High Level Conference:
"DC Electricity Distribution"
07 May 2019
Guarda, Portugal

Venue: Escola Superior de Tecnologia e Gestão, Polytechnic of Guarda,
Avenida Dr. Francisco Sá Carneiro, n.º 50, Guarda
(GPS: 40.5422107; -7.2810602)

Co-financed by: COMPETE 2020 PORTUGAL 2020 UNIÃO EUROPEIA Fundo Europeu de Desenvolvimento Regional

Auditório, Escola Superior de Tecnologia e Gestão

Tuesday, 07 May 2019	
09:00	Participants Registration
09:30	**Opening Session**: Joaquim M. F. Brigas, President of Polytechnic of Guarda and Antonio J. Marques Cardoso, Director of CISE - Electromechatronic Systems Research Centre
10:00	**Mario Dionisio, Programme Officer, European Commission, DG Energy**: "DC Based Architecture Enabling Grid Development, Cybersecurity and High RES Penetration"
11:00	**Coffee Break**
11:30	**Bernd Wunder, Group Manager "DC Micro Grids", Fraunhofer IISB**: "Challenges and Opportunity of DC Microgrids based on Cognitive Power Electronics"
12:30	**Lunch Break**
14:00	Visit to **Guarda International Research Station on Renewable Energies** (CISE | GIRS-RES)
14:45	**End of the visit**

Mario Dionisio, Programme Officer, European Commission, Directorate General for Energy

Mario Dionisio is a Programme assistant for EU policies in the directorate General for Energy of the European Commission in Unit C2 - New energy technologies, innovation and clean coal. He contributes to the development of relevant policies and programmes in the renewable energy domain. Actually, his main activities are focused on the digitalisation of the electrical power system. He is involved as well in the development of the Energy Work Programmes within H2020 and the implementation, management, co-ordination and related follow-up of energy research projects.
Mario holds a master degree in industrial engineering in electromechanics.
Prior to join the European Commission, he worked for 13 years in the Gran Sasso National Laboratories of the National Institute for Nuclear Physics (Italy) in the project and maintenance department for safety systems. Previously, he worked in the electric-electronic domains in ENEL, RAI (Italy) and Ericsson (Canada).

DC Based Architecture Enabling Grid Development, Cybersecurity and High RES Penetration

Abstract

The current AC based electricity system is guaranteeing energy supply to humankind since more than a century. Today, in the midst of the energy transition, this electricity system is challenged by the increasing penetration of renewables, the decentralisation of generation and the digitalisation. If, on one side, all these contribute to the EU's decarbonisation objectives, on the other, they represent growing complexities for an AC based electricity system. The most critical ones are 1. Long term grid planning and investments (horizon 2050), due to multiple scenarios development; 2. Countermeasures to faults and cybersecurity threats, due to the cascading effect; 3. The accommodation of increasing shares of renewables in an AC system with sensitive electrical parameter deviations constraints.

Today, the technological developments of power electronics, the enhanced converter technologies and the observation that many renewables generate in DC and much of the loads and equipment are already in DC, allows to look at

DC based systems as a potential flexible, secure and reliable solution.

A meshed DC electricity system architecture underlying interconnected local/micro/nano grids has the potential to address all of the three aforementioned challenges: 1. The modular characteristic of DC interconnection allows the development and coexistence of DC with AC grids (a hybrid electrical system); 2. This fractionated system restrains the cascading effect deriving from cyberattacks or faults; 3. Reduced and less critical electrical parameter constraints for RES penetration. Modelling is paramount to demonstrate, test and validate DC – AC/DC hybrid energy systems viability based also on a cost benefit analysis. The European Commission is technology neutral and supports R&D&I through the Work Programmes (ongoing Horizon 2020 and the next Horizon Europe 2021 – 2027), for innovative technologies aiming at a secure, clean and efficient energy at the benefit of all EU citizens.

Image

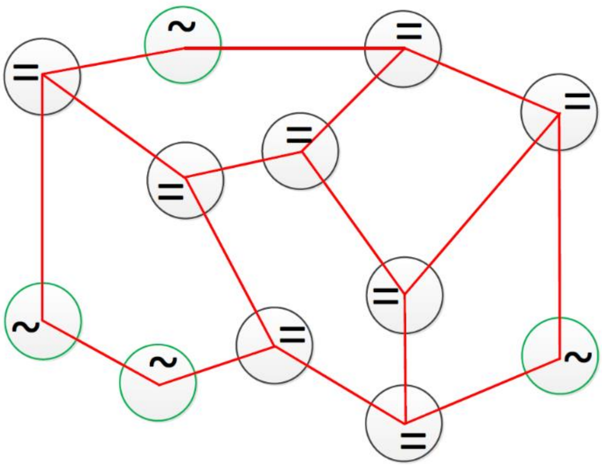

Figure 1: Symbolic representation of a hybrid grid

Publications

Dionisio M. (2018) Interactive Vertical Axis Wind Turbines: an Experimental Study.

