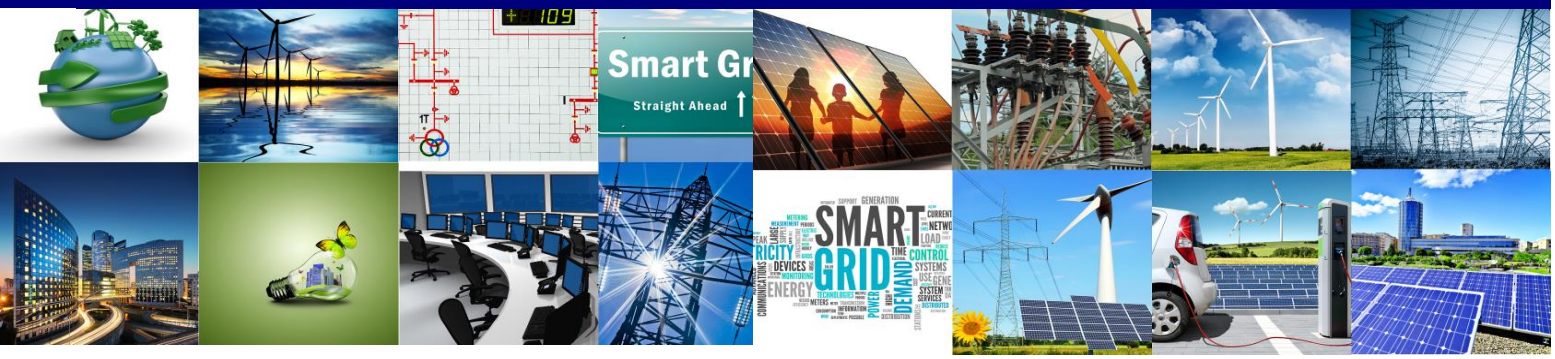
Project No. 609687

FP7-ENERGY-2013-IRP

ELECTRA

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



WP 10

Actions on International Cooperation

Definition of R&D topics of mutual interest for INCO activities with B.R.I.C.S and Developing Countries

Deliverable 10.2

Report on common interesting R&D topics for INCO with BRICS countries

11/01/2016

ID&Title	**D10.2** Report on common interesting R&D topics for INCO with BRICS countries	**Number of pages:**	25

Short description (Max. 50 words):

This deliverable outlines the common interesting R&D topics for INCO with B.R.I.C.S countries. Future collaborative actions are suggested.

Version	Date	Modification's nature
V0.1	28/09/2015	First Draft
V0.02	16/11/2015	Revised Draft
V0.03	01/12/2015	Final Draft
V1.00	01/12/2015	Under review
V2.00	11/01/2016	Released

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Executive summary

ELECTRA is an Integrated Research Programme IRP that supports networking 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.

The objective of task T10.5 is to develop a plan of activities for international collaboration (INCO) with B.R.I.C.S countries within the activity areas of ELECTRA and EERA Joint Programme on Smart Grids (JP SG) 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 areas and to contribute to a closer integration of the research programmes of the participating organisations.

This deliverable outlines the common interesting R&D topics for International Cooperation (INCO) with B.R.I.C.S countries. Future collaborative actions like e.g. workshops are suggested.

The plan of activities has been developed for international collaboration with B.R.I.C.S. countries based on the research topics covered by DoW of ELECTRA and EERA JP SG.

This is mainly in the area of power system management where different aspects attract common interest. Also different topics within transmission networks and research infrastructures are common interests for several of the B.R.I.C.S. countries.

The suggested types of actions may be taken into account in future workshops, projects and collaborations.

The plan of activities for the B.R.I.C.S countries will be further aligned with the similar plan for the INCO activities that will be reported in D10.3 (to be issued at month 30) and that considers extra-EU countries other than B.R.I.C.S.. It is noted that several of the topics are of common interest and that the types of activities also are similar. It is thus proposed that the ELECTRA effort is concentrated on these topics initially so that maximum effect is obtained.

