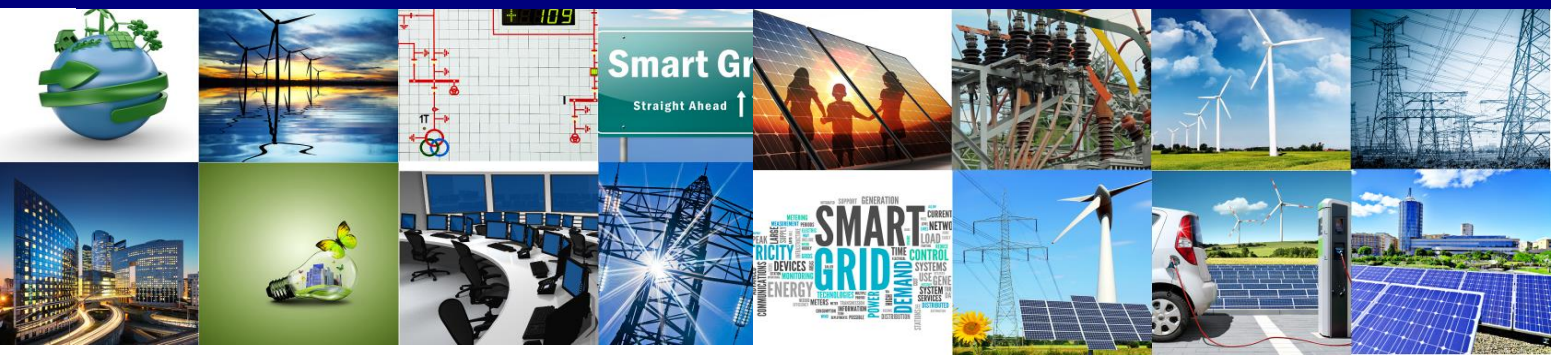
Project No. 609687

FP7-ENERGY-2013-IRP

ELECTRA

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



WP 10

Actions on International Cooperation

Deliverable 10.4

Final Report on Joint Collaborative projects launched and being launched with extra EU countries, and on synergies with Mission Innovation IC#1 on Smart Grids

20/03/2018

ID&Title	**D10.4** Final Report on Joint Collaborative projects launched and being launched with extra EU countries, and on synergies with Mission Innovation IC#1 on Smart Grids	**Number of pages:**	32

Short description (Max. 50 words):

This deliverable outlines the joint collaborative projects launched and to be launched with extra European countries in the smart grids field and the synergies with Innovation Challenge 1 on smart grids of Mission Innovation.

Version	Date	Modification's nature
V0.1	28/02/2018	First Draft
V0.02	06/03/2018	Revised Draft
V0.03	06/03/2018	Final Draft
V1.00	14/03/2018	Under review
V2.00	20/03/2018	Released

Accessibility

☒ PU, Public	
☐ PP, Restricted to other program participants (including the Commission Services)	
☐ RE, Restricted to other a group specified by the consortium (including the Commission Services)	
☐ CO, Confidential, only for members of the consortium (including the Commission Services)	
If restricted, please specify here the group:	

Owner / Main responsible:

Task 10.3 Leader:	Luciano Martini (RSE)	

Final Approval by:

ELECTRA Technical Committee TOQA appointed Reviewer:	Mihai Calin (DERlab) Seppo Hanninen (VTT)	20/03/2018

Authors

Name	Last Name	Organization	Country
Roberto	Zuelli	RSE	Italy
Pietro	Pinacci	RSE	Italy
Luciano	Martini	RSE	Italy
Evangelos	Rikos	CRES	Greece
Henrik	Bindner	DTU	Denmark
Anna	Mutule	IPE	Latvia
Josè Emilio	Rodriguez Seco	TECNALIA	Spain
Graeme	Burt	USTRATH	UK
Seppo	Hänninen	VTT	Finland

Copyright

Consisting of:

Coordinator	
Ricerca Sul Sistema Energetico – (RSE)	Italy
Participants	
Austrian Institute of Technology GmbH - (AIT)	Austria
Vlaamse Instelling Voor Technologisch Onderzoek N.V. - (VITO)	Belgium
Belgisch Laboratorium Van De Elektriciteitsindustrie - (LABORELEC)	Belgium
Danmarks Tekniske Universitet - (DTU)	Denmark
Teknologian Tutkimuskeskus - (VTT)	Finland
Commissariat A L'Energie Atomique Et Aux Energies Alternatives - (CEA)	France
Fraunhofer-Gesellschaft Zur Förderung Der Angewandten Forschung E.V – (IWES)	Germany
Centre For Renewable Energy Sources And Saving - (CRES)	Greece
Agenzia Nazionale per Le Nuove Tecnologie, L´Energia E Lo Sviluppo Economico Sostenibile - (ENEA)	Italy
Fizikalas Energetikas Instituts - (IPE)	Latvia
SINTEF Energi AS - (SINTEF)	Norway
Instytut Energetyki - (IEN)	Poland
Instituto De Engenharia De Sistemas E Computadores Do Porto - (INESC_P)	Portugal
Fundacion Tecnalia Research & Innovation - (TECNALIA)	Spain
Joint Research Centre European Commission - (JRC)	Belgium
Nederlandse Organisatie Voor Toegepast Natuurwetenschappelijk Onderzoek – (TNO)	Netherlands
Turkiiye Bilimsel Ve Teknolojik Arastirma Kurumu - (TUBITAK)	Turkey
University Of Strathclyde - (USTRATH)	UK
European Distributed Energy Resources Laboratories (DERlab)	Germany
Institute for Information Technology at University of Oldenburg (OFFIS)	Germany

Executive summary

ELECTRA is an Integrated Research Programme IRP that supports networking and R&D activities of the European Energy Research Alliance Joint Programme on Smart Grids (EERA JP SG) and aims at developing radical new control methods for the future renewable energy based electricity system. ELECTRA brings together the partners of the EERA JP SG to reinforce and accelerate Europe's medium to long term research cooperation in the smart grid area and to contribute to a closer integration of the research programmes of the participating organisations.

The main goals of Task T10.3 are: i) to launch effective INCO activities on specific topics by country or region in the smart grids field and ii) to leverage the synergies between ELECTRA and Mission Innovation Challenge 1 (IC#1) by defining a common strategy/approach and implementing international cooperation activities in the field of Smart Grids.

Deliverable D10.4 presents the status of the International Cooperation (INCO) activities in the smart grids field at the end of the ELECTRA IRP, including the synergies with Mission Innovation and the description of the impact on INCO activities of the Researchers Exchanges (REX) programme launched by ELECTRA.

Focussing on the Researchers Exchanges programme, the 3rd REX call was specifically dedicated to the exchanges with extra-European countries, allowing the INCO with extra-European experts for a more homogeneous concept of smart grids.

The ELECTRA INCO activities strongly relates to the first Challenge (IC#1) of Mission Innovation, the international initiative that aims to dramatically accelerate global clean energy innovation. The most relevant achievements of IC#1 in 2017 leveraged on the INCO activities carried out by ELECTRA; in particular, the KPIs and the R&D smart grids priorities identified in IC#1 took advantage of the work carried out by ELECTRA in the INCO field.

IC#1 can be considered as an example of International Cooperation on smart grids: it will allow continuous networking opportunities and information exchanges among experts, policy makers and all the interested parties, to strength the collaboration among innovators boosting the private sector engagement. Finally, the strong involvement of Europe in IC#1 and the synergies between ELECTRA and IC#1 will allow to confirm the leading role of Europe in smart grids.

