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INTERNATIONAL ENERGY AGENCY

IMPLEMENTING AGREEMENT FOR A CO-OPERATIVE PROGRAMME ON SMART GRIDS (ISGAN)

ANNEX 6: POWER T&D SYSTEMS

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CONTENTS

1 MOTIVATION

A smarter power system is essential for the clean energy transition. All supply of electricity needs to be backed by technical solutions that guarantee a continuous and safe flow of power, in spite of all kinds of potential disruptions. A reliable and efficient Power Transmission & Distribution (T&D) system is the foundation for the enabling infrastructure for continuous power delivery. This integrated power system has to instantaneously balance all fluctuations from all connected production and consumption sources of electricity. A massive introduction of Renewable Energy Sources (RES) is now underway, primarily to meet the need to reduce global CO2 emissions and to allow increased electrification in growing economies. These changes often encounter an ageing T&D infrastructure, and many countries face difficult challenges to rapidly building new conventional transmission lines. The path forward will require novel solutions that create smarter and stronger grids to maintain and improve the security, reliability and quality of electric power supply.

Significant challenges arise from introducing large amounts of variable output generation sources into transmission and distribution grids that are also seeing the addition of new types of consumer appliances. Increased installations of Distributed Energy Resources (DER) such as roof top PV and the use of Electric Vehicles with controllable battery charging, and other storage facilities will change the way traditional radial distribution grids and the bulk power system as a whole operate. Larger hydro power, wind power and concentrated solar power resources in remote locations will be integrated directly with the transmission grid. The much larger and unpredictable fluctuations in generation that might occur will require new flexibility options that include storage facilities and flexible production sources like reservoir-based hydro and pumped storage. This raises the need for increased focus on the behaviour of the entire power system, and the interaction between the transmission and distribution systems. New, smart technologies can play a large part in providing increased flexibility and capacity as well as improved visibility and controllability for balancing intermittent power production and demand. These technical advances combined with favourable governmental and regulatory policies can facilitate the necessary transition to a clean energy delivery system.

2 OBJECTIVES

The main objective of this Annex is to establish a long term vision for the development of “Smarter and Stronger Power T&D Systems”. The Annex shall consist of efforts to improve understanding of Smart Grid technologies applicable to or influencing power system performance, transmission capacities and operating practices; accelerate their development and deployment; and promote adoption of related enabling regulatory and government policies. This Annex focuses on power system-related challenges and is based, in part, on previous findings within the IEA Implementing Agreement on Electricity Networks Analysis, Research and Development (ENARD). The initial work during 2012 on smarter and stronger transmission systems is now being expanded to include interactions between the transmission and distribution systems with new active electricity customers with own PV panels and electrical vehicles. The Annex will track other ongoing initiatives, arrange workshops and continuously share relevant information in the form of reports, white papers and messages of relevance to power system planners, grid operators, policy makers, regulators,

academia and manufacturers. The first years of this work has due to the participating countries been focusing on the power systems in Europe and U.S. The continuation of the work will expand this to regions under electrification with rapidly expanding power systems such as India and Republic of South Africa.

The ambition is to map feasible smart and strong grid development according to different boundary conditions in different countries and also to create a case book over state-of-the-art and/or best practice Power T&D solutions for sharing of information. Finally the Annex 6 has the ambition to be a meeting place and knowledge sharing for ongoing R&D initiatives and stimulate cooperation.

3 VALUE PROPOSITION FOR PARTICIPANTS

ISGAN Participants contributing to this Annex will be able to understand and influence the frameworks and system solutions for an efficient and reliable electricity grid, able to cope with the new challenges at all network levels. Transmission lines normally take many years to plan and build. We do not have this time with the present expansion plans for renewables. Technologies and solutions to better utilize existing transmission corridors will be identified, along with more efficient processes to create new ones. This includes both onshore and offshore grids. At distribution systems level the key challenge is the massive integration of distributed energy resources (DER) in new control approaches to maximize the utilization of the existing infrastructure. One of the key issues is the interaction of future transmission and distribution systems. Beside international knowledge and experience exchange on a technical level, the Annex will develop urgently needed governmental and regulatory policy options to facilitate the development, demonstration and deployment of such technologies and policy options for adoption on a large scale. The Annex will also examine the need for relevant international standardization for interoperability between different manufacturers of new promising technology. Finally we need methods for quality assurance and risk management.

The development with more intermittent generation as Distributed Energy Resources (DER) or as larger wind parks or Concentrated Solar Power (CSP) together with distributed storage and demand response will diminish the traditional division between “transmission” and “distribution”. Furthermore, deregulation taking place will introduce new “players” on the power system field. Finally we see a need for more cross border interconnections and larger international power markets. All of this drives the need for new technology for improved monitoring and control of the power system in real time. As a consequence we see the need to bring together the most important system challenges with technologies and policies that contribute to the development of system solutions. And speed is essential.