Terminologies

Definitions

B.R.I.C.S.	Brazil Russia India China South Africa
INCO	International Cooperation

Abbreviations

D	Deliverable
DoW	Description of Work
EERA	European Energy Research Alliance
JP	Joint Programme
MS	Milestone
R	Internal Report
R&D	Research and Development
SG	Smart Grids
SP	Sub Programme
WP	Work Package

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1 Introduction

The objective of task T10.5 is to develop a plan of activities for international collaboration (INCO) between ELECTRA participants and B.R.I.C.S countries within the activity areas of ELECTRA and EERA JP SG. 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 areas and to contribute to a closer integration of the research programmes of the participating organisations.

The INCO activities described and carried out as part of WP10 of ELECTRA promotes international collaboration with extra-EU countries in general but also has a special emphasis in B.R.I.C.S countries.

This deliverable presents such a plan based on the interaction with B.R.I.C.S. partners through a questionnaire that contains a list of mutually interesting R&D topics and prioritization by country of R&D topics. Future collaborative actions are suggested.

In chapter 2 the methodology used to complete the suggested action plan is described. The analysis consists of gathering input data, categorization of interesting R&D topics and prioritization per geographical region or country. Furthermore the methodology used to suggest and select the appropriate types of action is described. For information it can be mentioned that the same methodology for collecting and prioritizing interesting R&D topics is also applied for extra-EU countries other than B.R.I.C.S. and will be separately reported in deliverable D10.3. In chapter 3 a list of prioritized R&D topics per county within B.R.I.C.S is outlined.

In chapter 4 the prioritisation for each B.R.I.C.S. country is aligned with the interest of INCO for extra-EU countries and a suggestion for type of action is presented.

2 Methodology

2.1 Overall description of the methodology

The process for collecting and gathering of the interesting R&D topics for countries outside EU and for B.R.I.C.S. countries has been divided into two steps. The same methodology has been applied for B.R.I.C.S and for other extra-EU countries hence the methodology will be described in the same way in deliverable D10.3 for INCO.

At the first stage, information has been collected via first interaction with external countries. The first interaction was based on international meetings, workshops and conferences. The results of this first interaction are presented in Deliverable D10.1 [2].

To expand the detail level of the input data and to get a more in depth picture of the geographical differences the second step was initiated. In the second step, a detailed questionnaire has been prepared and sent out to B.R.I.C.S. contacts (see Annex A. Answers to questionnaire from external contacts). This questionnaire was prepared so that the R&D topics are easily categorized and ways of interaction easily identified. The questionnaire was sent out by the partners to their collaboration contacts in extra-EU countries and B.R.I.C.S. countries. Answers from the first interactions from D10.1 [2] have also been mapped into the questionnaire.

Topics of interest are categorized according to the setup in the questionnaire.

2.2 Connection with EERA Joint Programme on Smart Grids

As outlined in the DoW the ELECTRA activity plan should be aligned with the activities of the EERA Joint Programme. Therefore the questionnaire for ELECTRA is prepared with R&D topics divided into the same categories as the Sub Programmes of EERA Joint Programme. The categories are presented in the Table 2-1 below.

Table 2-1 – Categories of EERA JP Sub-Programmes

SP no.	Sub Programme title
1	Network Operation
2	Power System Management
3	SG ICT and Control Systems Interoperability
4	Electrical Storage Integration
5	Transmission Networks

There is a particular emphasis on the topics that are also being researched in ELECTRA.

2.3 Data input from the initial contact

The result of the first interaction for collection of R&D topics is summarized in D10.1 [2]. The table from D10.1 is repeated below in Table 2-2.

Table 2-2Table 2-2 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 topic 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. This table is taken as a starting point for our analysis. Specifically it can be noted that, for all the B.R.I.C.S. countries, at least one topic of common interest has been identified.

Table 2-2 – 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	-

Country	Smart Grids R&D Topics	Importance	Notes / Possible links to EERA JP SG ELECTRA activities
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
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	-

2.4 Data input to the questionnaire

To expand the detail level and to be able to enhance the prioritization per geographical region/country and to develop it into a plan of activities a questionnaire has been prepared.

