CIGRE Study Committee C6

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

WG C6.41	**Name of Convenor:** Pablo Arboleya (Spain) **E-mail address**: arboleyapablo@uniovi.es	
Strategic Directions #[2]: 1, 2	**Sustainable Development Goal #[3]: 9, 11**	
The WG applies to distribution networks: Yes		
Potential Benefit of WG work #[4] : 1, 2, 3, 4, 5		
Title of the Group: Technologies for Electrical Railway Distribution Supply Systems		

Scope, deliverables and proposed time schedule of the WG:

Background

Railway transportation plays an increasingly important social and economic role in many parts of the world as it is green, comfortable and reliable. In recent years, high speed railways and urban transit have become popular, especially in East Asia and Europe.

High-speed railway operates significantly faster than traditional rail traffic, using an integrated system of specialized rolling stock and dedicated tracks. While there is no single standard that applies worldwide, new lines in excess of 250 km/h and existing lines in excess of 200 km/h are usually considered high-speed. Some specific regulations extend the definition to include lower speed rail systems in areas in which these speeds still represent significant improvements.

High speed and long-distance railways are typically fed using ac systems at the mains frequency. Other supply systems are also used, including legacy systems. Other transportation systems, such as suburban railways, light trains, trams and urban mass transportation systems, may use dc distribution systems.

The basic structure of the ac and dc railway supply systems has remained mostly unchanged for decades. The ac systems are single phase/level systems connected to the ac distribution or possibly transmission networks by means of power transformers. Special connections may be used to reduce unbalances. In the case of bi-level systems, mostly used in high speed applications, an autotransformer configuration is used to increase the distribution voltage and the distance between substations. In the case of the dc systems, they are usually connected to the ac distribution grid by means of rectifier substations using power transformers feeding conventional diode rectifiers.

The degree of controllability of such systems is low and power quality issues may arise. In the recent years, new technologies have appeared making the operation of these systems more flexible, improving the performance of the traction networks and reducing the impact on the main grid. In the case of ac systems, new railway power conditioners and flexible ac distribution devices are being proposed. In the case of dc networks, conventional non-reversible diode rectifier-based substations are being replaced with converters and substations that can regenerate traction system power into the main grid. The use of on-board or wayside storage systems is being considered and deployed in both ac and dc railway distribution systems. The deployment in railway supply systems of renewable distributed generation and distributed storage is also considered.

The new technologies being installed in the railway supply systems are changing the older and current railway supply paradigm and justify setting up a working group to study this significant load on active distribution grids.

Results from ongoing working group C4.51 "Connection of Railway Traction Systems to Power Networks" will be taken into account.

Scope

The scope of this working group is to study different systems, technologies and trends in ac and dc railway distribution supply systems, to assess their benefits to and impacts on active distribution grids, and their potential to enable enhanced operation of these grids. On-board traction equipment is outside the scope of this working group. It also proposes impact analysis tools and unified mathematical models for traction supply systems allowing operators and developers to carry out planning and operation studies of existing and new railway distribution networks.

The brochure will explore and discuss the following topics:

1. Historical perspective and review of existing installations, evolution and state of the art of electrical railway distribution supply systems – DC distribution, ac/dc converter stations (rectifiers), reversible ac/dc converters, dc and ac traction equipment power supply requirements – AC distribution, ac substations, traction equipment power supply requirements – Railway supply grid interaction and grid codes – Operation and power exchange with the distribution network, to meet railway system power and energy requirements.
2. Integration of distributed energy resources (DER), including renewable energy resources and electrical storage systems, into the railway supply system – Point of connection to the railway supply grid, installation principles, grid codes and business case.
3. Evolution of railway power systems towards integrated energy management concepts – Applying microgrids energy management principles to railway supply systems incorporating DER – Deployment of dc energy hubs for the integration of distributed energy resources and the installation of supply nodes for the charging of other electric transportation modes, including electric vehicles and truck.
4. Review and presentation of analysis and impact assessment tools for railway supply systems, incorporating DER and dc energy hubs – Planning and operation of railway supply systems, including wayside and onboard electricity storage, reversible substations, and dc energy hubs – Mathematical models for pseudo-static or dynamic simulation of ac and dc networks supplying railway equipment – Impact analysis and assessment of railway supply systems on distribution system performance and effective use of assets.
5. Evaluation of future trends in ac and dc railway supply systems, new power conversion devices, network configurations and supply system operation approaches.

Deliverables:

☒ Technical Brochure and Executive Summary in Electra
☒ Electra Report
☐ Future Connections
☐ CSE
☒ Tutorial
☒ Webinar

Time Schedule: start: October 2020 **Final Report**: December 2022

Approval by Technical Council Chairman:

Date: September 27th, 2020

Notes: [1] Working Group (WG) or Joint WG (JWG), [2] See attached Table 1, [3] See attached Table 2 and CIGRE reference Paper: Sustainability – at the heart of CIGRE's work. [4] See attached Table 3

Table 1: Strategic directions of the Technical Council

1	The electrical power system of the future reinforcing the End-to-End nature of CIGRE: respond to speed of changes in the industry by preparing and disseminating state-of-the-art technological advances
2	Making the best use of the existing systems
3	Focus on the environment and sustainability (in case the WG shows a direct contribution to at least one SDG)
4	Preparation of material readable for non-technical audience

Table 2: Environmental requirements and sustainable development goals

	CIGRE selected the 7 SDGs that are the most relevant to CIGRE. In case the WG work refers to other SDGs or do not address any specific SDG, it will be quoted 0.
0	Other SDGs or not applied
7	**SDG 7: Affordable and clean energy** Increase share of renewable energy; e.g. expand infrastructure for supplying sustainable energy services; ensure universal access to affordable, reliable, and modern energy services; energy efficiency; facilitate access to clean energy research and technology
9	**SDG 9: Industry, innovation and infrastructure** Facilitate sustainable infrastructure development; facilitate technological and technical support
11	**SDG 11: Sustainable cities and communities** Increase attention on sustainable and resilient buildings utilizing local (raw) materials, power for electric vehicles, strengthening long-line transmission and distribution systems to import necessary power to cities, developing micro-grids to reinforce the sustainable nature of cities; protect and safeguard the world's cultural and natural heritage; reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and waste management
12	**SDG 12: Responsible consumption and production** E.g. Promote public procurement practices that are sustainable; address reducing use of SF6 and promote alternatives, encourage companies to adopt sustainable practices and to integrate sustainability information into their reporting cycle, address inefficient fossil-fuel subsidies that encourage wasteful consumption
13	**SDG 13: Climate action** E.g. Increase share of renewable or other CO_2-free energy; energy efficiency; expand infrastructure for supplying sustainable energy; strengthen resilience and adaptive capacity to climate-related hazards and natural disasters; integrate climate change measures into national policies, strategies and planning; improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning
14	**SDG 14: Life below water** E.g. Effects of offshore windfarms; effects of submarine cables on sea-life
15	**SDG 15: Life on land** E.g. Attention for vegetation management; bird collisions; integration of substations and lines into the landscape

Table 3: Potential benefit of work

1	Commercial, business, social and economic benefits 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 directions
5	Guide or survey related to existing techniques; or an update on past work or previous Technical Brochures
6	Work likely to contribute to improved safety.