Participation in the Annex will help ensure that this system approach is built on international know how, development and best practices. Participants will better know what technology is available and what operational and regulatory frameworks are beneficial. All major stakeholders in the electricity sector would benefit from this systems approach, including policymakers, regulators, standardization bodies and international organisations, manufacturing industries, power producers, TSOs, DSOs, other power utilities as well as aggregators and other market players. Last but not least, the consumer who will depend increasingly on reliable, high-quality electricity will benefit.

4 CONTEXT & DEVELOPMENT

This annex is based on the previous work upon transmission and distribution power systems within the IEA Implementing Agreement on Electricity Networks Analysis, Research and Development (ENARD).

ENARD started 2006 with the mission "To provide a major international forum for information exchange, in-depth research and analysis and collaborative R&D in relation to electricity T&D networks". Within ENARD there were two annexes relevant to and passed on to this ISGAN annex as a base for further work: ENARD annex II "Distributed Generation Integration in Distribution Networks" and ENARD annex IV "Transmission Systems".

ISGAN ExCo approved unanimously, on March 29, 2012 the ISGAN Annex 6 Power T&D System including the acceptance of STRI as Operating Agent. The work with transition from ENARD Annex IV to ISGAN Annex 6 was however initiated during 2011 by a coordinating group consisting of Italy, Norway, Sweden and USA. The work made by ENARD Annex IV was formally transferred from RSE and SINTEF to STRI as OA for ISGAN Annex 6. This approach allowed for a "flying start" and the first coordinating group meeting as ISGAN was held on April 3, 2012. Since then, over 30 coordinating group meetings (physical or phone) have been held. All are documented with MoM on the internal Annex 6 website. In addition several working meetings have been held within each national group or between the ISGAN Annex 6 country participants on specific issues.

Since 2012, several international workshops have been organized by the Annex together with different hosts from the member countries. During 2014 a workshop on "Large-Scale Integration of Renewables and Power Transmission and Distribution Interaction" was held in May in Dublin kindly hosted by Eirgrid and Sustainable Energy Authority of Ireland. A second workshop on "The Evolution of the Power Grid through Smart Grid Innovations" is organized in combination with the 8th ExCo in Montreal kindly hosted by Hydro-Quebec and its research centre, IREQ.

An updated Program of Work 2.0 was presented and adopted at the 5th ExCo in Moscow and version 3.0 was presented and adopted at the 6th ExCo in Stavanger.

The basic idea is that the participants in this Annex will contribute with their experience and participation in other initiatives, presented at workshops and by summarizing this in "Special Reports" that are posted on the common workspace on Internet. Some of the Special Reports and workshops were summarized in two Discussion Papers and one Technology Brief which were presented in the Stavanger workshop in conjunction with 6th ExCo meeting in Norway 2013. So far during 2014 a two-page flyer, based on the first two Discussion Papers, was produced for the 5th Clean Energy Ministerial in Seoul, a third Discussion Paper and the first version of the T&D Case Book were produced for the 8th ExCo in Montreal.

5 GENERAL APPROACH

The Annex 6 PoW are organised into five main tasks. Task 1-4 main focus has been on the different systems, markets and regulatory aspects and technology developments that are of prime importance for future Power T&D systems. Task 5 is added for the work on Transmission and Distribution Interaction. In addition the original task 1-4 will further extend the scope to Transmission and Distribution Systems and give input to task 5.

Task1: Policy and Regulation
Lead by USA through Department of Energy

Task 2: Expansion Planning and Market analysis
Lead by Italy through Ricerca sul Sistema Energetico, RSE SpA

Task 3: Technology Development and Demonstration
Lead by Sweden through STEM

Task 4: System Operation Management and Security
Lead by Norway through Sintef Energy Research

Task 5: Transmission and Distribution System Interaction
Lead by Austria through AIT Austrian Institute of Technology