Terminologies

CEM	Clean Energy Ministerial
D	Deliverable
DSM	Demand Side Management
DoW	Description of Work
EERA JP	European Energy Research Alliance Joint Programme
ELECTRA	European Liaison on Electricity Committed Towards long-term Research Activities for Smart Grids
ETIP SNET	European Technology and Innovation Platform for “Smart Networks for the Energy Transition
EUWP	End Use Working Party
ExCo	Executive Committee
FOA	Funding Opportunity Announcement
GSGF	Global Smart Grids Federation
IC#1	Innovation Challenge 1 on Smart Grids
IEA	International Energy Agency
IEC	International Electrotechnical Commission
INCO	International Cooperation
IRP	Integrated Research Programme
ISGAN	International Smart Grid Action Network
MARE	Mediterranean Activities for Research and innovation in the Energy sector
MI	Mission Innovation
REX	Researchers Exchanges
R&D	Research and Development
RD&D	Research Development and Demonstration
SIRFN	Smart Grid International Research Facility Network
SG	Smart Grids
T	Task
TCP	Technology Collaboration Programme
WP	Work Package

Table of contents

List of Figures and Tables

1 Introduction

ELECTRA is an Integrated Research Programme (IRP) that supports networking and R&D activities of the European Energy Research Alliance Joint Programme on Smart Grids (EERA JP SG) and aims at developing radical new control methods for the future renewable energy based electricity system. WP10 of ELECTRA mainly focuses on International Cooperation in the smart grids field and in particular on:

- the identification of promising INCO partner programmes/organisations;
- the definition of R&D topics of mutual interest for International Cooperation activities;
- the coordination of these R&D topics with the IRP and the EERA JP;
- the contribution to the major worldwide initiatives such as ISGAN and the GSGF;
- the coordination with Mission Innovation Challenge 1.

Mission Innovation (MI) is a global initiative of 22 countries and the European Union to dramatically accelerate global clean energy innovation. The first of the seven challenges (IC#1) defined in MI focusses on smart grids and is co-led by China, India and Italy. IC#1 aims to enable future grids that are powered by affordable, reliable, decentralised renewable electricity systems [5].

The presence of a very significant number of European countries in ELECTRA and IC#1 at the same time allowed and will allow to leverage on common aspects and experiences gained in the ELECTRA period, especially in the INCO framework. Currently, IC#1 can count on nineteen countries and the European Union represented by the European Commission (EC) and nine of them are also involved in the ELECTRA IRP, highlighting the existing strong link between the two.

The goal of Deliverable D10.4 is to provide a summary of the activities carried out within ELECTRA, including the synergies with Mission Innovation (MI) and the Researchers Exchanges (REX) programme launched by ELECTRA itself.

The document is organized as follows: Chapter 2 provides an overall description of the activities carried out on International Cooperation, Chapter 3 focusses on the link between ELECTRA and Mission Innovation Challenge 1 (IC#1), Chapter 4 draws the conclusions related to the ELECTRA INCO activities, evidencing the way forward for INCO activities.

2 Overall description of past WP10 achievements

In this chapter the most relevant results achieved by ELECTRA on INCO are resumed, providing information and references on specific issues.

Starting from the elaborations presented in [2], WP10 prepared a questionnaire for the identification of the relevant R&D priorities in the smart grids field outside the European boundaries. Feedback were received from three continents (i.e. Asia, Australia and USA) and their elaboration allowed the definition of an action plan for each of the prioritized R&D topics for the launching of specific INCO activities on smart grids [3], [4]. The methodology adopted for the implementation of the WP10 questionnaire and the related elaboration was adopted as reference in IC#1, as described in 3.2.

Furthermore, a specific set of KPIs was defined for the evaluation of the INCO activities. The KPIs were classified in i) evaluation KPIs and ii) impact KPIs: the former aims to effectively measure the INCO activities, the latter to assess the results of the INCO activities.

The proposed Evaluation KPIs to monitor the INCO activities are reported in the following:

1) number of involved extra-European institutions;
2) number of involved extra-European countries;
3) total duration (in months) of the INCO activities;
4) number of events (workshops, meetings, webinars etc.) for the INCO activities;
5) number of stakeholders involved in the INCO activities (through meetings, workshops etc.);
6) number of weeks dedicated to the INCO activities by REX researchers.

While the considered Impact KPIs are:

1) number of R&D topics jointly addressed through the launched INCO activities;
2) number of joint publications issued through the INCO activities;
3) number of letters of endorsement/support or similar received.

Finally, as for the questionnaire, the presented set of KPIs was considered in IC#1 as described in 3.2.

The link between INCO and REX is detailed in 2.2; researcher exchanges with extra-European countries were launched through dedicated calls that allowed applicants to spend a period in extra-European institutions to jointly carry out the analysis of specific issues related to smart grids.

2.1 International Cooperation

In this paragraph the International Cooperation the ELECTRA members have in place with institutions outside Europe are reported. Information related to INCO activities were provided by RSE, CRES, DTU, IPE, TECNALIA, USTRATH and VTT.

2.1.1 RSE INCO activities

As part of its international activity, RSE is involved in several international initiatives, joint collaboration and ministerial activities of paramount importance in terms of international cooperation.

IC#1: *Mission Innovation Challenge 1*

As further described in Section 3 IC#1 (Innovation Challenge 1) is one of the seven Challenges launched by Mission Innovation, the international initiative that aims to reinvigorate and accelerate public and private global clean energy innovation with the objective to make clean energy widely [5].

RSE is a member of the Italian steering committee of Mission Innovation and co-leads, together with China and India, the first Challenge (IC#1) focused on smart grids.

On 2017 RSE signed two cooperation agreements for "Strategic key programme for international scientific and technological innovation" with the co-leading Institutions of IC#1: IEE CAS (China) and IIT Roorkee (India).

Both these international collaborations aim to carry out the strategic research of smart grids technology innovation towards 100% renewable energy, including intelligent regional and distribution networks, microgrids and additional smart grids related areas, as well as to overview smart grids cross-research fields, such as power electronic and ICT.

Furthermore, the two INCO agreements will allow to carry out the work of IC#1 and the organization of technical workshops, seminars, joint web meetings, technical conferences etc.

On 2020 the parties will evaluate the outcomes from the collaboration and re-discuss the terms and conditions of the agreements to possibly renew it for other three years. RSE, besides co-leading the Challenge, is the reference Institution for the BIE (Business and Investor Engagement).

ISGAN: International Smart Grid Action Network

ISGAN is a Clean Energy Ministerial (CEM) initiative on smart grids organized as a IEA Technology Collaboration Programme (TCP). Currently ISGAN can count on twenty-five member countries that agreed to collaborate on advancing clean energy technologies, following the CEM high level attention and commitment to concrete steps - both policies and programs - that accelerate the global transition to clean energy. In particular, ISGAN aims to improve the understanding of smart grid technologies, practices and systems and to promote adoption of related enabling government policies. ISGAN creates a mechanism for multilateral government to government collaborations to advance the development and deployment of smarter electric grid technologies, practices and systems, [11].

In the frame of ISGAN, RSE has always covered important coordination roles: after being one of the founder and having held the chairmanship for more than five years, currently RSE has the vice-chairmanship and provides the Italian delegate and alternate member within the Executive Committee (ExCo). RSE is also involved in the ISGAN annexes, representing Italy in Annex 4 "Synthesis of Insights for Decision Makers", and participates to the Budget Review Group (BRG), which monitors ISGAN's economic and financial status. Under the INCO point of view ISGAN offers many opportunities, allowing to complement, leverage and bolster existing or nascent international efforts on smart grid through high level government to government engagement, consulting with smart grids stakeholders and institutions and supporting closer targeted collaborations.

IEA: *International Energy Agency*

In addition to the IEA Technology Collaboration Programs ISGAN, RSE represents Italy in several others TCPs and in particular has the chairmanship of the IEA TCP HTS (High Temperature Superconductivity) for assessing the impacts of high temperature superconductivity on the electric power sector.

In the framework of the IEA Energy Technology Network, RSE is one of the Italian national representatives within the Committee on Energy Research and Technology (CERT), which is the body supervising the activities of all 38 TCPs of the IEA. The CERT contributes to shape the activities of more than 6000 researchers representing nearly 300 public and private organizations located in 53 countries.

RSE has the vice chairmanship of the End Use Working Party (EUWP), whose main objectives are to guide the work of the IEA TCPs more focused on end uses of energy, (namely ISGAN, HTS, and DSM) and to identify gaps in technologies and energy end-use systems. The EUWP builds relationships and engages with industry and partner countries through the work of the end-use IEA TCPs.

CEM: *Clean Energy Ministerial*

RSE assists the Italian Ministry of Economic Development (MiSE), the Italian Ministry of Foreign Affairs and International Cooperation (MAECI) and the Italian Ministry of Environment Landscape and Sea (MATTM) in their contribution to CEM. This initiative is a global forum of 24 countries and the European Commission to promote policies and share best practices to accelerate the global transition to clean energy.

