 'CanmetENERGY' in collaboration with the Standards Council of Canada and other Partners; at the provincial level, each local government has one of its ministries or agencies closely involved in Smart Grid developments. The Mexican grid is controlled by the Federal Electricity Commission (Comisión Federal de Electricidad or CFE). Mexico faces different electric grid challenges, such as high non-technical distribution losses, unreliable grid infrastructure, and rapidly growing electricity demand, than Canada and the USA.

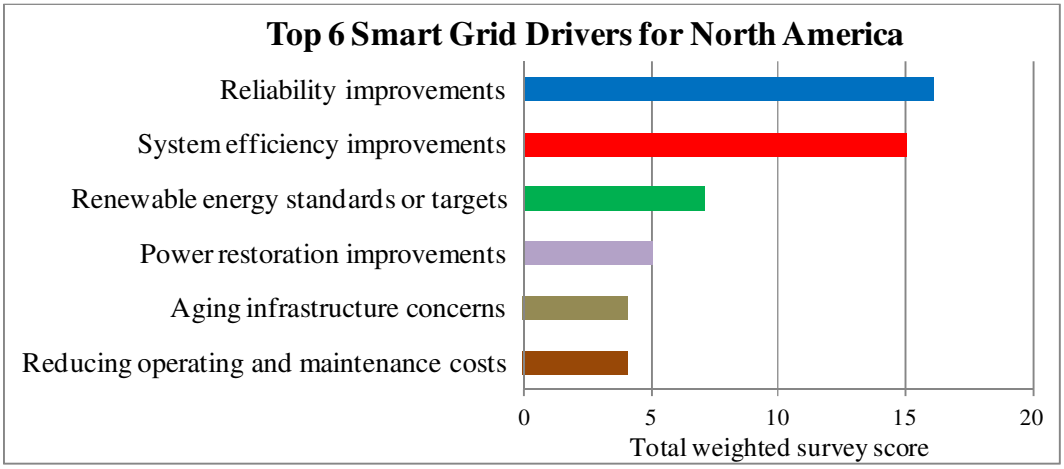

Figure 6. Top 6 Smart Grid Drivers for North America identified by 2014 ISGAN Annex 1 Survey

The top 6 Smart Grid drivers for North America based on a 2014 survey of ISGAN participants are shown in Figure 6. The above 6 drivers include all of the top 3 drivers for the three individual participating countries. 'Reliability improvements,' 'System efficiency improvements,' and 'Renewable energy standards' are paramount to North America, just as seen for Asia and Europe. North America also regards 'Power restoration' as an important driver in the wake of recent mega-storms, while 'Aging infrastructure concerns' highlight the issue faced by the aging North American grid. These six drivers play an important role in determining the main application areas of the projects in North America.