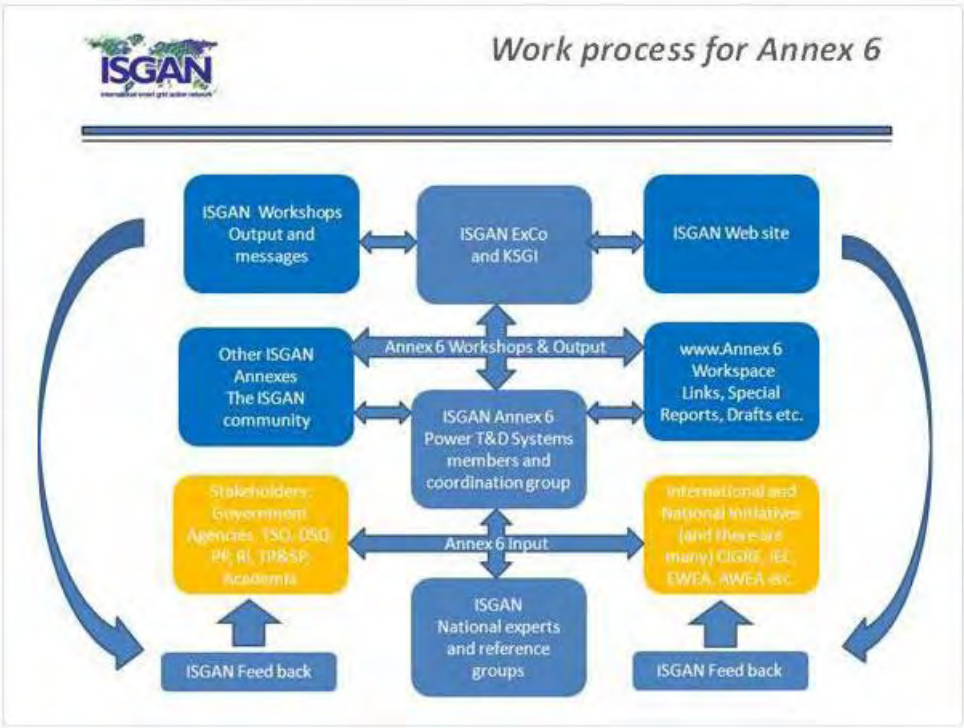
The five tasks are treated in common meetings since they all contribute to the overall system approach. Participating countries can select to participate within one or several tasks. Each task leader organizes the work individually depending on participating countries and expertise with reporting at the regular common Annex 6 meetings. Over time the priority of the tasks may change dependent on the participants' objectives.

This work includes collecting, integrating, synthesizing, and dissemination of information on Smart Grid technologies, practices, policies, etc. with a system level approach in workshops, reports and/or position papers. This work are based on earlier conclusions made within ENARD and by following the ongoing International initiatives on Smart Grids relating to power transmission, distribution and system operation. Synthesis for CEM meetings and/or other policy makers will be submitted to ISGAN ExCo when required in cooperation with other ISGAN Annexes.

6 SCOPE

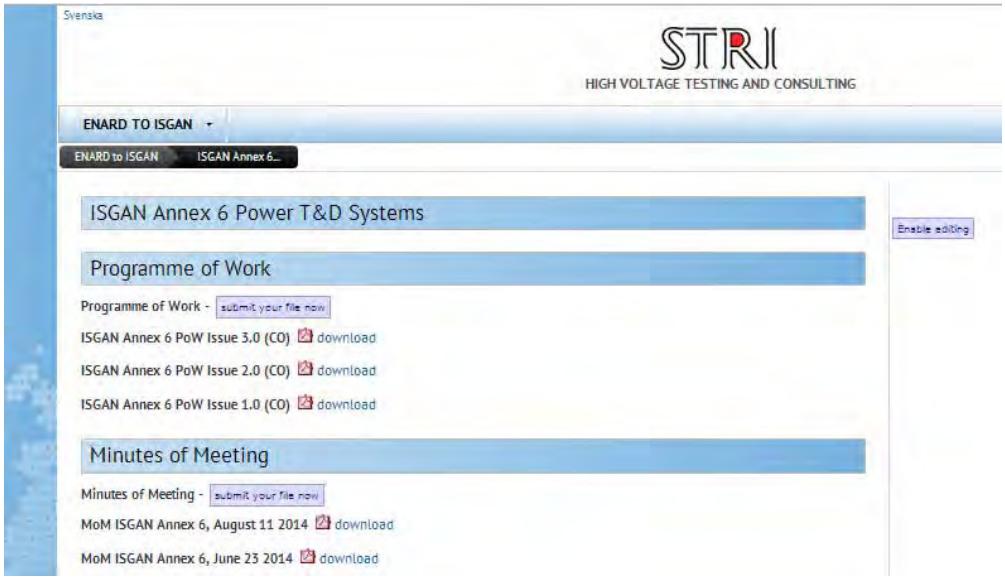
The work is based on collecting, integrating, synthesizing, and distributing information on Smart Grid technologies, practices, policies, and systems through workshops, reports and/or position papers based on a system level approach. Work and conclusions are system oriented. This work is based on earlier conclusions made within ENARD and by following the ongoing International initiatives on Smart Grids relating to power transmission. The idea is NOT to repeat what is already done but to learn from this. The initiatives going on within and publications and being issued by IEA, CIGRE, IEC, IEEE, FERC, ACER. NIST, regional and national initiatives, interest groups as

EWEA and AWEA as well as research programs are valuable input to this work. The importance is once again to process this information and deliver important conclusion for the complete system. To establish this combined knowledge base it is of importance to have as many countries represented as possible. It is also important to have a mix of experts from system operators, regulators, academia, research institutes and major manufacturers of system components and solutions contributing to this work.