RSE has participated in nearly all the sessions of the CEM, either as a member of the Italian national delegation or in its capacity of chairman of ISGAN. Close contacts have been established with the coordination bodies of the CEM thanks to the continuous necessity of reporting, being ISGAN one of the outstanding initiatives of CEM. Moreover, RSE is a member of the advisory board of the Clean Energy Solutions Centre, the key initiative for knowledge and expertise sharing.

2.1.2 CRES INCO activities

During the ELECTRA IRP project CRES has had the chance to collaborate with universities and research institutes from non-European coutries including Jordan, Egypt and Morocco. This collaboration was established in the frame of the EU funded project “Mediterranean Activities for Research and innovation in the Energy sector - MARE” and the organisations from the countries involved in the consortium of the project were the following: Royal Scientific Society-National Energy Research Center (RSS-NERC) from Jordan, Universite Abdelmalek Essaadi (UAE) from Morocco and National Research Center (NRC) from Egypt. The collaboration of CRES with the abovementioned organizations aimed to tackle important global challenges for Mediterranean Partner Countries, similar to the EU challenges regarding secure, clean and efficient energy and to many respects similar with the ELECTRA objectives.

From a technological point of view and in relation with the ELECTRA activities the most important topic addressed by the specific collaboration in the frame of MARE was microgrids. This was achieved by means of a set of networking activities that included:

- analysis of market and technology opportunities regarding the energy pillars addressed by the project;
- boosting of regional market uptake of research results by identifying innovation strengths, bringing together actors of the whole innovation value chain and visiting sites and presenting technologies to regional beneficiaries to demonstrate these technologies and exploitation ideas;
- supporting innovation and contributing towards best practices exchange by activities like seminars, on-site visits etc., as well as partners collaborations in mini-projects and case studies.

The duration of the collaboration was 30 months, from September 2013 to March 2016. The collaboration among project partners, regional key actors and policy makers contributed to the mobilization and enrichment of national, regional, EU & International market of energy related technologies, stimulating the market pull and technology push intersection. It also built bridges among the EUROMED Energy Innovation Ecosystem actors and worked towards their Research to Innovation capacities on business, innovation and technology commercialization topics, in order to improve competencies on local actors and organisations by providing training seminars on these issues in 7 countries. Finally, the project MARE mobilized a large set of people and organizations through activities dedicated to experience sharing and learning.

2.1.3 DTU INCO activies

In the ELECTRA period, the activities carried out by DTU in the frame of international collaboration has included the following three tracks:

- activities fostered within ELECTRA;
- activities in other international networks boosted by the ELECTRA activities;
- activities within DTUs existing international collaboration that has been extended due to ELECTRA.

During the project, ELECTRA participated in many INCO activities. This has included task lead that has resulted in the information collection of ELECTRA INCO activities and the “Joint Brazilian – ELECTRA Smart Grids Workshop” held on November 2015 in Florianópolis, Brazil [12].
The workshop resulted in a researcher exchange that has further resulted in research activities on distributed control; the work includes experimental work as well as scientific papers.
Similarly, a researcher exchange involving SLAC/LBNL has resulted in scientific papers and in additional staff exchanges in the form of two PhDs from DTU having their external research stay (three months) at SLAC.

DTU has also been increasingly involved in the work of ISGAN/SIRFN partly as a results of the ELECTRA INCO activities. This work has contributed to the power system testing activities as well as the microgrid activities of SIRFN and will continue after the end of ELECTRA.
DTU has also been significantly involved in the MI IC#1 activities together with other ELECTRA partners, in particular RSE. As also presented in Chapter 3 DTU is fully involved in Mission Innovation Challenge 1 on smart grids; in particular DTU has a co-lead role of the task on Demand Response and is contributing to several other activities, such as the organization of the 3rd IC#1 deep-dive workshop presented in 3.4.
Finally, the ELECTRA activities has provided a basis for additional activities with other international partners such as in China, where DTU has been involved in microgrid and integrated energy system projects drawing from the results of ELECTRA as well as the contributing to the INCO activities.

2.1.4 TECNALIA INCO activies

As part of its international activity, TECNALIA has developed or is developing, in parallel to the ELECTRA Programme course, the following joint collaborative projects in the field of smart grids with extra-EU countries. The projects include R&D activities, policy and regulation definition, and support to smart grids technologies deployment:

Colombia: *Development of the regulatory framework for the development of electric vehicles in Colombia* (December 2013 – September 2014)

The objective of the project is the development of the regulatory framework required for the deployment of electric vehicles in Colombia. Activities include the diagnosis of the situation in Colombia and the benchmarking with five leading countries.

The regulatory framework includes policies, recommendations, strategies and the definition of the roadmap for the implementation.

Iran: *DLMS Iran* (October 2014 – December 2015)

This project aims at defining the smart meter communication protocol requirements (IEC 62056-DLMS/COSEM functionality) to be used in the distribution networks of Iran, as well as the specification of the test cases used to evaluate the conformity of the devices with those requirements.

Australia: *Development of multi-level converters for Power Electronics Laboratory* (May 2014 – May 2016)

Within this project with the Australian Energy Research Institute of the Universidad de New South Wales, several medium voltage converters were developed. Specifically, 3-level ANPC topology and 9-level MMC (Modular Multilevel Converter) topology converters were built, including the power hardware, control hardware and modulation algorithms. This equipment was part of the new power electronics facility of the Australian Energy Research Institute for HVDC (High Voltage Direct Current) research.

Ecuador: *Smart Meters Ecuador*

(January 2015 – December 2015)

The project objective is to support the smart meter roll-out in the country: 1.5 million electronic meters for the electrical distribution companies of Ecuador. The activities involve the formulation of the technical specifications, technical assistance for the acquisition of the meters, inspection of the Chinese meter manufacturer factories and the laboratory testing.

Dubai: *Integrated Energy Intensity Mapping of Dubai - Initiation and Pilot Implementation* (September 2015 – March 2016)

The basic goal of the project is to gain insight and enable project planning for a full scale implementation of an energy intensity mapping system on the scale of all buildings in Dubai. With this aim, the main project objective is to develop a platform based on a Geographic Information System (GIS) where information is stored and analysed in order to get a set of Key Performance Indicators (KPIs) of the energy and water use of buildings in Dubai. The platform is implemented and tested in this phase for one hundred buildings of Dubai city and designed to accommodate the entire city in the future. Key tasks are related to energy use and efficiency, and ICT architecture development.

Saudi Arabia: *AMI systems and DLMS functionalities*

(2015 – 2017)

The project deals with the massive deployment of smart meters in the country, including the support for the selection of the AMI (Advanced Metering Infrastructure) system and the set-up of a local testing centre for evaluation of smart meters and data concentrators, with the focus on the communication protocols (IEC 62056: DLMS/COSEM).

Lebanon: *Evaluation of a Pilot Project for an AMI system*

(2016)

Basically, the project analyses the performance of an AMI system, emphasizing the analysis of inconsistencies in the received data by the Head End system from the smart meters.

Argentina: *Master Plan for Energy Renewable Technologies*

(2017 – 2018)

The aim of this project is to develop a master plan to advice a National Research Centre on the priorities and technological strategy to support the deployment of renewable energy in the country.

2.1.5 USTRATH INCO activities

The University of Strathclyde has a number of extra-EU collaborations and engagements that the ELECTRA team have been able to make use of in stimulating new and expanded international cooperation. These include international strategic research partnerships, international industry cooperation, international professional activities and the hosting and training of international researchers.

International Strategic Research Partnerships

USTRATH has a range of international strategic research partnerships with prestigious universities around the world, and energy systems and smart grids represent a common theme across many of these. This has provided a useful outlet for dissemination and direct collaboration regarding decentralised control and the Web-of-Cells concept. In particular, the partnership with Nanyang Technological University (NTU) in Singapore, a globally leading technological university, has facilitated direct cooperation on the Web-of-Cells concept, its validation, and its integration with other controls such as based on consensus algorithms. Experimental cooperation, supported by ELECTRA REX researcher exchange and transnational access, has resulted in joint publications, and this has now prompted further cooperation in decentralised control research proposals and new PhD studentships starting in 2018.

