

Ingegneria dei  
sistemi elettrici  
*Electric systems*

DII research group  
Power System Group



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[www.dii.unipd.it/en/power-system-group](http://www.dii.unipd.it/en/power-system-group)

Dr. Riccardo De Zan,  
Dr. Maria Rosaria Guarneri,  
Dr. Paolo Sylos Labini and  
Dr. Giuseppe Lavecchia  
with Terna Rete Italia, Rome.

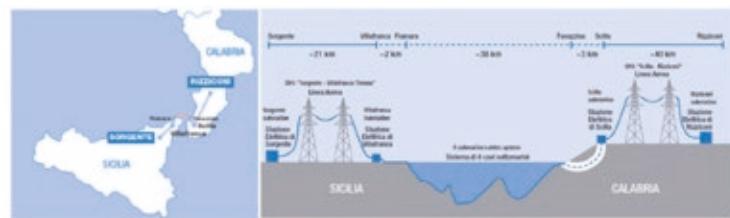


Main research topics:

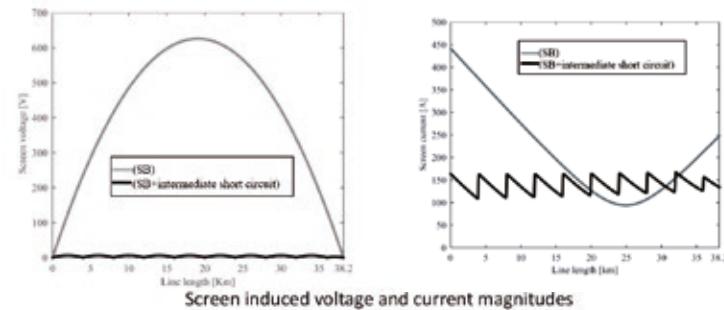
- Smart grids: the operation and control of active networks.
- Voltage regulation in the distribution network with high penetration of distributed generation
- Large-scale energy storage in the network
- EHV/HV dc and ac innovative transmission lines e.g. insulated cables and gas insulated lines;
- Synergy between railway and highway infrastructures and insulated cables
- Multiconductor cell analysis (MCA) of asymmetric systems by means of self-implemented matrix procedures (insulated cables with screens and armours, gas insulated lines with enclosures, overhead lines with one or more earth wires)

## Sorgente-Rizziconi (Sicily-Calabria) 43 km Double-Circuit AC 380 kV Submarine-Land Cables

The Power System Group has investigated and deeply contributed in the analysis and in the planning choices of the future extra-high voltage (EHV) double-circuit cable line between Sicily and Calabria which is a reinforcement of the Italian southern transmission grid. This will be one of the longest AC submarine link in the world. The multiconductor cell analysis (with acronym MCA: software devised and entirely developed by the Group) of these land-submarine double-circuit single-core cables has been compared with an Electro Magnetic Transient Program (EMTP-RV) model with a very good agreement. The different choices of bonding systems implemented in the real Italian installation have been theoretically justified by means of the two software comparison. It is worth remembering that the first link between Sicily and Italy mainland is dated 1955 and was a 220 kV double-circuit overhead line with a crossing span of 3.65 km. In 1981 these overhead lines were dismantled and substituted by a very challenging submarine 400 kV single-circuit cable installation in the difficult environmental conditions of the Messina Strait. More recently, the necessity of substituting this submarine oil-filled cable link and of strengthening the Italian southern EHV grid have brought to the planning and installation of a very long AC double-circuit single-core cable line chiefly constituted of a submarine armoured cable system (38 km long) and of two land parts (wholly about 5 km long) in Sicily and in Calabria Regions. This link with different cable types presents both the most important bondings of cable screens i.e. solid-bonding and cross-bonding. In the submarine part, the cable is armoured and the screen and armour of each single-core cable are bonded together every 4 km. At both ends of the submarine part, all the screens and armours are solid-bonded. The land part is cross-bonded in order to have negligible induced currents in the screens. Therefore, in the submarine part, only solid-bonding is possible: this implies induced currents and voltages in the screens and armours which have been computed. The Group has also demonstrated that in order to keep the screen induced voltages sufficiently low it is necessary to bond them together with armours at given intervals along the submarine part: the evaluation of this length interval has been given by means of MCA. The Group has also clearly shown that the stray current in the sea is practically negligible and the additional losses of solid-bonding armours are very low so giving a very environmental-friendly installation



From left: Cable drum in the cable laying ship Giulio Verne; an installation phase of the submarine laying; an impressive view into the vertical tunnel



Screen induced voltage and current magnitudes