The above figure shows the work process for Annex 6 and is similar to the other Annexes. ISGAN National experts and reference groups in the participating countries are the fundamental source of knowledge and experience. In addition we shall have close cooperation with stakeholders and follow the development of related initiatives. The analysis, conclusions and reporting is done by the Annex 6 members and coordination group, compiled and submitted by the Operating Agent to KSGI and ISGAN ExCo for further distribution.

To facilitate the work within ISGAN Annex 6 a special interactive internal website has been created as seen here below. (www.stri.se/enardtoisgan) This includes the results from both the previous work of ENARD to ISGAN transition as well as the ongoing work within ISGAN Annex 6. You may describe it as a working data base with links to related activities, special reports, MoM etc. All members of Annex 6 can upload and download documents. In addition Annex 6 is also included in the official ISGAN website and available for all ISGAN members. (www.iea-isgan.org) Here the final documents are posted. Announcements and uploaded documents are however only available for annex participants after registration by KSGI.



There are many ongoing International and national initiatives affecting this annex. This includes work within IEA and other ISGAN Annexes as well as CIGRE, IEC, NIST, FERC and other standardization and recommending organizations, interest groups such as EWEA and AWEA for wind but also NGOs like Green Peace and WWF. This work is being followed and is available through links in the Annex 6 common workspace on Internet.

ISGAN Annex 6 has an ambition to share information and conclusions with similar International initiatives and organisations through the participation in these initiatives by ISGAN Annex 6 members and their technical experts. This includes as examples ENSTO-E, iTESLA, e-Highway2050, STRONGRID, Gridplus, GridTech, eBadge, Insight-E.

https://www.entsoe.eu/ http://www.itesla-project.eu/ http://www.e-highway2050.eu/e-highway2050/ http://www.nordicenergy.org/project/smart-transmission-grid-operation-and-control/ http://www.gridplus.eu/ http://www.gridtech.eu/ http://www.ebadge-fp7.eu/ http://www.kic-innoenergy.com/blog/2014/05/16/inisight_e-energy-think-tank-for-the-european-commission/

7 PARTICIPANTS AND RESPONSIBILITIES

Annex 6 participants include per August 2014, Austria, Belgium, Canada, France, India, Ireland, Italy, Norway, South Africa, Sweden, and USA constituting the annex coordination group.

It is of great importance that each participating country has a national network with expertise from institutions, academia, grid owners and operators and industry which can contribute in this work.

STRI AB (Formerly Swedish Transmission Research Institute), an independent research and consulting company with an accredited high voltage laboratory is acting as Operating Agent for ISGAN Annex 6 according to decision of the ISGAN Executive Committee. The Annex OA work by STRI is financed by the Swedish Energy Agency.

The national participants are expected to contribute and supplement the work by:

- Ensuring that the Operating Agent has a copy of the Notice of Participation, indicating their Contracting Party's commitment to the Annex.
- Attend and participate in relevant calls, workshops, and meetings, as organized by the Operating Agent in coordination with the Task leaders.
- Support the Operating Agent and Task leaders in the discharge of their duties through the timely and appropriate provision of information, data, and other material, as may reasonably be required per the descriptions of tasks below.
- Take the lead responsibility on an individual national basis for the sourcing and integration of any information inputs to the Annex.
- Assist in the organisation of any national workshops as may be desired in support of the work programme.
- Take the lead responsibility on an individual national basis for the dissemination of the outputs from the Task.
- Produce and submit deliverables to Task Leaders and OA.

8 PROGRAMME OF WORK

The Programme of Work for each task is described below:

Task 1: Policy and Regulations:

Effective policies and efficient regulations are critically important at both the transmission and distribution system levels, both of which are strongly regulated. Policies must address economic, environmental, renewable energy resources, demand response and storage, grid reliability and other issues that often fall under the jurisdiction of several different regulatory agencies. These policies need to be tailored to harmonize at geographic (national, regional and local) as well as system levels (low voltage to highest voltage). Just and reasonable economic regulation of energy and ancillary services in the Smart Grid will require market designs that allow for participation of distributed generation, storage, demand response and electric vehicles in balancing and reserve markets at the distribution network level. Environmental concerns include carbon emissions, visual impact, water usage and regulation of the use of natural resources.

The aim of this activity is to review policy options and regulatory initiatives under development and deployment across ISGAN members to surface the intent and design of these options and initiatives, and how they interact with successful and unique technologies and best practices in planning, siting, and operating transmission and distribution assets. Some view the planning and operation of the electric power system as a balance among three areas: technologies, policies and markets. This suggests policies and regulations be viewed in this context, and in particular requires Task 1 to interface with the other four tasks in Annex 6 to take this interaction into account. Some of the practical issues are creating stable and fair regulation that is harmonized across large regions with fair rules concerning who pays for network developments, and best practices on how to enhance or build new transmission and distribution systems in order to minimize environmental impacts and maximize public acceptance.

Activity 1.1: Identify current major economic, reliability and environmental policies and regulations that impact transmission and distribution systems.