The questionnaire was based on the same categories as used in the EERA Joint Programme/Sub-Programme (see chapter 0). Each of the SP categories is divided into sub-topics. In this way it might be easier for the respondents to identify their preferences. However not all relevant R&D

topics could be covered by the JP SP categories, and therefore extra categories has been added to the questionnaire, see Table 2-3.

The first added category is: Research infrastructure, lab facilities and testing. The second added category is: Other topics, meant for topics that are not covered by the other suggested categories. In excess of the two added categories the questionnaire also gives possibility for the respondent to suggest up to two other topics, in case their priorities are not met in the already suggested topics. The categories are therefore extended with the following categories, as listed in Table 2-3 below.

Table 2-3 – Additional categories in the questionnaire

Research infrastructure, lab facilities and testing
Other Topics
Suggested Topics

For each category specific R&D topics are suggested. For example, for the category ”Research infrastructure, lab facilities and testing” the following topics are indicated: Lab Validation Proof of Concept, Laboratory Testing, Research Infrastructures, Research Facility, Use Cases methodology.

Furthermore, the questionnaire asks the respondents what type of action they prefer for the selected topic. The answer of this will indicate at what level the respondent is willing to interact and collaborate for the specific topics. The types of action preferred are listed in Table 2-4 below.

Table 2-4 – Types of action preferred

Workshops
Conference side events
Researcher exchange
International collaboration fora
Joint proposals
Joint projects
Summer schools
Joint publications
Joint use of international research infrastructures

The answers to the questionnaire are attached as annex to this report in “Annex A. Answers to questionnaire from external contacts”. From this annex the priorities from the different organisations can be seen.

The list of persons who has received the questionnaire is seen from Annex B.

3 List of prioritized R&D topics by country

The R&D topics of interest are reported in Table 3-1 below. The ranking is based on “1” as the lowest priority and “5” as the highest priority. The data input is from the initial contact and answers from the questionnaire that was sent out to B.R.I.C.S. contacts. The analysis is based on answers from the results from the initial contacts where all B.R.I.C.S. countries are represented and answers to the questionnaire. The responses to the questionnaire are from Brazil, CEPEL - CENTRO DE PESQUISAS DE ENERGIA ELÉTRICA, (Research institution), India Smart Grid Forum(Public Private Partnership of Ministry of Power, Government of India), China, Zhejiang University and China, Biejing Jiaotong University. Although the number of answers to questionnaire is not too large, nevertheless some important indications can be obtained.

In “Annex A. Answers to questionnaire from external contacts” the priorities from the different organisations can be seen in detail.

The structure of the questionnaire is used to categorize the topics from the initial contact, so they can be mapped into EERA categories; moreover it matches the categories used for the extra-EU countries as described in Deliverable D10.3 (to be issued month 30).

Table 3-1 – R&D topics per country

Category	Smart Grid R&D topic	Country	Ranking
Network Operation	Dynamic Control Schemes	India	4
	Dynamic System Resilience	Russia	3
	Distribution System Planning	India	5
	System stability	Brazil	5
	Microgrid control	China	4
Power system management	Control concepts	South Africa	3
	Scenarios and trends	China	2
	Control room functions	Brazil	3
	Supervisory Grid observability needs	India	5
	Grid architecture	India	5
	Grid flexibility	Brazil	3
	Market design	India	2
	Energy market and business models	Russia	1
		China	5
		South Africa	5
	Power system operation	Brazil	3
	Forecasts of generation and consumption	India	5
		China	1
	Smart Grid data mining	Brazil*	2 and 3

