

SC C1 Activity Report, 2011

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System Development and Economics

Overview

SC C1 is focused on issues related to the development and economics of power systems. In establishing study activities, SC members must consider the technical aspects of the power systems, the requirements and expectations of customers, new technologies that lower cost or improve performance, total asset lifetime issues and overall business impacts.

SC C1 increasingly focuses on the strategic decisions of network entities in light of different operating realities and pressures. While the pressures vary according to jurisdiction of the entities and the industrial development stage of the countries, it is evident that power systems are facing a number of very significant challenges. Climate change and the need to reduce the environmental impact of energy require new approaches. Established power systems such as in Europe and North America require redesign to cater for very high penetrations of renewable and often intermittent generation which is either in new bulk locations such as offshore or distributed more closely to loads. Rapidly expanding economies, such as China and India, are building new systems which incorporate renewables but also have the opportunity to include new technologies that allow higher efficiency delivery. Active distribution systems which cater for large-scale distributed generation are evolving to use advanced metering infrastructure to better understand and manage the varying load flows.

The above changes require new planning solutions including supergrids and microgrids which provide more efficient and effective ways to connect customers with their energy sources. These solutions are supported by advanced technologies such as FACTS devices which help control load flows and voltages. The demand requirements of loads are also changing with the advent of electric cars and remotely controllable appliances. In some cases there are opportunities to match these new loads with intermittent generation or to introduce a range of storage devices to better manage the load profiles.

Solutions to these challenges can be delivered through market solutions or through central planning, government mandates, standardisation or regulations. These mechanisms are being applied to varying degrees in different countries across the world. The market mechanisms allow innovative solutions to be developed through competition but make the long-term planning decisions more challenging. The centrally planned solutions are more suited to long-term decisions but risk being less responsive to changing opportunities and challenges.

A further challenge to many power systems is the need to replace significant proportions of ageing infrastructure. In some cases this requirement can be leveraged to help justify the substantial investment in new solutions. In other cases deferral options need to be considered as the increasing uncertainty raises the risk of asset stranding. These asset

management challenges must be considered alongside planning decisions to ensure the most economic investments are made.

Strategic Direction

SC C1 focuses on providing unbiased, useful information for system development practitioners and planners, as well as policy makers, across the world. While the position, nature and role of system development and planning continue to evolve, SC C1 has generally aligned its work to the CIGRE Strategic Plan 2010-2020.

The work of SC C1 is generally broken down into the following areas: system development; business investment; and asset management. The emphasis of each of these three areas is refreshed every two years at the Paris SC meeting. However, from ongoing consultation with the C1 Advisory Groups and receiving input from C1 members worldwide, it is apparent that these basic categories of SC C1 work remain relevant. The asset management work is focussed on broad high level issues that cut across a number of study committees. As such there tends to only be one or two working groups in operation at any one time.

A summary and brief description of ongoing, as well as recently completed, working groups and technical brochures for system development; business investment; and asset management is as follows:

System Development

- **TB 433 Planning to Manage Power Interruption Events:** This TB reviews major events that have occurred over a number of years and examines planning opportunities that may limit the impact of major unreliability events rather than prevent their occurrence.
- **TB 453 Glossary of Terms used in the Electric Industry:** This TB provides the definitions of various terms in the following domains: Electric quantities, Electric Systems, System Operations, Electricity Market and Entities in the Electricity Market.
- **WG C1.9 Planning Issues for Newly Industrialised and Developing Countries:** This soon to be published TB documents the issues, methods and approaches to carrying out power system planning in developing and newly industrialised countries within Africa and provides a technical summary for each country.
- **WG C1.13 System complexity and dynamic performance:** This soon to be published TB focuses on voltage stability aspects and discusses how active and passive compensation devices (FACTS) can help to improve voltage stability.
- **JWG C1/C2/C6-18 Coping with limits for very high penetrations of renewable energy:** This WG is exploring the limits to the penetration of renewable energy in electric power systems that are today considered in different islanded and continental power systems worldwide, as well as the technical problems causing such limits.
- **WG C1-12 The impact of transmission codes on the planning of systems:** The aim of this WG is to use a number of case studies to determine the extent to which transmission codes impact planning.

- **WG C1-19 Green field network, designing future networks ignoring existing constraints:** Without considering the constraints of existing infrastructure, this WG is exploring the design of future power systems for the long-term and considers the implications for the planning of today's power systems.
- **WG C1-20 Accommodating high load growth and urban development in future plans:** This WG is reviewing the methodologies and processes followed to formulate and prepare the development plans of transmission networks designed to supply high density urban areas within different countries.
- **WG C1-21 What advanced components and technologies are needed and which are available or under development to meet future network development requirements?:** The aim of this WG is to provide TSOs and technology providers for a future transmission grid a clear picture of available, near-term and long-term technological options. The focus of this work is to promote high level understanding of the need for and implications of these new technologies from a system planning perspective.
- **JWG C4/B4/C1.604 Influence of Embedded HVDC Transmission on System Security and AC Network Performance:** This JWG follows on from previous work on the application of HVDC and examines special control features of HVDC systems, overload capabilities etc.