Activity 1.2: Assess the impacts and interactions among the economic, reliability and environmental policies and regulations for transmission and distribution systems.

Activity 1.3: Identify and evaluate policy options that would support future smart grids with respect to combined transmission/distribution planning and operations tools that maximize system efficiency in the presence of distributed energy sources, storage, demand response and electric vehicles at the distribution system level.

Activity 1.4: Assess the impacts and challenges of developing market designs and policy options for implementing advanced ICT, control, and other advanced technologies with respect to data sharing, cybersecurity and consumer sensitivities.

Task 2: Expansion Planning and Market Analysis:

Unbundling of the electric power industry creates new challenges for transmission expansion planning, in terms of environmental concerns (difficulties in getting construction permits especially for overhead lines), cost of transmission projects and the uncertainties concerning the benefit and profitability of transmission projects in a changing environment. The time horizon from planning and consenting processes to actual construction and commissioning of transmission projects are often longer than the corresponding process to construct new power plants. The new balancing challenges must be dealt with already in the system planning stage. This represents a huge challenge towards the development of cost optimised and efficient transmission networks.
Distribution systems will be revolutionized in the next years as an effect of massive introduction of distributed generation, smart-grid evolution and the consequent bi-directionality of the exchanges with the transmission. This will require not only a higher level of operative coordination between TSOs and DSOs but will undoubtedly also affect transmission planning.

The aim of this task is therefore to assess available methods and tools for transmission expansion planning, possible technologies to make efficient use of existing infrastructure and to identify the need for new tools that integrate market modelling, network analysis and security assessment, also including the possible contribution of promising transmission technologies.

The fair distribution of added cost from a system perspective must be reflected in the market pricing. At the same time, the electricity markets are deeply transforming themselves under the push of RES deployment and necessity to tightly interconnect the national pools. As a consequence of high RES penetration, the present clearing mechanisms based on a merit order selection based on bidding, supposing that bidding is a way for revealing marginal costs of generation, are showing zero or negative clearing prices in many hours. This makes it necessary to rethink to the possibility to introduce new market mechanisms. Additionally, the necessity to tighten the ties among the national pools is implemented by introducing market coupling mechanisms (volume or price coupling). These mechanisms present on one side some criticalities in managing complex bidding schemes (e.g. aggregated offers) and, on the other, are prone to distortion in case of different incentivising policies between the coupled countries.
Finally, coupling is very likely to be progressively extended towards real markets, most notably balancing markets, with the aim to create a final pan-European management of reserves and an overall reduction of procurement costs. How reserve sharing could affect prices in balancing market is an important issue that needs to be thoroughly investigated.

There is also an interlink between the market design in task 1 and the market analysis in task 2. Task 2 includes the following activities:

Activity 2.1: Assessment of available methods and tools for transmission expansion planning

Activity 2.2: Potential of transmission technologies in enhancing power system exploitation

Activity 2.3: Identification of requirements for tools addressing new transmission planning needs

Activity 2.4: Analysis of market problems. Methods and tools for the analysis

Task 3: Technology development and demonstration

The planned rapid growth of both distributed and large scale wind and solar power generation will require a smarter and stronger transmission system with flexibility to handle larger variations and larger transmission capacity than before at minimum losses and maintained reliability. At the same time is the construction of new transmission lines with today´s design more difficult especially in heavily populated areas. UHVAC & UHVDC "Supergrid" are under development in China and India and HVDC "Highways" are discussed for Europe. To harvest Concentrated Solar Power from Deserts in addition of existing and planned large hydro power plants HVDC is normally used. In addition compact lines and substations, upgrading of existing transmission lines for higher voltage and/or current, AC/DC conversion of existing lines, high capacity cables, FACTS, new types of energy storage, as well as on-shore and off-shore DC grids based on HVDC-VSC are examples of alternative solutions. Equally important is the development of ICT for Power Utility Automation from smarter and active substations to system monitoring, control and protection such as Wide Area Monitoring, Protection & Control (WAMPAC) and Flexible Line Management (FLM) allowing enhanced utilization of the infrastructure by real time overview and rapid response.

At distribution system level it is required to integrate a high share of distributed generation mainly based on fluctuating renewable resources (e.g. photovoltaics). To enhance the DER hosting capacity of existing infrastructure recently several new technologies have been developed (e.g. volt/var control in PV inverters, on-load tap changer for secondary substation transformers).

The aim of this activity would be to identify potential and feasibility of new technology, to prioritize the need for further developments and to make recommendations on how to stimulate the demonstration and deployment of promising technology options, for example through large scale demonstration projects. Furthermore necessary measures, practices and standards to manage risks and interoperability should be identified in order to ensure a faster, more efficient and more reliable deployment of new technology. Task 3 will interact with the work within the other tasks and is closely interlinked with task 4.

Activity 3.1: Review of feasible technologies for enhanced T&D capacity and flexibility.

Activity 3.2: Identify ICT priorities to enhance power system monitoring and control.