International industry cooperation

A number of industry partners utilise the experimental smart grid facilities at USTRATH, and these relationships have supported direct cooperation of relevance to the refinement and implementation of the Web of Cells concept. For example, the collaboration with Nokia (and formally Alcatel-Lucent) has for several years uncovered key performance characteristics of the communications infrastructure through which decentralised controls will be realised. A research fellowship has been newly committed to in 2017, which will focus on developing and validating communications solutions for smart grid applications, underpinned by Strathclyde's research infrastructure and the ELECTRA use cases. In particular, this cooperation will link the capabilities of Nokia's laboratories in Plano (Texas, USA) and USTRATH's facilities to establish new ways of testing control and protection functions.

Similarly, the USTRATH team's research collaboration with the Canadian team at RTDS Technologies has supported the Web-of-Cells validation capability utilised within ELECTRA. RTDS Technologies is a major manufacturer of innovative real-time simulation hardware, with an extensive number of users for smart grid research and testing around the world. The company was happy to see an RTDS PhD student directly contribute to the experimental capabilities developed and utilised in ELECTRA WP7. These results were further disseminated through USTRATH hosting the RTDS European User's Group Meeting in September 2016. This included

presentations and laboratory demonstrations of the Web of Cells controllers to delegates from Europe, North America, and South America in 2016.

International professional activities

ELECTRA's INCO activities have benefited from the international professional activities of the USTRATH team. For example, USTRATH is a member and regular attendee of IEC Technical Committee 57 Working Group 10, which manages the IEC 61850 international standards. This has fostered specific engagement with Hydro-Québec (network operator for the Québec region of Canada) to understand the challenge of implementing radical decentralised controls like Web of Cells and associated adaptive protections. Furthermore, USTRATH has utilised his membership of CIGRE Working Group B5.64, which is analysing methods to automatically manage specifications for control, protection, and automation system. This activity is linked to the Smart Grid Architecture Model (SGAM) activities developed within ELECTRA WP7.

As an actively publishing team, the USTRATH ELECTRA team have engaged extensively in international conferences, informing the global community of the relative merits of the web of cells concept and stimulating new discussions across alternative smart grid architectures. This has included keynote addresses (e.g. EDST'16), special sessions (e.g. IRED'14, ISGT Europe'16, CIRED Workshop'16, ISGT Europe'17), and conference tutorials (e.g. DPSP'16). The latter was entitled "selected R&D projects for protecting and controlling the future grid", and included dissemination of the ELECTRA Web of Cells concept and associated protection implications to the global audience attracted to this preeminent global conference for power system protection.

Hosting and training international researchers

The USTRATH team have used active participation in mobility, transnational access, training schools and workshops to support their INCO activities, through which the Web of Cells concept has become more widely recognised. For example, the H2020 ERIGrid Transnational Access programme has enabled researchers from National Renewable Energy Laboratory (NREL) in the USA and Nanyang Technological University (NTU) in Singapore to visit USTRATH for collaborative experimental research, with the latter engagement building on a previous ELECTRA REX exchange. A group of smart grid project students were hosted from Washington State University (USA) in summer 2017, and together with WSU senior academics were introduced to the ELECTRA Web of Cells concept and laboratory validation. Likewise, laboratory demonstrations of decentralised control through Web of Cells formed part of the programme for two training events for early stage researchers in smart grid metrology, as well as for senior level visits from CEPRI (China), NTU (Singapore), Tsinghua University (China), Texas A&M University (USA), India, Seoul National University (Korea), and KEPRI (Korea), amongst others.

2.1.6 VTT INCO activities

VTT's international collaboration activities have linked to ELECTRA frequency, balance and voltage control activities. The projects include R&D activities for developing micro-grids and their control and energy management, and support to SG technologies deployment:

Singapore: *Adaptive Integrated Hybrid DC-AC Micro Power Parks System*

(January 2015 - December 2017)

VTT collaborated with Nanyang Technological University (NTU) to develop an Adaptive Integrated Hybrid DC-AC Micro Power Park (MPP) system – a family of micro-grids, based on modular architecture for rapid deployment. The main task was to develop a hybrid DC-AC module for the MPP that can adapt to different renewable energy sources and variable speed diesel generators with the primary purpose to provide emergency power sources for critical functions in disaster

zones and future applications such as a smart microgrid for military, fringe network and long-term deployment in remote areas and islands. The work covered the design and development of a portable containerized microgrid energy system and the advanced coordination control techniques for the MPP system. The work covered also the development of an Energy Management System for the adaptive hybrid grid module to run as a standalone system or to run, in conjunction with a family of modules to form a MPP.

South Korea: *Development of management system for DC distribution and DC MicroGrid* (2017-2018)

The collaboration focuses on aspects of customer interfaces in DC distribution systems. This will specifically include management of local DC microgrids enabling islanded operation, smart metering technologies, demand response strategies and customer-level user interfaces. Such DC microgrids will integrate small-scale generation, energy storages, controllable loads, EV charging and other smart grid technologies. The research will be closely applying ICT solutions such as communication technologies or data management. The overall objective is to define the technical concepts feasible for integrating customers in DC distribution.

2.1.7 IPE INCO activities: The ERANet-LAC Second Joint Transnational Call

As a result of the joint workshop organized in Florianópolis (Brazil) on November 2015 between ELECTRA and the Institute for Systems and Computer Engineering, Research and Development of Brazil (INESC P&D) Brazil [12], IPE applied for the project under the programme project proposals under the ERANet-LAC Second Joint Transnational Call in Research and/or Innovation Projects. The consortium involves Institutions from European and Latin American countries, included Latvia (IPE), Romania, Brazil (INESC Brasil R&D), Chile and Barbados.

The application was evaluated very highly and the consortium received funding for its activities and continues to cooperate.

The funded project aims to develop an ICT platform for sustainable energy ecosystem in smart cities (ITCity) for responding to citizens' needs on new information technologies applications of various energy technologies usage, integrated in an intelligent way within platform area at city level [13]. The general expected results are based on the design of an intelligent ICT platform that will promote energy efficiency initiative in cities and municipalities, will contribute to urban planning and environmental lifestyle, will take part in active power management of energy consumption and will support energy endusers who become active market players. The creation of a platform for the direct communication with the consumer may also play an important role in the development and consolidation of smart cities, supporting the development of innovative services for the electricity market.

Project results will also provide system users with solutions related to smart services and will ensure transparency for efficient use of the available resources related to the multienergy vectors. The newly elaborated intelligent ICT platform will contribute to city energy ecosystem and will improve city services and quality of life at transnational level.

2.2 The synergies between Researchers Exchanges and International Cooperation

ELECTRA Researcher Exchange (REX) is a mobility programme created to support the exchange of smart grid researchers, and the project team have demonstrated to good effect how mobility can provide valuable assistance to INCO goals.

The ELECTRA REX programme was designed to reinforce collaboration between project partners and external collaborators and enhance R&D. The aims was to realise new breakthrough smart grid control solutions, through the initiation, support and enhancement of researcher exchanges between project partners and with external collaborators, and thus developing early career researchers. From its formation at the start of the project, the REX team envisioned an international activity with global reach, and this was reflected in the design of the mobility "products". These are shown in Figure 1, with the "Global exchange" providing the opportunity for exchanges with global collaborators.