Category	Smart Grid R&D topic	Country	Ranking
		India	4
	Demand Response	China	4
SG ICT and Control Systems Interoperability	Standards	China	3
	Security issues	Brazil	This topic will gain importance in a few years, but is not yet among the top 5.
Electrical storage integration	Integration of EV into the grid	China	2 and 5
	Storage systems integration	China	3
Transmission networks	Wide area grid observability needs	Brazil	3
	Interarea Control Schemes	China	5
	Transmission grid architecture	China	5
	Transmission system planning	China	5
		Brazil	4
		South Africa	3
		India	5
	Integrating Control Schemes	Brazil	5
Research infrastructure, lab facilities and testing	Laboratory testing	China	1
	Research infrastructures	India	4
		Brazil**	1
	Use cases methodology	India	4
Other topics	System reliability and use of distribution management systems	India	5

*Brazil: Important topic, on which we have almost no experience yet.
**Brazil: Some SG labs are being created in Brazil. The potential for joint work is significant.

It appears that the research priorities differ from country to country. However, there are some common topics of interest. This is mainly in the area of 'Network Operation' and 'Power System Management' where different aspects attract common interest. Different topics within 'Transmission Networks' are also of common interest for B.R.I.C.S. countries – especially transmission system planning is common interest for several B.R.I.C.S. countries.

'Research infrastructure, lab facilities and testing' is a priority topic for Brazil, China and India.

China is the only country within B.R.I.C.S. who has indicated interests within the categories 'SG ICT and Control Systems Interoperability' and 'Electrical storage integration'. However Brazil comments that security issues is expected to be prioritized in the coming years.

4 Proposed activity plan

The common interesting R&D topics for INCO with B.R.I.C.S countries are presented in Table 4-1 as well as a suggested activity plan. Based on the suggested activity plan a list of activities is recommended. The common interest with extra-EU countries is based on the answers in D10.1 [2] and the answers received so far from the extra-EU countries (to be reported in D10.3 month 30).

Table 4-1 – Suggested activity plan

Category	Common interest between B.R.I.C.S. and extra-EU countries	Action Types preferred								Suggested activities
		Workshops	Conference side events	Researcher exchange	International collaboration fora	Joint proposals	Joint projects	Summer schools	Joint publications	Joint use of international research infrastructures	
Network Operation	Brazil, Russia, India – common interest with USA, Australia and other large power systems			x		x	x			x	Russia has indicated interest in network reliability and fault detection and clearing. India in distribution system planning. Brazil in all topics within system stability. This seems similar to the interests of USA and Australia and large power systems where a workshop with the following topics is suggested: • Distribution system planning • Distribution system resilience and reliability • System stability Workshops might lead to common projects of interest and eventually joint use of international laboratory infrastructure where relevant.
	China – common interest with Singapore and	x								x	China has indicated interest in microgrid control. This could be aligned with Korea and Singapore where a workshop

	Korea									is suggested covering the topics: • Potential for microgrids • Frequency control • Voltage control
	India – no extra-EU countries have indicated this topic	x				x	x			x	Dynamic Control Schemes
Power system management	South Africa – common interest with USA and Asia	x	x	x	x				x		• Control concepts and control room functions • Distribution management systems • Distribution network reliability • Impact on network management with variable generation Action types could be many. Collaboration may initiated by a workshop or conference side event, where other types of activities can be agreed and developed.
	South Africa, China and Russia – common interest with USA and Asia	x		x	x	x					Topic on energy markets and business models might be included in the above suggested cooperation.
	China and India – common interest with Jordan	x		x	x	x	x			x	Forecasts of generation and consumption. Many action types are suggested.
	China, India and Brazil - none of the extra-EU countries have indicated these topics as priorities.	x	x		x		x	x	x		Topics of interest • Scenarios and trends • Supervisory Grid observability needs • T&D losses • Smart metering • T&D system efficiency • Network automation • Distribution management systems • Voltage control • Smart grid data mining Action types could be many. Collaboration may be initiated by a workshop or conference side event, where other types of activities can be agreed and