Activity 3.3: Recommendations regarding the promotion and prioritization of technology demonstration activities and methods to speed up deployment of promising solutions for a smart and strong grid. This activity will include five different power systems: European Nordic, European Continental, U.S., India and Republic of South Africa which may differ in different focus.

Activity 3.4: Interacting and contributing to key international projects: Several ISGAN participants have activities in key European Smart Grid projects, regional projects, or national projects within Power T&D Systems. This is the case for EU funded projects through the FP7 framework programme and future Horizons 2020. Several ISGAN participants are not part in these projects and may have invested interests in the topics and results from these projects. ISGAN serves as a means

for information sharing, but there is a bigger potential for actual research collaboration that could help for better interaction of ISGAN members through R&D contributions of different international projects. Within this activity Annex 6 should:

- Identify key "active" projects of interest for different parties (e.g. FP7 iTesla, Nordic Energy Research STRONgrid, FP7 eHighway, FP7 Garpur, etc.)
- Formulate interaction projects. These shall be research or/and demonstration projects that help directly in meeting challenges and achieving goals of the projects of the already active projects identified in point 1. These projects should have an active component of direct contribution to the active project deliverables.
- Identify possible participants for the interaction projects.
- Assist in the identification, provisioning and assignment of funding resources for these projects through appropriate national or international agencies.

Task 4: System Operation Management and Security

The development of electric power systems with a larger mix of generation technologies and an increased penetration of renewable energy sources is expected to lead to larger and more frequent changes in generation behaviour in the future. Generation will also be located further away from demand. The distribution networks with flexible demand and embedded generation will also behave differently. Following this development, the physical characteristics of the power systems will change in terms of frequency and voltage control, inertia, fault clearing and other security related issues. This emphasises the need for new methods and tools for monitoring and control of power systems, including the management of loads (demand side participation) and new energy storage facilities.

The aim of this activity is therefore to assess available methods and tools for operational monitoring and control, and in particular to identify the need for new tools and methods to manage future challenges in balancing control also accounting for the potential of transmission technologies. This also includes market design and management of balancing services, as well as methods for adequate provision and distribution of operational reserves and other ancillary services. The development of real time markets is an essential element.

Task 4 includes the following activities in the areas of operational monitoring and control for managing power system balancing and security:

Activity 4.1: Balancing control: Assessment of available methods and tools for power balancing assessments and the need for new tools also enabling the contribution to balancing and reserve market from distribution system level. In particular this activity will deal with requirements, technical possibilities and market solutions regarding provision of necessary reserves, including backup capacity, in power systems with large amounts of variable Renewable Energy. Main questions are: How to identify the right amount of reserves and the most cost-effective solutions from the complete transmission and distribution power system using the opportunities both at the

consumers (prosumers) and the producers? What are the requirements and optimal mix between the need for local backup capacity versus global reserves?

Activity 4.2: Wide Area Monitoring Systems (WAMS): Assessment of promising applications of Wide Area Monitoring Systems for improving situational awareness in system operation. Identify the need for further developments of tools and security standards in order to accelerate the implementation and deployment of WAMS technology. A main result from this activity will be a practical guide for deployment of Wide area monitoring system applications at transmission and distribution grid levels.

Activity 4.3: System control for smarter operation of T&D grids: Assessment of the most promising control applications for managing the future power systems, including Wide area protection and control, FACTS applications and control of multi-terminal HVDC grids. Identify the main barriers towards implementation and deployment of the new technologies in order to recommend priorities for future research and development. A main focus will be on system controls utilizing demand resources. How can we improve stability and power system security by actively utilizing the interaction between transmission and distribution grids?

Task 5: Transmission & distribution system interaction and optimisation:

Main objective of Task 5 on T&D system interaction is to gain knowledge, experiences and develop recommendation on future technical and market based interaction and optimisation of distribution and transmission networks and DSOs – TSOs respectively. Based on the previous work in task 1 to 4, in task 5, acting as an umbrella task, in particular the interaction of both levels will be investigated. The work will be divided into three strongly interrelated activities reflecting the three different levels of T&D interaction:

- Technical interaction (Activity 5.1)
- Market and policy framework (Activity 5.2)
- TSO/DSO Data exchange and required ICT (Activity 5.3)

Activity 5.1: Interaction of future control approaches at transmission and distribution level

Based on the experiences from Task 4 a qualitative analyses of the interaction of different control approaches for massive integration of renewables at transmission and distribution level (DSO – TSO interaction), in order to gain as much as possible flexibility in the entire system, will be performed. Possible and required objective functions for the entire system operation will be discussed and highlighted. In particular it is going to be considered how to overcome contradicting requirements from DSO and TSO level as well as contradicting requirements from technical and economical perspective (market driven controls vs. network driven controls). The work will result in a definition of minimum information which needs to be exchanged and the identification of possible conflicts between controls at different network levels. For instance:

- Influence of DER integration on LV and MV level on transmission system power flows

- Controllability of distributed DER by TSOs and DSOs
- Impact and integration of distributed DSM on DSO and TSO operating process
- Optimisation of Volt/Var control – reactive power flow management
- Contribution of DER to Ancillary Services
- Ancillary Services from Distribution Networks
- Ancillary Services for TSOs coming from Resources embedded in the Distribution Networks

Activity 5.2: Market, policy and regulatory framework for T&D interaction

In future it is expected that more and more technical transmission system based services will be provided from distribution level. Currently a limited amount of practical experiences on markets, policies and regulatory frameworks enabling these services is available. Aim of activity 5.2 is to collect experiences among the ISGAN partners about distribution and transmission interaction (e.g. balancing services, reactive power management, frequency control, inertia) and related markets. Additionally it is still open whether all or just a part of these services will be market based or either mandatory and thus considered in grid codes (policy/regulatory level). Aim of the activity is to identify possible pathways towards future T&D interaction, gaining experiences among the ISGAN community and finally providing policy and market recommendations.

Activity 5.3: T&D data and information exchange and required ICT

In order to enable an interaction between transmission and distribution system both on technical and market level data exchange and communication between DSOs and TSOs is necessary (e.g. forecast information sharing between transmission and distribution level). The data exchange will take place vertically between DSOs and TSOs as well as horizontally between TSOs. Aim of the activity is to identify what data should/will be exchanged between the system operators including the related data formats, protocols necessary time resolution. The required information and communication technologies will be analysed at both levels and the interfaces will be discussed and described on a qualitative level.

9 SUMMARY OF DELIVERABLES

The original timetable up to 2014 from 3.0 has in principle been followed. A Discussion Paper on Power System Integration of Electrical Transport has not been written, but an internal summary from the GSGF report dealing with integration of electrical vehicles. For the remaining part of 2014 and 2015 the plan has been updated as follow with deliverables.

Year One (2012):

(1) Organizing of a work shop aimed at collecting "Quick messages about transmission system development" to be delivered to ISGAN ExCo for further discussions with representatives of Clean Energy Ministers. (Completed)
(2) A common website with links to relevant sites is operational (Completed)
(3) Develop further guidance and PoW for all four tasks, and if required additional tasks. (Completed)
(4) "Kick-off" workshop of the new Annex with further development of messages. (Completed)
(5) Regular physical/phone meetings by coordination group members registered in MoM and updating of internal website with "Special Reports" for knowledge sharing. (Completed)

Year Two (2013):

(1) Jan. 7 – 9 Annex 6 planning and work session in Trondheim
(2) Feb. 1 Updated PoW 2.0 with new activities including distribution systems
(3) March, Discussion paper draft on "Smarter & Stronger Power Transmission: Review of feasible technologies for enhanced capacity and flexibility"
(4) March, Technology Brief I-POSITION CE^4"
(5) March 11-15 Participation in Moscow ExCo 5 workshop
(6) April 3-4 Coordination group meeting and workshop in U.S.
(7) May 13 Annex 6 workshop during Austria Smart Grid Week
(8) July 15-16 Annex 6 coordination group meeting and workshop in Paris
(9) Aug. Discussion Paper on "Enabling Policies and Methods for Flexible Power Delivery Systems"
(10 Oct. 7-11, 2013 Workshop & 6th ExCo Stavanger, Norway
(11) Nov. 21-22, 2013 Concluding Annex 6 workshop in Belgium
(12) Dec. Concluding & visionary Discussion Paper on "Smarter and Stronger Power T&D Systems for the Clean Electric Energy Efficiency Evolution - CE^4"

Year Three (2014):

(1) Publication of a Power T&D Case Book; SPOTLIGHT ON STRONG AND SMART POWER T&D INFRASTRUCTURE in cooperation with GO15
(2) Discussion Paper on Power T&D Interaction and Optimisation
(3) Discussion Paper on Power System Integration of Electrical Transport in cooperation with EVI
(4) Discussion paper on Analysis of balancing control and provision of reserves – the need for new methods and tools
(5) Two international workshops in cooperation with cooperating organisations

