CIGRE Study Committee C1

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

WG* N° C1.35	**Name of Convenor :** Jun Yu (CN) **E-mail address**: yu-jun@sgcc.com.cn	
Technical Issues # [(2)]: 4, 7, 10		**Strategic Directions # [(3)]: 1, 3, 4**
The WG applies to distribution networks [(4)]: Only indirectly		
Title of the Group: Global electricity network feasibility study		

Scope, deliverables and proposed time schedule of the Group :

Background :

The concept of a global electricity network would address the challenges, benefits and issues of uneven distribution of energy resources across the world, as they affect the goal to achieve overall sustainable energy development. A global electricity network can be envisaged to consist of inter-continental and cross-border backbone interconnections as well as the power grids (transmission and distribution networks) in all interconnected countries at various voltage levels. The global electricity network would take advantage of diversity from different time zones, seasons, load patterns and RES intermittent availability, thus supporting a balanced coordination of power supply of all interconnected countries.

The large-scale utilization of fossil energy has resulted in a series of prominent problems such as occasional resource shortages, environmental pollution and climate change. Based on Ultra High Voltage AC/DC, smart grid technologies, and clean energy generation, the global electricity network would hopefully provide a secure, manageable, affordable, renewable, technologically advantageous and sound solution for sustainable and reliable energy supply.

To date, few studies of such a future global network have been undertaken, and barriers for its realisation would be paramount, requiring political vision and a worldwide collaborative mood, however the high potential rewards of such a concept deserve a scientific, expert-based and truly international effort, well matching CIGRE’s distinctive character of unbiased vision and worldwide excellence.

Scope :

To carry out the first known feasibility study by grid experts from countries of all continents, on the technical challenges, potential benefits, economic viability, fit with global energy policies and environmental impact for the concept of a global electricity network. The main steps are:

1. Collect relevant data on energy supply, consumption and transportation patterns from international organisations, in particular IEA, for the different areas of the world (areas to be identified with energy-interdependency criteria); search and review relevant prior work, in particular CIGRE’s Network of the Future paper.
2. Adopt one reference long term scenario for consumption and supply volumes, which shall be credible, prudent, consistent with the global climate protection goals of 2 ton CO_2 equivalent emissions per person and per year, which implies electrification of heating and transport; the scenario shall be considered more as an input than a focus of the WG study, therefore effort shall be placed on sound and robust selection/adaptation of existing authoritative projections and making them consistent worldwide, rather than on building/arguing the scenario itself or sensitivity cases.

3. Identify key grid technologies and architectures to be then utilised as building blocks of the new interconnections. This shall consider AC vs DC solutions, underground vs OHL splitting, voltage levels, capacity levels, number of parallel circuits/redundancy & reliability levels, basic HVDC configuration (bipolar vs multi-monopolar schemes, ground/sea return vs metallic return, converter technology, cable performances).
4. Sketch possible global transmission links at both intra-continental and inter-continental scale with particular effort in coordinating the overall picture. This would extend to large links which do not exist nor get studied today between neighbouring areas, for example: between Central Asia, India, China and Siberia, between Europe, North Africa and Middle East, between Canada and the US sunny deserts and windy prairies, between the Amazon immense potential and the load centers further south, between Australia and the South-East Asia. Subsea cables connecting areas and continents shall also be considered, after identifying the technical limits and performances expected in the selected time-horizon.
5. Provide a rough estimation of the economic viability of the major interconnections, based on a very simplified model for optimizing the overall system costs, comprising construction and operation of conventional and renewables power plants, of storage facilities, of transmission grids between areas; under certain boundary conditions (cap on CO_2 emissions, minimum self-sufficiency rate per country, etc.), the model shall consider a 1-node-per-area topology, i.e. neglecting transmission issues inside each area, in order to capture first-order effects and mega-trends (at least at an approximate abstract level), like the daily and seasonal interplay of hydro, wind, sun, and time-zone differences (e.g. peak PV production time moves regularly across longitude). Aiming at both dimensions of energy (TWh) and capacity (GW), each node has attached demand and load patterns, RES potentials and production, transmission connections to neighbouring nodes; demand in every area has to be met in every time-span (initially corresponding only to day-night and main seasons) by the selected technology mix and inter-area transmission capacities. Only a static approach is used: dynamic issues are out of scope. Upon consolidation of this macro-approach, future studies can be conducted with larger granularity, time-wise and space-wise.
6. Identify specific advantages of global interconnections as additional to those deriving from the parallel processes of subcontinental-scale grid integration, of deployment of smart grids, demand response and battery storage; in very basic terms, this means to analyse the trade-off between investing in more transmission or more generation, especially fossil fuelled; the trade-off shall be not only in economic terms, but also in environmental impact (CO_2, footprint, etc.).
7. Identify separately technical and socio-economic challenges for the realisation of global interconnections; provide a qualitative roadmap to overcome such barriers.
8. Summarise previous analysis into a description of costs, benefits, risks, challenges, and factors required for a global network to become feasible in the coming decades. To the extent made possible by the confidence level of the input data and of the depth of the analysis, extract some general principles and criteria for such feasibility to materialise; these may differ by continent.

Time Schedule: December 2015 – August 2018

Agreed ToR: Dec. 2015

1st WG meeting: Q1/2016

Collection of available data: Q2/2016

2nd WG meeting: Aug. 2016 (Paris)

Scenarios defined: Fall 2016

Possible transmission schemes and sketches defined: Q1/2017 WG meeting, milestone report to C1: May 2017 (Dublin) Viability estimation after scope step 4: Summer – Fall 2017 WG meeting to discuss draft report: Winter Q4/2017 Presentation to C1 at the 2018 CIGRE Session, August 2018 Final report: Fall 2018 **Deliverables :** Technical brochure, summary in Electra, Tutorials, conference presentations
Comments from Chairmen of SCs concerned :
Approval by Technical Committee Chairman : M. Waldron **Date** : 25/02/2016

(1) or Joint Working Group (JWG) - (2) See attached table 1 – (3) See attached table 2
(4) Delete as appropriate

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 within distribution level and to the upstream network.
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 (cf. 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