										developed.
	China common interest with Singapore and Japan	x			x	x				Demand response
SG ICT and Control Systems Interoperability	China – no extra-EU has indicated interest in this topic	x	x		x					Standards
Electrical storage integration	China common interest with Singapore and Jordan	x		x	x	x	x		x	x	The topic of integration of EV into the grid as well as storage systems integration is of common interest, many suggested types of actions.
Transmission networks	India common interest with Singapore									Transmission grid architecture including transmission adequacy and HVDC.
	Brazil, India and South Africa common interest with USA				x		x	x		x	Transmission system planning including renewables integration, generation adequacy and security issues
	Brazil – no extra-EU has prioritized these topics									Wide area grid observability needs and Integrating Control Schemes. These topics have not been prioritized and no actions are suggested.
	China – no extra-EU has prioritized these topics									Interarea Control Schemes. This topic has not been prioritized and no action is therefore suggested.
Research infrastructure, lab facilities and testing	China and Korea			x						Both countries have indicated laboratory testing as a common interest. Both have indicated researcher exchange as a proper action.
	Brazil, India – Common interest with Singapore and Poland			x		x	x		x	Research infrastructures, suggested actions are joint projects or joint use of international research infrastructures
Other topics										This category has not been prioritized by B.R.I.C.S and no action is therefore suggested.

To concentrate the effort it is proposed to initiate the following activities for at start:

Region of common interest	Topic	Suggested activity
B.R.I.C.S. and North America (USA)	Power System Management incl. control concepts	Workshop
B.R.I.C.S. and North America (USA)	Planning methods for distribution and transmission networks	Workshop
Brazil, China and rest of Asia	Control concepts	Workshop
China and Singapore	Integration of EV into the grid	Workshop
Brazil, China, India and Singapore, Korea, Poland	Laboratory testing and research infrastructures	Potential for researcher exchange, joint projects or joint use of international research infrastructures

5 Conclusions

A plan of activities has been developed for international collaboration with B.R.I.C.S. countries based on the research topics covered by DoW of ELECTRA and EERA JP SG. The plan is developed on the basis of the results of ELECTRA T10.1 as reported in D10.1 [2] and a questionnaire prepared to detail the information in particular the types of interaction.

This is mainly in the area of power system management where different aspects attract common interest. Also different topics within transmission networks are common interests for B.R.I.C.S. countries. Laboratory testing and research infrastructures are also prioritized by Brazil, China and India.

The suggested types of actions may be taken into account in future workshops, projects and collaborations.

The plan of activities for the B.R.I.C.S countries will be further aligned with the similar plan for the INCO activities that will be reported in D10.3 (to be issued at month 30) and that considers extra-EU countries other than B.R.I.C.S. It is noted that several of the topics are of common interest and that the types of activities also are similar. It is thus proposed that the ELECTRA effort is concentrated on these topics initially so that maximum effect is obtained.

6 References

[1] http://www.electrairp.eu (ELECTRA IRP web site)
[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”

7 Disclaimer

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

Annex A. Answers to questionnaire from external contacts

Category	Term / R&D Topic	Examples of potential joint R&D activities	Rankings, 5 highest…1 lowest								Action Types preferred								Comments
			China (D10.1)	Brazil (D10.1)	Russia (D10.1)	India (D10.1)	South Africa (D10.1)	China Biejing Jiaotong uni	ISGF India	Zhejiang University, China	CEPEL- Brazil	Workshops	Conference side events	Researcher exchange	International collaboration fora	Joint proposals	Joint projects	Summer schools	Joint publications	Joint use of international research infrastructures	
Network operation	Dynamic Control Schemes	Control Systems for Increasing Penetration of Variable Generation e.g. integration of DER and RE in the system control, coordination with large hydro power							4			x				x	x			x	
	Frequency control	New frequency control schemes to accomodate DERs, storage and load demand management, incl. Low intertia systems																			
	Grid observability needs	Grid observables requirements, PMU and WAMS applications, integration with new control schemes																			
	Local Control Schemes	Analysis methods for decentralised systems in a market based system for assessing performance and stability, web-of-cells, exploitation of local measurements and control capabilities																			
	Distribution system planning	Planning methods that include active grid contgrl, DER, RE and addresses reliability							5					x		x	x			x	
	Microgrid control	Microgrids control, microgrids interactions						4				x								x	
	System stability	Analysis methods for systems with DER and RE									5	x	x	x	x		x		x		
	Dynamic System resilience	Ability to withstand large disturbances, continuity of supply after catastrophic events			3																Russia: Network reliability and fault detection and clearing.
	Voltage control	Voltage control in the presence of high RES and DER penetration																			
	Network automation	Use of automation devices to ensure automatic system control																			