2. Franciotti D., Aprili PG., Dionisio M. (2001) European Safety and Reliability of "The Italian Gran Sasso National Laboratory in the Gran Sasso Highway Tunnel, a unique situation of cohabitation between a road tunnel and an Underground High Energy Physics Laboratory – An example of Safety analysis performed for one of the main experiments".

Bernd Wunder, Group Manager "DC Micro Grids", Fraunhofer IISB

Bernd Wunder has received a degree in Electrical Engineering from Friedrich-Alexander University Erlangen-Nuremberg in 2010. From 2010 until 2013 he was employed as scientific assistant at the Chair for Electronic Components and developed several power electronic systems for EVs. In 2013 he founded the group for DC microgrids at the Institute for Integrated Systems and Device Technology (IISB) to design new destructive infrastructure for regenerative and sustainable energy usage. As well-known DC entrepreneur he was honoured and strongly supported the IEEE ICDCM2015 and organized the IEEE ICDCM 2017 conference in Nürnberg as leader of the technical program. He is also active in IEC where he represents Germany as national delegate in the IEC SyC LVDC committee. In 2017 his team founded the start-up CEUS to makes their ideas and new technologies available to everyone.

Challenges and Opportunity of DC Microgrids based on Cognitive Power Electronics

Abstract

A DC-based low-voltage power supply offers many advantages over the historically grown AC voltage infrastructure. This lecture shows the potentials for cost reduction, efficiency enhancement and equipment miniaturization thru new cognitive power electronics, but also discusses the obstacles to a faster market penetration of DC microgrids. These constraints include aspects of grid control, grid stability, security and safety. As main challenge, the arc phenomena in connectors, which affects all mechanical connectors in a DC grid installation, will be discussed.

Motivation: One of the driving forces behind the electrification of Germany, initiated more than a hundred years ago, was undoubtedly promoted by mill owners and agriculturists, who experimented direct current dynamos, generating their own power. The many advantages of electricity, and especially the convenience of electrical lighting, prompted a rise in demand and its rapid expansion. Nowadays, electric energy systems based on a single-phase AC 50 Hz supply are the standard. To ensure continuous power transmission, every supply unit requires local energy storage elements, namely electrolytic capacitors. To avoid harmonic interference in the AC grid caused by the charging currents of these capacitors, standards require power factor correction (PFC) methods. For the most part, these PFC units are switched mode converters which cause high frequency interferences on their end. These interferences have to be filtered as well, hence requiring more passive components in the AC filter. More than half of the volume and weight of the power supply unit are therefore made up by the AC frontend converter and the supply. At the same time, passive elements are the most expensive part of an AC frontend converter. The majority of the other components have gained from the advances in the field of power electronics, such as enabling miniaturization by raising switching frequencies. Due to the fixed mains frequency of 50/60 Hz and the required energy storage capacity, the potential size reduction of AC frontend converters is very limited. Unsurprisingly, AC power supplies are rarely included in modern, highly compacted electronic appliances, and rather are located in external devices. A number of studies and practical examples were able to confirm these hypotheses. In the example of a computing centre, a DC supply improved the centres energy efficiency by 10 %, decreased its capital cost by 15 % and reduced the space required for DC infrastructure by 25 %. The potential increment in efficiency of a data centre may be as high as 20 %, and the supply reliability is ten times as high. Due to the PFC unit's voltage requirements, this voltage needs to be a little above the peak value of the highest AC mains voltage used by household and office appliances. As per Figure 1, this results in a voltage level of around 380 V.

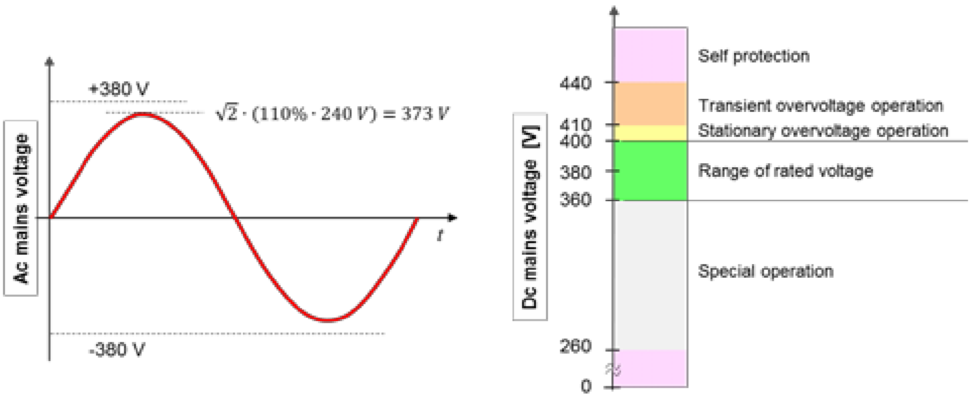

Figure 1. Classic AC / DC mains voltage level and functional voltage bands for DC mains.