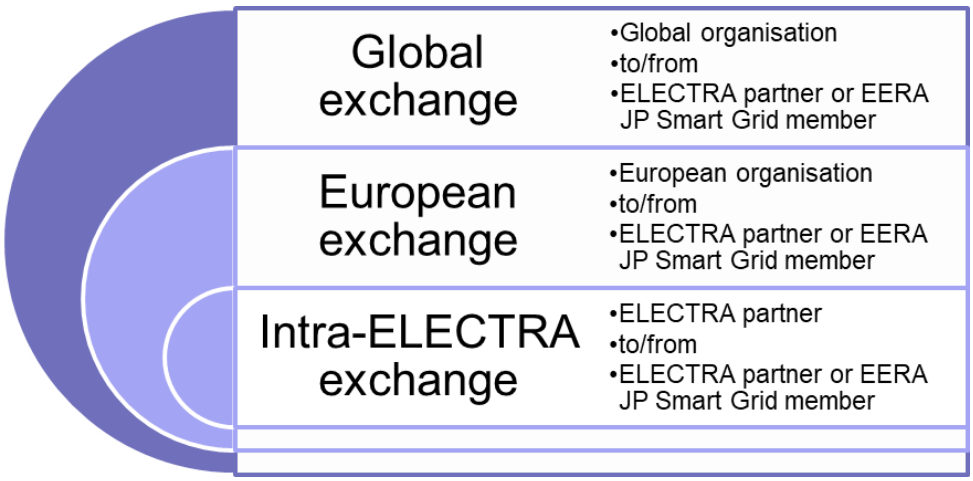


Figure 1 - ELECTRA REX mobility "products"

The inclusion of the Global exchange product has been given high profile by the ELECTRA team as part of their collective INCO effort. The third Call for applications, termed REX Call 3, was in fact reserved exclusively for Global exchanges, in order to be sure to reach the desired audience. This in itself provided a clear statement of intent, and generated good publicity.

The offer of mobility opportunities is an attractive one and, while attracting large numbers of applications has proved difficult, genuine enthusiasm has been stimulated for collaboration. The consortium organised the ELECTRA-Brazil conference in Florianopolis (Brazil) on 11th and 12th November 2015, and the offer to participate in ELECTRA REX Call 3 was useful in drawing researcher interest.

Two Brazilian academics were in fact successful in their applications, and spent time on exchange in USTRATH (UK) and DTU (DK). Co-authored papers have been generated, and a desire to remain engaged and participate in further research projects remains to this day. The offer of researcher mobility is a useful demonstration of openness to international collaboration, that can serve as an attraction to INCO activity, even when individual circumstances might not always support direct participation.

The exchanges successfully commissioned in REX Call 3 are illustrated in Figure 2, while a total of 13 Global exchanges were conducted over the project duration. These encompassed exchanges between ELECTRA/EERA collaborators and research teams in North America, South America, Russia, Asia, and Australasia. In each case, co-authored papers have been produced from the valuable work conducted on exchange, and in some instances new project collaborations commenced that will long-outlast the ELECTRA project and continue to support the EERA Joint Programme's INCO activities.

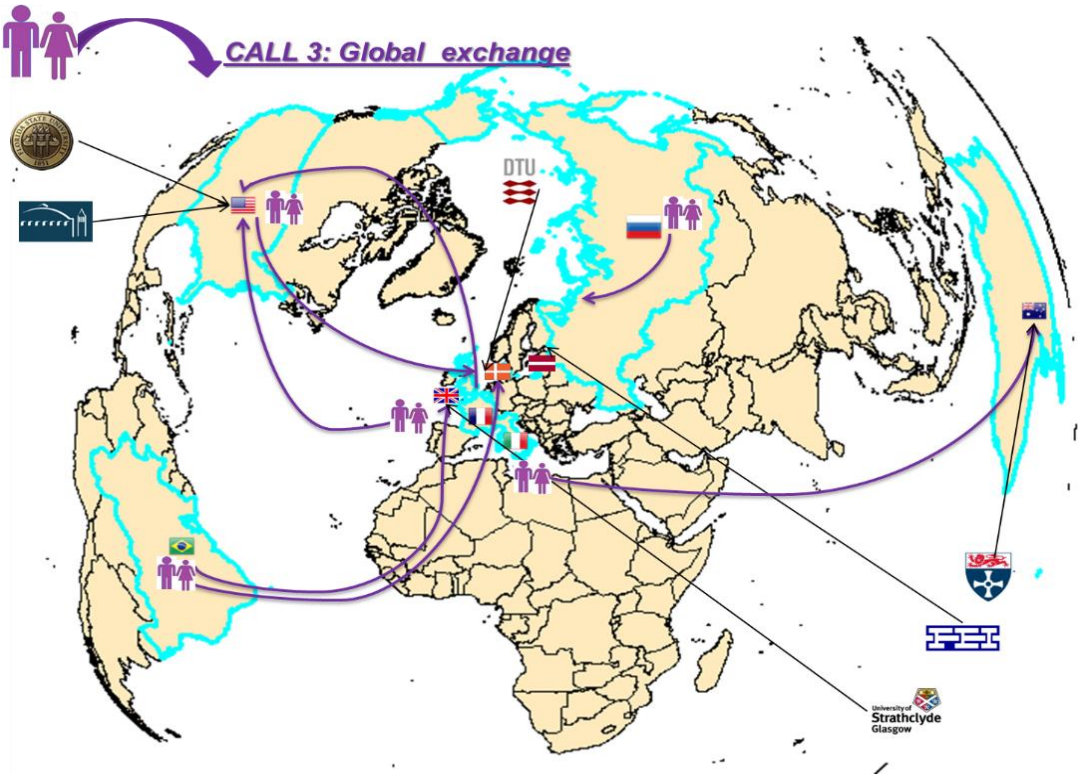


Figure 2 – REX Call 3 global exchanges

3 INCO activities and Mission Innovation Challenge 1

Mission Innovation (MI) is a global initiative that currently involves 22 countries and the European Union to dramatically accelerate global clean energy innovation. As part of the initiative, participating countries have committed to seek to double their governments' clean energy R&D investments over five years, while encouraging greater levels of private sector investment in transformative clean energy technologies. These additional resources will dramatically accelerate the availability of the advanced technologies for a future global energy mix that is clean, affordable and reliable [5]. Mission Innovation was announced on November 30th, 2015 as world leaders met in Paris to undertake ambitious efforts to fight climate changes. At the end of 2016 the following 7 Innovation Challenges have been agreed upon and launched:

1) Smart Grids
2) Off-Grid Access to Electricity
3) Carbon Capture
4) Sustainable Biofuels
5) Converting Sunlight
6) Clean Energy Materials
7) Affordable Heating and Cooling of Buildings.

The Smart Grids Innovation Challenge (IC#1) will support the transition from today's power grid – still strongly based on fossil fuelled power plants - to tomorrow's grid powered by affordable, reliable, decentralised renewable electricity systems able to balance supply and demand at any time, even when primary energy sources are not available. IC#1 aims at developing an improved and shared understanding of main R&D needs and gaps; fostering national research towards jointly identified R&D priorities; promoting opportunities to researchers, innovators and investors from around the world and strengthening and expanding collaboration between key partners, leveraging their complementarity and synergies [5].

IC#1 is co-led by China, India and Italy and involves the following countries: Australia, Brazil, Canada, Denmark, the European Union, Finland, France, Germany, Indonesia, Mexico, Norway, Saudi Arabia, Republic of Korea, Sweden, the Netherlands, the United Kingdom, and the United States [6]. Among the countries involved in IC#1, nine are also involved in the ELECTRA IRP, giving the possibility to leverage on the existing synergies in terms of common topics and participants involved in the activities.

The cooperation among European and non-European countries will allow to tackle common open issues in the smart grids field on a global level and with different approaches and conditions towards a clearer definition and implementation of smart grids.

3.1 Synergies between WP10 and IC#1

As a global initiative, IC#1 can be considered as a way to implement INCO activities in the smart grids field; in fact, the involvement of several countries either in ELECTRA and IC#1 allows to leverage on experiences and lessons learnt and make them available outside the European boundaries, remarking the key role played by Europe in smart grids.

The practical activities of IC#1 have been launched in January 2017. It is noteworthy to highlight that the methodologies and the experiences gained within ELECTRA put the basis for the activities carried out in IC#1. As presented in the following sections, the questionnaire developed for the

identification of potential joint R&D activities in the smart grids field and the set of KPIs defined to monitor the ELECTRA activities allowed to define the methodology adopted also within IC#1.

3.2 First results of IC#1 and ELECTRA team contributions

On 2017 the first relevant results of IC#1 were achieved; in fact, as reported in the following, many relevant achievements were reached:

(1) Launching of a survey on top 10 R&D topics (Questionnaire Q#1);

(2) Launching of a survey to identify energy strategy, main actors and ongoing RD&D projects in IC#1-member countries (Questionnaire Q#2);

(3) Organization of two international deep-dive workshops on IC#1;

(4) Organization of specific meetings involving industries;

(5) Participation to dedicated workshops and meetings with IEA and related TCPs;

(6) Releasing of the Smart Grids Innovation Challenge Country Report 2017 (CR2017);

(7) Definition of the first set of joint R&D tasks to be launched;

(8) Identification of the first set of KPIs to monitor IC#1 activity progress;

(9) Launching of first funding opportunities for joint IC#1 projects.