Business Investment

- **WG C1-15 Review the drivers for transmission investment decisions and the role of technical planning criteria in transmission investment:** This WG reviews the rationale used for transmission investment decisions, establishes the role of technical planning criteria in investment decisions and identifies trends in investment drivers.
- **WG C1-22 New investment decision processes and regulatory practices required to deal with changing economic drivers:** This WG is reviewing decision processes in a changing environment and will propose orientations for future processes.
- **WG C1-23 Transmission investment decision points and trees** This WG is establishing if and how target networks are being used and if they are used to generate decision trees and key decision points. In particular, it is investigating processes used to determine the timelines of the decision points in the different countries and the methods used.
- **WG C1-24 Tools for developing Optimum Network Development Plans:** This WG is studying the need for new tools and techniques to assist in the development and economic justification of long-term transmission plans.

Asset Management

- **TB 422 Transmission Asset Risk Management:** This TB describes developments in electricity transmission systems and specifically as it applies to the major risk of asset aging. In particular it identifies international developments

in asset management that have influenced new approaches and specifications which emphasise or mandate risk management as one of the key processes for asset management decision making.

- **Invited Paper, “Asset Management Strategies for the 21st Century”, *Electra*.** The article summarises the current status of asset management in transmission companies, as informed by CIGRE analysis and industry best practice. It also reviews emerging trends in asset management, which is of particular relevance to decision-makers and executives.
- **WG C1-25 Risk Management and Information Processes for Asset Management in Electricity Transmission Companies for current and future power systems:** This WG will provide an insight into the current and future application of asset management, risk management and the information needed for these processes in electricity transmission companies as we prepare for future challenges.

Future work

Future work is aligned to the context described earlier and will ultimately be categorised into system development, business investment and asset management. The latter will particularly consider the implications of the activities on asset management strategies and methods. The work is also guided by two technical committee projects “Power Systems of the Future” and “Energy Efficiency”. Both have helped elevate broader, system-wide issues.

Power Systems of the Future

The Power System of the Future project has framed its work around 10 key technical issues which need to be solved to keep the system operating efficiently and managing the, at times contradictory, policy responses and market pressures. Each of these individual Technical Issues has a set of identified key challenges and areas of work for individual Study Committees. In the case of SC C1, the following indicative activities will guide the next tranche of Working Groups:

- More sophisticated and detailed demand forecasting which recognises the changing nature of supply and demand in light of climate change related policies and the evolving difficulties associated with embedded generation
- The need for major investment to accommodate future demand in the context of new technologies and increasing uncertainty
- The future of reliability in terms of what; the customer needs; the future system can accommodate and; new technologies can deliver
- Greater flexibility for accommodating variable intermittent generation
- The potential for super-grids which integrate renewables from remote areas such as the North sea and African desert to major load centres

- Tools and approaches for planning networks which integrate HVDC and HVAC networks
- Investigation into what is the most efficient means of planning and operating the network with regard to the transmission and distribution interface.

Energy Efficiency

The Energy Efficiency project has identified four priority technical areas which are critical to the success of this initiative. They include high efficiency equipment; emerging technological options; new network topologies; and energy storage. In particular, new network topologies and energy storage contain a number of areas relevant for future work in SC C1.

In relation to new network topologies, specific areas of work include:

- Developments in UHVAC and HVDC Grids as an overlay
- Providing interconnections between large, separate systems
- Examination of new information from smart meters and distribution SCADA systems which is highlighting key system inefficiencies (eg. distribution transformers)
- Load shifting (demand management)

For energy storage, specific areas for future work are:

- Maximising the value of energy efficiency measures by using energy storage to allow demand reduction when it has the highest value and to apply load to generation at times of low demand
- Integrating energy storage in HV grids
- Examining the influence of bulk energy storage

New Working Groups

The future work outlined above will be regularly reviewed for relevance and priority and will shape new working groups as resources become available. In line with this approach, a recently approved and a new proposed Working Group, are as follows:

C1.27 Definition of reliability in light of new developments in various devices and services which offer customers and system operators new levels of flexibility This WG will determine if there is a need for a modified or expanded definition of adequacy in light of the expected new devices and services.

Proposed WG “Planning challenges for major transmission interconnections between regions and countries” This WG will draw upon examples of successful interconnections from across the world and provide useful information for planners in developed and fast developing regions to increase their electrical systems integration.

Meetings and events

- Joint C1, C2, C5 Symposium, “Operation and Development of Power Systems in the New Context”, Guilin City, Guangxi Province, China, October 28 - 30, 2009.

- Joint C1, C2 and C4 Symposium, “Assessing and Improving Power System Security, Reliability and Performance in Light of Changing Energy Sources”, 3-6 April 2011, Recife, Brazil.
- “The Electric Power System of the Future: Integrating supergrids and microgrids”, 13-15 September 2011, Bologna, Italy.
- SC C1 is planning to hold a symposium in South Africa in 2013 which will be held in conjunction with other Study Committees and its annual C1 meeting.

Workshops

A workshop was held in conjunction with the Joint C1, C2 and C5 Symposium in Guilin, China on October 27, 2009

- “Wind generation: Issues for investment and system operation”.

A workshop was also held in conjunction with the Joint C1, C2 and C4 Symposium in Recife, Brazil on April 3, 2011:

- “Integration of Renewable and Storage Energy to Deliver Optimum System Performance”.

Further information on these workshops can be obtained by contacting the SC Secretary, Peter Roddy or the the SC Chairman, Phil Southwell. Contact details can be found on the C1 website.