Power System Management	Common case studies	Definiton of common case studies for results comparison and related discussion, preparation of openly available consolidated data sets																		
	Scenarios and trends	Generation and load forecast for the future grid					2				x	x								
	Control room functions	New functionalities and available data in control rooms for real-time grid management								3	x		x	x				x		
	Control Concepts	Control Systems for Increasing Penetration of Variable Generation focus of interaction between ICT and control performance, control and market				3														South Africa: Generation adequacy and bulk renewables integration: use of PMU to enhance system stability (SP2 SP5)
	Distributed/decentralised Vertical Control Concepts	Architecture of distributed/decentralised control integrating TSO/DSO resources for voltage control																		
	Distributed/decentralised control requirements	Requirements of distributed/decentralised control																		
	TSO - DSO Role and interaction	Re-definition of interaction between TSO and DSO																		
	Grid architecture	New grid architectures and grid operation, power system modelling			5															India: System reliability and use of Distribution Management Systems
	Grid flexibility	Optimal power flow, Flexibility resources requirements, technology, load demand management		3																Brazil: T&D system efficiency amd use of advanced technologies (PMUs, voltage control, network automation)
	Supervisory Grid observability needs	Grid congestion management						5			x	x		x		x				
	Microgrid operation	Microgrid requirements, microgrids control, microgrids interactions																		
	Market design	New market structure to integrate DERs and flexibility resources, business models			2															India: Revenue collection and system efficiency: AMI
	Distribution and Energy management	Develop a Software Tool for Economic Benefits of Energy Storage for the Integrated Transmission and Distribution System																		
	Energy market and Business models	Development of new business models, financial impact of DERs, flexibility and storage			5		3			5		x		x	x	x				Russia: Electricity end-user market involvement and economical advantages: AMI (SP2/SP3) South Africa: Revenue collection and different solutions: AMI and pre-paid contracts
	Power system operation	Simulation of Smart Grid Operations, Markets and Benefits, Loss minimization		3																Brazil: Reduction of T&D losses: smart metering and AMI
	Performance verification	Methodologies for quantification and verification of service delivery from system with DER																		
	Forecasts of generation and consumption	RES forecasts, forecast of flexibility from DER						5	1		x		x	x	x	x			x	
	Self-healing at distribution system level	Power system feature to recover its functionalities automatically																		

	Smart grid data mining	Data management for real-time analysis, roll out of smart meters and PMUs, utilisation of data for system operation optimization, data fusion		3					4		2	x	x	x	x			x	x		Brazil: Reduction of T&D losses: smart metering and AMI
	Demand response	Demand response refers to the capability of smart grid technologies to allow for reductions in electricity use targeted at times when demand is highest.								4		x			x	x					
	Characterization of DER technologies	Characterization of DER technologies in terms of consumption patterns, flexibility																			
SG ICT and Control Systems Interoperability	Functional architeture	Relation with Smart Grid Architecture Model (SGAM) and conceptual architecture definiton, description of power systems functions incl. Ancillary services																			
	Interoperable Systems	Use of world-wide accepted standards for ICT technologies to grant full compatibility among system devices																			
	Security issues	Cyber-security issues in the ICT architecture for smart grids																		*	*Brazil: This topic will gain importance in a fews years, but it is not yet among the top 5.
	Smart grid interface	Definition of the power and the information flow exchanged by the grid operator and the client																			
	Standards	Communication standards (IEC 61850) and interoperability issues						3				x	x		x						
	Home Energy Management Gateways	Standards for interfacing at the HEMS level to ensure interoperability between aggregators																			
	Interoperable Energy Management Systems and Control	Definition of control functionality fro HEMS systems, standard interfaces between power system actors icl. Aggregators, BRPs and DSOs																			
Electrical Storage Integration	Storage systems integration	Local storage, long duration storage, technology, estimation to accomodate DERs integration, economic benefits								3		x		x		x					
	Controllable flexibility achieved by storagees in the smart grid applications	Grid impact of ESS, tools for analysis ofenergy storage integration																			
	Economic and technical benefits of incorporating an ESS into network	Methods and tools for analysis of ESS at system and business level																			
	Integration of EV into grid	EV integration, fleet energy management						5		2		x		x	x	x	x		x	x	