In summary:

(1) questionnaire #1 (Q#1) was elaborated by ELECTRA based on INCO activities and including ETIP SNET Roadmap 2017-2026 R&D topics challenges. RSE was in charge of the elaboration of the received replies and the definition of the main outcomes (top 10 R&D priorities in the smart grids field);
(3) RSE co-led the two deep-dive workshops organized by IC#1 on 2017 with the strong support by several ELECTRA partners as DTU, SINTEF, and VTT;
(4) initial involvement of industries in IC#1 was obtained by organizing dedicated sessions during the deep-dive workshops in Beijing and New Delhi;
(5) ELECTRA members that are also very active within IEA ISGAN TCP, namely RSE, AIT, DERLab, and TECNALIA, promoted the exchange of information and effective interaction with IC#1;
(6) the IC#1 CR2017 includes contributions from 14 countries (4 continents) with leading role in smart grids; 7 out of the 14 contributions are from European countries and 6 of them from ELECTRA members countries: Italy, Denmark, Finland, France, Germany, and Norway. The collection and incorporation of those contributions was possible thanks to the active role of ELECTRA partners as RSE, DTU, VTT, SINTEF that also fully engaged with colleagues from Sweden whose important contribution was also secured;
(7) after the elaboration of Q#1, ELECTRA partners were instrumental to the definition of the first 6 joint R&D tasks to be launched; moreover, ELECTRA partners as RSE, DTU, and VTT also volunteered to draft the Programme of Work for some of those tasks and to lead them. Being RSE together with US DoE/PNNL leading the Tasks on “New grid architectures” that includes specific work on the Web-of-Cells and related concepts;
(8) on the experience gained in ELECTRA, RSE defined the first set of KPIs to be used to monitor the progress of IC#1 activity. The proposed KPIs have been approved and adopted by IC#1 and also shared with Mission Innovation for the benefit of all the 7 Innovation Challenges;

(9) on this specific aspect European countries are still lacking behind other countries as China, India, and Australia that already launched funding opportunities dedicated to MI and IC#1 members. Apart from a call by EC open to INCO with preference to India, it is worth to mention the Funding Opportunity Announcement (FOA) launched by India and a joint RD&D proposal involving RSE that was successfully passing the first stage evaluation and then submitted to the second stage; final outcomes of the evaluation are still pending.

Some additional details about the performed activity and related achievements are reported in the following.

In the first semester of 2017, IC#1 launched a questionnaire to identify the most important RD&D priorities in the national strategies of IC#1 member countries. The main aim was to agree and then launch IC#1 activities related to the topics that gathered most interest. Each member country and the EC were asked to choose and rank, according to the view of its nation, the ten most relevant "Smart Grid Challenges" among the 44 proposed. The main reference for the elaboration of the questionnaire was the "Final 10-year ETIP SNET R&I roadmap covering 2017-26" released by ETIP SNET (European Technology and Innovation Platform for "Smart Networks for the Energy Transition) on December 2016 [8].

The proposed challenges covered various aspects of the smart grids field and were grouped in the following nine "policy drivers" or areas:

- flexible generation;
- load;
- network infrastructures;
- digitalization of the network (ICT and interoperability);
- network Operators – TSOs (Transmission network);
- network Operators – DSOs (Distribution network);
- technologies;
- interaction with energy system;
- market.

By replying to this questionnaire there was also the possibility to propose additional R&D topics not included within the "Smart Grids Challenges" list. Fifteen countries replied to this questionnaire. Moreover, six of them provided more than one filled in questionnaire (up to 6 replies for a specific country) for a total of 35 replies; four countries suggested extra R&D topics. Averaging all the responses the top ten relevant challenges were identified. For the countries that provided more than one feedback it was taken into account the average of their replies, in this way all counties had the same weight on the final ranking.

Beside the ranking of the challenges, in the questionnaire Q#1 it was asked the willingness to participate and/or to lead the possible future R&D Tasks that could be launched based on the selected top challenge topics (10 = the Highest and 1 = the Lowest). In addition responders had the opportunity to specify the preferred way of collaboration, ranging from sharing available information till the launch of joint cooperative RD&D projects.

The elaboration of the replies received from IC#1 members allowed the identification of a set of smart grids priorities (6) to be further analysed in the next years, as a practical example of international cooperation among the interested countries towards the MI goals.

In Figure 3 the priorities that will be further analysed within IC#1 are highlighted in green; the initial focus will be on storage integration, demand response, electricity highways, flexibility options, new grid architectures and power electronics.

MISSION INNOVATION
Accelerating the Clean Energy Revolution

Top 10

	Smart Grid Tasks	Further Details
10	Improve storage integration at all time scales (in operation for system services but also when performing planning studies as an additional degree of freedom) as a source of flexibility	Integration of storage in network management
9	Use of demand response for system services with well-defined interactions among market players and network operators (and TSO-DSO exchange of information)	Grid observability, demand response
8	Developing regional electricity highways with both AC and DC technologies	New materials and technologies, grid controllability, flexible grid use
7	New planning tools able to account for the full complexity of electricity networks (distributed and intermittent generation, variable and controllable loads, power electronics, storage)	Optimal grid design New planning approaches and tools
6	Identify and support improvements of suitable flexibility options (RES generation, flexible thermal power generation, load, network, storage, integration with other energy network) to ensure adequacy and security	Storage integration, demand response, flexible grid use, interaction with non-electrical energy networks, flexible thermal power generation; Active demand response to automation and control of MV network, flexible decentralized thermal power generation
5	Study and demonstrate new grid architectures both at transmission and distribution level as a source of flexibility	Optimal grid design, flexible grid use
4	Optimizing the existing assets and the network capacity making use of new technologies	Smart asset management, new materials and technologies
3	Improve the accuracy of the generation forecast	RES forecast; DSO integration of small DER, monitoring and control of LV network, automation and control of MV network
2	Optimization of the energy system	Integration with other energy networks
1	Novel / advanced power electronics technology for improving efficiency and controllability of smart grids	Power electronic devices for power systems

Figure 3 – R&D priorities on smart grids identified by IC#1

A comparison between the smart grids priorities identified by ELECTRA and by IC#1 highlights the existence of common aspects. As outlined in Table 1 the correspondence between the smart grids priorities identified by IC#1 and ELECTRA is evident. Of paramount importance for ELECTRA is the Task #6 related to new grid architectures that allow for a clear and strong link with the “Web-of-Cells” concept developed by ELECTRA.

Table 1 – Correspondence between ELECTRA and IC#1 priorities on smart grids

#	IC#1 Tasks	Further details	Link with ELECTRA priorities
1	Improve storage integration at all time scales (in operation for system services but also when performing planning studies as an additional degree of freedom) as a source of flexibility	Integration of storage in network management	Electrical storage integration

#	IC#1 Tasks	Further details	Link with ELECTRA priorities
2	Use of demand response for system services with well-defined interactions among market players and network operators (and TSO-DSO exchange of information)	Grid observability, demand response	
3	Developing regional electricity highways with both AC and DC technologies	New materials and technologies, grid controllability, flexible grid use	Transmission and distribution systems planning
4	New planning tools able to account for the full complexity of electricity networks (distributed and intermittent generation, variable and controllable loads, power electronics, storage)	Optimal grid design New planning approaches and tools	Transmission and distribution systems planning
5	Identify and support improvements of suitable flexibility options (RES generation, flexible thermal power generation, load, network, storage, integration with other energy network) to ensure adequacy and security	Storage integration, demand response, flexible grid use, interaction with non-electrical energy networks, flexible thermal power generation; Active demand response to automation and control of MV network, flexible decentralized thermal power generation	Grid flexibility
6	Study and demonstrate new grid architectures both at transmission and distribution level as a source of flexibility	Optimal grid design, flexible grid use	Web-of-Cells, new grid architectures
7	Optimizing the existing assets and the network capacity making use of new technologies	Smart asset management, new materials and technologies	
8	Improve the accuracy of the generation forecast	RES forecast; DSO integration of small DER, monitoring and control of LV network, automation and control of MV network	Forecasts of generation and consumption
9	Optimization of the energy system	Integration with other energy networks	
10	New materials and technologies to increase the flexibility of the grid	New materials and technologies	
11	Novel/advanced power electronics technology for improving efficiency and controllability of smart grids		

The second questionnaire (Q#2) aimed to collect national specific information including the energy strategy, main actors and ongoing RD&D programmes and projects of IC#1 countries. Eleven countries, replied to the questionnaire thus providing a broad view on their recent past, present and future R&D activities and strategy. The information collected by Q#2 put the basis of the country contributions reported in the IC#1 CR2017.

