CIGRE Study Committee C1

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP[1]

WG N° C1.39	**Name of Convenor:** Chongqing Kang (China) **E-mail address:** cqkang@tsinghua.edu.cn
Strategic Directions #[2]: 1, 3	**Technical Issues #[3]:** 4, 7
The WG applies to distribution networks[4]: Yes	
Potential Benefit of WG work #[6]: 1, 2	
Title of the Group: Optimal power system planning under growing uncertainty	

Scope, deliverables and proposed time schedule of the Group:

Background:

Power systems are faced with unprecedented growing uncertainties coming from:

(1) Countries around the world set very aggressive goals for the high penetration of renewables in the future power systems.

(2) Electrification of transportation, heating and cooling brings significant uncertainty on the demand side.

(3) The development of distributed energy, micro-grid, energy storage facilities and smart grid contributes increasing uncertainty to the power system.

(4) The worldwide trend of power reform and marketization bring policy and structural uncertainties to the power system.

The growing uncertainty will fundamentally change the way that the power system balances the generation and load, and further challenge the power system planning. For example, China's large wind farms are generally far from the load center, at the end of the grid. Large-scale wind power integration will inevitably inject more uncertainty into the power system. Wind farm access to the regional grid is often weak and it's uncertainty not only affects the voltage stability and frequency stability of the power grid, but also affect the power flow distribution, which brings a series of new challenges to the power system planning.

Traditional power system planning is a "routine" that uses deterministic methodology and fixed criteria, which are similar all around the world. However, as the power system evolves, such as massive renewable energy integration, the traditional methodology and criteria may not be applicable. New ways of planning have been explored, but are different around the world. Making optimal investment decisions under growing uncertainty requires common perspectives on the challenges and new mechanisms, methodologies, and criteria, specifically:

(1) Understanding of the impact of uncertainty factors on the reliability, economy, stability and sustainability of power system, and the interrelationship among the various factors.

(2) Widely accepted mechanism and robust planning methodologies under uncertainty, such as generation planning with high share of renewable energy, risk based transmission network planning, etc.

(3) Probabilistic planning criteria under uncertainty. Such as typical operating state chosen, safety margin, capacity reserve requirement.

Making investment decisions under growing uncertainty is a significant issue that the power systems around the world need to address in the near future. It requires comprehensive

understandings of mechanism, methodologies, experiences as well as policy and technical barriers for implementing investment decisions under growing uncertainty. Gathering the worldwide experiences and insights from experts would be beneficial to improve such understanding. Therefore, the proposed working group well matches CIGRE's distinctive character of unbiased vision and worldwide excellence.

Scope:

The investigated dimensions for optimal investment decisions under growing uncertainty will include:

1. Collecting the uncertainty factors considered and methodologies employed in the grid planning analysis from countries of all continents at present. Both uncertainties from the generation side and the demand side, transmission level and distribution level are to be included. Data and overview on the impact of the uncertainties will be covered, to identify the challenges of uncertainty on power systems.
2. Summarizing lessons learned from grid planning under growing uncertainty. Collect overview of mechanisms, methods and criteria of power system planning under growing uncertainty from grid companies or independent system operators. Search and review relevant prior work, in particular CIGRE's previous papers and brochures.
3. Introducing best practice of planning under growing uncertainty around the world. Identify key grid planning theories and technologies utilized under different market schemes. Access different methods of grid planning under growing uncertainty in different power systems around the world.
4. Identifying specific requirements for power system planning under growing uncertainty and carrying out up to five cases study on the real grid configurations.

For the above topics, a survey of existing data and cases shall be done, analyzing the drivers, rationale and criteria for the selected grid-planning model under growing uncertainty, with scope to infer some general principles as useful guidelines for the design of future projects. Innovative models, aimed at achieving the efficient planning with uncertainty considerations, shall also be proposed.

Deliverables:

☒Technical Brochure and Executive summary in Electra

☒ Electra report

☒ Tutorial[5] - To be determined upon receipt of survey responses

Time Schedule: start: January 2017 **Final Report**: October 2019

Agreed ToR: March. 2017
1st WG meeting: Q2/2017 (Dublin)
Design and distribute questionnaires Q3/2017
Collection of methodologies and experiences on the power system planning: Q4/2017
Compile and analyze data Q2/2018
2nd WG meeting: Aug. 2018 (Paris)
Best practice chosen: Q3/2018
Draft report on survey results and best practice: Q4/2018
WG meeting, milestone report to C1: Q1/2019
3rd WG meeting to discuss draft report: Q2/2019
Presentation to C1 at the 2019 CIGRE Session, August 2019
Final report: Oct 2019

Approval by Technical Committee Chairman: M. Wald

Date: 17/03/2017

Notes: [1] or Joint Working Group (JWG), [2] See attached Table 2, [3]See attached Table 1,

[4] Delete as appropriate, [5] Presentation of the work done by the WG, [6] See attached table 3

Table 1: Technical Issues of the TC project "Network of the Future" (cf. Electra 256 June 2011)

1	Active Distribution Networks resulting in bidirectional flows
2	The application of advanced metering and resulting massive need for exchange of information.
3	The growth in the application of HVDC and power electronics at all voltage levels and its impact on power quality, system control, and system security, and standardisation.
4	The need for the development and massive installation of energy storage systems, and the impact this can have on the power system development and operation.
5	New concepts for system operation and control to take account of active customer interactions and different generation types.
6	New concepts for protection to respond to the developing grid and different characteristics of generation.
7	New concepts in planning to take into account increasing environmental constraints, and new technology solutions for active and reactive power flow control.
8	New tools for system technical performance assessment, because of new Customer, Generator and Network characteristics.
9	Increase of right of way capacity and use of overhead, underground and subsea infrastructure, and its consequence on the technical performance and reliability of the network.
10	An increasing need for keeping Stakeholders aware of the technical and commercial consequences and keeping them engaged during the development of the network of the future.

Table 2: Strategic directions of the TC (ref. Electra 249 April 2010)

1	The electrical power system of the future
2	Making the best use of the existing system
3	Focus on the environment and sustainability
4	Preparation of material readable for non-technical audience

Table 3: Potential benefit of work

1	Commercial, business or economic benefit for industry or the community can be identified as a direct result of this work
2	Existing or future high interest in the work from a wide range of stakeholders
3	Work is likely to contribute to new or revised industry standards or with other long term interest for the Electric Power Industry
4	State-of-the-art or innovative solutions or new technical direction
5	Guide or survey related to existing techniques. Or an update on past work or previous Technical Brochures
6	Work likely to have a safety or environmental benefit