Transmission Networks	Wide area grid observability needs	Grid observables requirements, PMU and WAMS applications, focus on Transmission system level		3															Brazil: Reduction of T&D losses: smart metering and AMI (SP5)
	Interarea Control Schemes	Control Systems for Increasing Penetration of Variable Generation	5																China: Renewables integration targets with special reference to wind integration (SP5)
	Energy management	Develop a Software Tool for Economic Benefits of Energy Storage for the Integrated Transmission and Distribution System																	
	Transmission Grid architecture	New grid architectures, power system modelling, multiterminal HVDC	5																China: Transmission adequacy and impact of HVDC (SP5)
	Transmission Network automation	Use of automation devices to ensure automatic system control																	
	Transmission system planning	Optimal planning methodologies taking RE and cross country/region aspects into account and new extended control concepts	5				3		5		4		x	x	x		x	x	x	x	China: National security issues and transmission system management (SP5) South Africa: Generation adequacy amd bulk renewables integration: use of PMUs to enhance system stability
	System reliability and Self-healing	Power system feature to recover its functionalities automatically																	
	Integrating Control Schemes	Architecture that enables simulataneous vertical and horizontal integration of TSO/DSO resources for voltage control		5															Brazil: T&D system efficiency and use of advanced technologies (PMUs, voltage control, network automation)(SP5)
	Integration control schemes requirements	Requirements for simulataneous vertical and horizontal integration of TSO/DSO resources for voltage control																	
Research infrastructure, lab facilities and testing	Lab Validation Proof of Concept	Specific CHIL, PHIL, … testing																	
	Laboratory Testing	Conformance Testing, Energy Storage Performance Metrics and Testing Procedures, demand response, distributed control schemes, signal communication						1						x					
	Reseach infrastructures	Research facilities for lab testing, system studies, software testing and demonstartions, simulation							4		1	x		x		x	x		x	Some SG labs are being created in Brazil. The potential for joint work is significant.
	Research Facility	Mapping, effective use, testing protocols, …																	
	Use cases methodology	Review/discussion of use cases for the frequency/voltage control schemes							4					x				x	x	

Other topics	KPIs identification	Key Performance Indicators to check grid performances and project contributions																			
	Researcher Exchange	Definition of procedures, scope, objectives																			
Suggested other topics (max. 2 topics)	Topic **A**																				
	Topic **B**																				

Annex B. Contact list for B.R.I.C.S

Partner		Contact external		
Organization	**Name**	**Country**	**Name of contact person**	**Institution**
DTU	Henrik Bindner	China	Prof Song	Tsinghua and Zhejiang Universities
DTU	Henrik Bindner	China	Jiuchun Jiang	Beijing Jiaotong University
SINTEF Energy Research	Andrei Morch	India	Reji Kumar Pillai	India Smart Grid Forum
SINTEF Energy Research	Andrei Morch	India	Vittalkumar Dhage	European Business and Technology Center
Institute of Physical Energetics, Latvia	Irina Oleinikova	Russia	n/a	n/a
IEN	Michał Kosmecki	Brazil	Wo Wei Ping	Electrical Energy Research Center (Cepel)
University of Strathclyde	Graeme Burt	Brazil	Gilberto Pires De Azevedo	Electrical Energy Research Center (Cepel)