The activity and related actions to be performed were agreed during web meetings and dedicated calls among co-leads and IC#1 representatives; however, in several occasions national and general workshops have been organized to exchange views and to discuss how to proceed. In particular, during the first IC#1 deep-dive workshop held from 6th to 8th June 2017 in Beijing, as a side event of CEM8 (Clean Energy Ministerial) and MI-2 (Second Mission Innovation Ministerial) the results of Q#1 and Q#2 were presented and discussed as well as the set of KPIs to be adopted.

With the presence of representatives from 12 member countries, the European Commission, the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA) and Austria as an observer, this workshop was a great success. In fact, it enabled experts from around the world who are active contributors in the smart grids area to discuss and exchange in-depth experiences and insights on smart grids development in future energy systems, sharing best practices, addressing common issues and focusing on future work thus exploring a new frontier in collaboration. It is noteworthy to highlight that IC#1 was the very first Challenge to organize a dedicated workshop, highlighting the positive collaborating environment existing among the involved members.

By the active participation and discussion of all representatives the so called "*Beijing Consensus*" was agreed and signed by all representatives. This Consensus document, which states the objectives of MI IC#1, identifies the selected four sub-challenges on smart grids, confirms the near term deliverables and promises to strengthen collaborative network among all member countries. The Consensus was signed by the Deputy Ministers of the co-leading countries (China, India and Italy), witnessing the strong commitment on this initiative by all the participating countries. In fact, after the 2-day closed-door meeting, on June 6th IC#1 organized a public event at the China National Convention Centre (CNCC) as side event of CEM8 & MI-2 that was attended by more than 150 delegates from about 20 countries and international organizations as IEA, IRENA, WEF, universities, research institutes and enterprises.

The two main overarching goals of this event were publicly announced: accelerating clean energy revolution towards the road on 100% renewable energy and enabling future grids that will be powered by affordable, reliable, decentralized renewable electricity systems.

The public event also included three panel discussions focusing on strategies and plans, R&D challenges and business opportunities for smart grids, providing to worldwide representatives from governments, funding agencies, business leaders and experts. The invited experts brought their knowledge and perspective on the importance of public investment for innovation and the ways that the public and private sectors can engage more productively.

For what concerns with the industry sector, this event allowed the participants to share their innovative smart grids and clean energy technologies, products, and business models and to express their strong interest and willingness to support possible research and other activities.

Figure 4 – First IC#1 deep-dive workshop in Beijing on June 6th, 2017: IC#1 "*Beijing Consensus*" signature by Ministers from co-leading countries (left) and panel session 1 with representatives from IEA, EC, US DoE and the Swedish Smart Grid Forum (right)

A second IC#1 deep-dive workshop was held from 16th to 19th November 2017 in New Delhi. This workshop that spanned over three days, included a two-day closed door technical brainstorming session on the ongoing IC#1 activities, whereas the third day was organized as an open public event. A technical expo was also organized on the third day to showcase some of the national & bilateral research development & demonstration programmes on smart grids supported by the government of India along with industry participation.

In summary, the main deliverables and outcomes from the second IC#1 workshop are reported in the following:

- *New Delhi Declaration* on IC#1 present and future strategy and specific activity agreed, signed and released thus further consolidating the IC#1 team;
- official release of IC#1 Country Report 2017;
- agreement on the first R&D Tasks to be launched by early 2018 with the definition of involved countries as leaders and contributors;
- bilateral collaboration agreements officially signed (India with UK, US, Italy);
- Announcement of next IC#1 workshop.

It is important to highlight that till now the ELECTRA website has been used as the only repository for all the public documents released by IC#1; this is the case for example for the 1st and 2nd deep-dive workshop agenda and documents, but also for the CR2017 released in November 2017 with more than 110 downloads. Moreover, the ELECTRA website provides IC#1 also with reserved areas for co-leads and for members where relevant information (e.g. country representatives name and affiliation, mailing list etc.) and working documents are stored.

Figure 5 – ELECTRA website repository and working space dedicated to MI and IC#1

In addition to the two international IC#1 deep-dive workshops, preparatory work under the Challenge has been undertaken both remotely and by means of dedicated meetings and workshops organized either with the IEA (International Energy Agency) or at national level.

In particular IEA organized an international workshop on February 2017 in Paris "*Maximising the impact of IEA Technology Collaboration Programmes (TCPs): opportunities of collaboration under Mission Innovation*". This workshop aimed at providing a valuable opportunity for a selection of TCPs to brainstorm with representatives of MI countries, CERT Delegates, and the Building Coordination Group under the IEA Working Party on End-Use Technologies on possible synergies, ways to strengthen collaboration, and strategic directions. Recognising that it would have been impractical to seek to address all Innovation Challenges in one event only, the scope of the workshop was limited to exploring synergies with TCPs whose activities are most relevant to the following two Innovation Challenges: (i) Affordable Heating and Cooling of Buildings; and (ii) Smart Grids. During this workshop the IC#1 co-leads from China, India and Italy had the opportunity for the first time to meet with the chair or a key representative from relevant TCPs and in particular from:

- TCP on Smart Grids (ISGAN TCP);
- TCP on Demand-Side Management (DSM TCP);
- TCP on Hybrid and Electric Vehicles (HEV TCP).

The fruitful following round table also involved representatives from industry thus to also collect inputs and perspectives from the private sector.

An EERA JP SG / ELECTRA international workshop on International Cooperation was organized on April 4th, 2017 hosted by EC JRC in Ispra (IT). This workshop constituted a great opportunity to get an overview on energy strategies and ongoing smart grid and RES integration programmes in the USA and China. IC#1 co-leads from China, India and Italy that attended this workshop either physically or by videoconference. They had the opportunity to engage into discussion with EERA JP SG representatives and to receive specific information about ELECTRA – in particular research infrastructures, REX and INCO, and on key smart grids related aspects as interoperability, PV performance and deployment, and EMC testing of electric and hybrid-electric vehicles.

Moreover, in Italy and India two national events were organized, involving ministry representatives, industries and research centres with the goal to disseminate approach and results of IC#1 and to collect suggestions on strategy and next steps from the involved parties.

The Indian workshop held in May 2017 in New Delhi allowed the Indian colleagues to agree on their national smart grids R&D priorities; the outcomes of this workshop was used by India to fill in Questionnaires #1 and #2 in preparation of the first deep-dive workshop discussion.

On the contrary, the Italian national event was organized in September 2017 in order to share with national relevant stakeholders information about IC#1 strategy, first achievements and to openly discuss and agree on the foreseen future steps. This event hosted by GSE in Rome got the full support from the Italian Ministry of Economic Development (MiSE) that acknowledged the very positive first achievements of IC#1. Speakers at this event included EC representative and the scientific advisors of the Chinese and Indian Embassies. Moreover, during a dedicated round table, Italian representatives from utilities (i.e. TERNA and ENEL Distribuzione) as well as from manufacturers associations, test and consulting companies, and MiSE discussed on very relevant aspects related to the Italian participation to MI. A specific focus was dedicated to the Italian contribution to IC#1 being smart grids a field where Italy, owing to the deep experience from the very high RES grid integration, has broad knowledge and specific technical solutions to recommend.

3.3 Highlights of additional MI IC#1 related activities

Some of the additional MI IC#1 related activities performed in 2017 with the strong support or leveraging previous ELECTRA experiences are briefly summarized in the following.

Key Performance Indicators

Starting from the ELECTRA experience presented in Section 2, IC#1 defined a set of KPIs to periodically monitor how the Challenge activity is progressing.