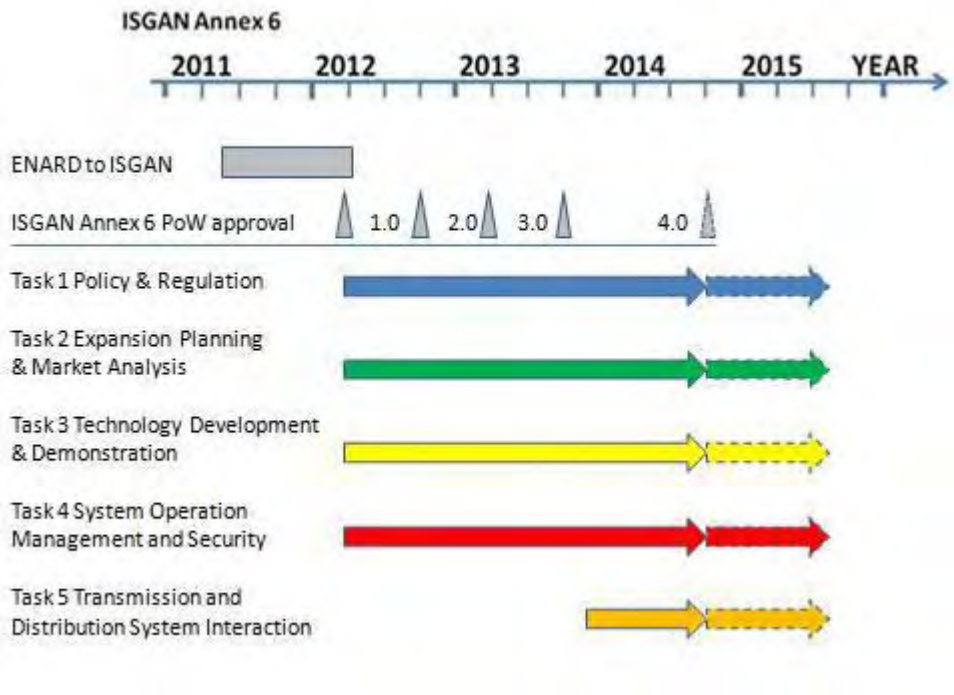
Year Four (2015):

Key theme: ”How do we best use the smartness”

(1) Publication of an extended Power T&D Case Book; SPOTLIGHT ON STRONG AND SMART POWER in collaboration with GSGF
(2) Extended work with the discussion paper on T&D Interaction focusing on regulatory learning.
(3) Discussion paper on Energy Storage
(4) Discussion paper on the rapidly expanding power systems in the regions under electrification
(5) Discussion paper on Wide Area Monitoring and Control
(6) Two international workshops in cooperation with cooperating organisations

10 TIME TABLE

This term of this Annex is planned to extend for the full term of ISGAN. The PoW is regularly updated to reflect the changes since the start Q1 2012. The version 4.0 is presented for approval at the 8th ExCo in Montreal. See time chart below:



11 BUDGET

The budget for this Annex consists of costs to develop the basic framework, as well as the continuing work with five defined tasks, to gather, assess, and synthesize the data, to develop, host and maintain the online website (in service), and to organize and host related meetings and workshops.

The Annex is based on "the task sharing principle" meaning that participating countries pay their own costs and the common cost reduced to a minimum and in this case zero. The cost for coordinating each tasks - are taken by each lead country. For the overall coordination of different working tasks during 2011-2014, Sweden (Swedish Energy Agency) has financed STRI AB as Operating Agent. STRI is during this period planning and carrying out decisions made by the coordination group. All countries participating in this coordination group are financing their own costs. This is also expected from future other members in the coordination group.

(The budgeted cost for the Operating Agent is 100 000 EURO per year.)

The required estimate of In-Kind Staff Resources Needed in person month (pm) will be depending on the planned scope and performed activities. As an indication the following figures are given: For each task leader is 2 pm per year, for other participants 1 pm per year.

The expected contribution of each national participant is specified under section 7. Costs for any required "extras" such as printed publications and larger events have to be decided and financed separately.

12 RIGHTS AND OBLIGATIONS

The principal results and outputs from this Annex will remain confidential to its Participants for a period of not less than 6 months after completion of the specific Task in question, unless the Participants agree, by majority vote, to an earlier release of information. After this period, all results, except those containing information or data previously flagged as sensitive, will be made freely available via the ISGAN web site.

The Annex will be required to produce an executive overview report of its activities, in cooperation with Annex 4 and the ISGAN Secretariat, not containing any sensitive information or data, which is suitable for publication in the public domain and distribution to leaders in relevant fora (e.g., the Clean Energy Ministerial).

Although the programme of work, as described herein is not anticipated to lead to the development of any new Intellectual Property (IP), the ownership and commercial exploitation of any IP which may be produced shall be established by the ISGAN Executive Committee in a manner consistent with the IEA ISGAN Implementing Agreement.

Revisions from issue 1.0

The complete description has been updated to reflect the work being done and the new members joining. The main changes are:

This issue 2.0 has been updated with more details on how distribution systems are included.
The detailed description on each task has been moved from “Scope” “Program of Work”.
In the section “Scope” a more detailed description has been added.
A more detailed list of deliverables for 2013 has been added.

Revisions from issue 2.0

The description has been updated to reflect the work being done and the new members joining. The main changes are:

Task 3 and 4 has been updated.

Task 5 has been added.

Work plan for 2014 has been added.

Revisions from issue 3.0

The description has been updated to reflect the work being done and the new members joining. The main changes are:

Context and Development have been modified

Task 2 has been updated

Work plan for 2015 has been added.