IC#1 is the first Challenge who developed a set of KPIs, stimulating the interest of the MI Secretariat, that is interested in sharing this as an input to MI at large, in standardizing metrics across the 7 Challenges and in increasing their international exposure.

In particular, IC#1 defined fifteen KPIs grouped in five categories:

1) endorsement by MI countries/organizations;
2) impact and outcomes;
3) external engagement and BIE (Business and Investors Engagement);
4) dissemination and public visibility;
5) new funding allocation.

The first category aims to measure how the countries are involved in IC#1 by means of organizations, experts, information exchanges and technical visits. The impact and outcomes category instead evaluates the IC#1 activities in terms of identified priorities in smart grids (see Q#1), launched joint R&D tasks and countries involved in these activities. In order to succeed in the MI overall goals, IC#1 will periodically monitor also the external and business and investors engagement. In order to disseminate the IC#1 achievements and purposes, a specific focus will be on the dissemination and public visibility, in terms of meetings and events organized, papers issued and newsletters and website statistics. Finally, IC#1 will monitor also the funding allocation of the involved countries towards the MI goal (i.e. doubling the their public clean energy R&D investment over five years).

New Funding opportunities

In this regard, to achieve the MI objectives in fighting the climate change one of the goal for the involved countries is the to dramatically accelerate global clean energy innovation. As part of the initiative, participating countries committed to seek to double their governments' clean energy research and development (R&D) investments over five years [5]. In this frame, some of the involved countries already launched funding opportunity related to smart grids: Australia ([9]), India ([10]), Norway and Mexico and other countries are in the process to do the same.

Increasing IC#1 country membership

Finally, the success of IC#1 is increasing the interest worldwide, allowing the already involved countries to boost their involvement and to "recruit" new countries. Currently, further countries are in the process to officially join IC#1, highlighting the interest on smart grids as a viable "instrument" to fight the climate change at worldwide level.

3.4 Agreed IC#1 activity and next steps

Since the beginning of 2017, the continuous interaction among IC#1 members allowed to make an action plan for the next future. Among the IC#1 activities, i) the continuous networking opportunities among experts, policy makers and all the interested parties, ii) the information exchange of national plans and progress made and iii) the developing opportunities to strengthen collaboration between innovators and to boost private sector engagement will be considered.

The 3rd IC#1 deep-dive workshop will be held from 20th to 22nd May 2018 in Copenhagen and Malmö, Denmark. As for the first workshop, on the 22nd of May IC#1 will have the opportunity to make a side event to the CEM9 (Ninth Clean Energy Ministerial) and MI-3 (Third Mission Innovation Ministerial). The event will bring together international experts for a technical discussion on smart grids main challenges and it will be the opportunity to disseminate the IC#1 activities and have open discussions on smart grid aspects, involving key stakeholders for discussing and contributing on smart grids innovation.

Among the most relevant aspects that will be considered in this workshop there will be the opportunity to officially launch the six identified tasks. The official launch is of paramount importance since it is the very first tangible step for Mission Innovation and IC#1 in particular to move towards the claimed clean energy revolution.

The launch will also be a signal for those countries who are not fully engaged in IC#1 and for those not involved in IC#1 yet, giving the chance to reinforce the team with additional expertise in the smart grid field.

On 2018 IC#1 will also officially launch its service platform, moving from the temporary space made available from the ELECTRA website. In this regard, in addition to the contributions expected from co-leading countries, RSE as Italy already provided its contribution, by putting the basis for the service platform. The service platform will be publicly available by the end of the first semester of 2018.

In addition to the six tasks to be launched in the first semester of 2018, IC#1 aims to launch additional tasks, by choosing among those already identified through the questionnaire Q#1 (Figure 3).

In order to keep monitored the status of the activities, IC#1 will also be periodically monitored by means of the KPIs presented in the previous section. The monitoring will allow to identify the

strengths and weaknesses of the Challenge in order to put in place an action plan in order to succeed in the achievement of the Mission Innovation's purposes.

By the end of 2018 the fourth IC#1 deep-vive workshop will be organized, allowing to push forward IC#1 activities and to strength the cooperation among the members.

Further collaboration on Smart grids innovation beyond 2020 will likely be needed to realise the objectives for 2030. The role of this Mission Innovation Challenge will be reviewed in 2019.

4 Conclusions

The potential of International Collaboration (INCO) for the definition of smart grids solutions applicable to different power systems is among the most important levers for the worldwide development and harmonization of the smart grid concept.

In this frame, the aim is to launch effective INCO activities on specific topic by country in the smart grids field and to leverage on the synergies between ELECTRA and Mission Innovation Challenge 1 (IC#1).

The deliverable D10.4 provides an overview on i) the INCO activities implemented in ELECTRA, ii) the link with the researchers exchanged of WP9, iii) the synergies with Mission Innovation (MI).

Some ELECTRA members provided examples of INCO in place in the ELECTRA period in the smart grids field, giving an overview on how they collaborate with extra-European institutions.

Among the tools for the implementation of INCO activities, the researchers exchange (REX) allowed ELECTRA members to address issues related to smart grids with extra-European institutions. In particular, the third REX call was dedicated to global exchanges, allowing researchers to collaborate on specific smart grids issues. The results of these exchanges were presented in technical papers and presented to international conferences.

The activities carried out provided important input to Innovation Challenge IC#1 on smart grids, where Europe plays a relevant role due to the commitment of nine countries and the European Commission.

The ELECTRA IRP put the bases for the identification of the most relevant R&D priorities in the smart grids field and for the periodical monitoring of the Challenge. In particular, ELECTRA defined a methodology for the identification of the R&D priorities on smart grids at worldwide level. The methodology was taken as reference and improved with the contents of the “Final 10 Year ETIP-SNET R&I Roadmap covering 2017-26” released by ETIP SNET on December 2016, defining the first questionnaire of IC#1, available on the ELECTRA website [1].

The identification of the most interesting ten R&D priorities in the smart grids field gives the opportunity to IC#1 to launch six tasks that will involve institutions from all over the world. Among the six tasks to be launched on 2018, one will specifically focus on new grid architecture for future power systems. In this frame, the Web-of-Cell concept defined by ELECTRA may be further investigated.

In addition, IC#1 defined a set of KPIs to periodically monitor the success of the Challenge. The set of KPIs took as reference the outcomes of ELECTRA, highlighting the importance of the work carried out in those WPs.

IC#1 can be considered as an example of International Cooperation on smart grids: the involvement of eight European countries and the European Commission either in ELECTRA and IC#1 gives the opportunity to make grow the Web-of-Cell concept defined in ELECTRA either under the technical and the international cooperation point of view.

Finally, IC#1 will allow continuous networking opportunities and information exchanges among experts, policy makers and all the interested parties, to strength the collaboration among innovators in a view to boost the private sector engagement.

5 References

[1] http://www.electrairp.eu
[2] ELECTRA D10.1 “List of mutually interesting R&D topics and prioritization by country of R&D topics to be jointly addressed – Phase I”
[3] ELECTRA D10.2 “Report on common interesting R&D topics for INCO with BRICS countries”
[4] ELECTRA D10.3 “List of mutually interesting R&D topics and prioritization by country of R&D topics to be jointly addressed – Final Report”
[5] http://mission-innovation.net
[6] Mission Innovation Challenge IC#1 – Progress Summary
[7] Mission Innovation Challenge IC#1 – Smart Grids Innovation Challenge Country Report 2017
[8] ETIP SNET “Final 10 Year ETIP-SNET R&I Roadmap covering 2017-26”, December 2016.
[9] http://minister.industry.gov.au/ministers/sinodinos/media-releases/australia-and-china-sharing-research-and-innovation
[10] http://mission-innovation.net/2017/07/27/india-funding-opps-smart-grids-off-grid-access/
[11] http://www.iea-isgan.org/
[12] http://www.electrairp.eu/index.php?option=com_content&view=article&id=306:joint-brazilian-electra-smart-grids-workshop-towards-international-cooperation&catid=48&Itemid=233
[13] http://fei-web.lv/en/itcity

6 Disclaimer

The ELECTRA project is co-funded by the European Commission under the 7th Framework Programme 2013.

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

The European Commission is not responsible for any use that may be made of the information contained therein.