Foreword

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Biographical notes: Sandro Bologna received his degree in Physics from the University of Rome 'La Sapienza'. He has more than 40 years experience with the Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) and abroad, where he has covered different positions as a researcher, head of research units, and head of research projects at national and international levels. His main research activities deal with the achievement and assessment of computer-based system safety and reliability, large networks vulnerability analysis and critical infrastructure protection. In this field, he has co-authored several scientific publications and books and served in the editorial board of different international journals. At present, he is the President of the Italian Association of Critical Infrastructures Experts.

This special issue is based on papers selected from the satellite workshop on topological approach to the vulnerability assessment and cascading failure analysis of electricity networks, organised in the framework of the 7th International Conference on Critical Information Infrastructures Security, held in Lillehammer, Norway, September 17–18, 2012, in short CRITIS'12.

The workshop, organised on behalf of the EU FP7 SASAME Project, https://www.sesame-project.eu/ intended to address the interdisciplinary perspectives on applying the latest results of complexity science to vulnerability assessment and cascading failure analysis of electricity networks (especially electricity transmission grids) by inviting domains experts together with experts in complexity science applied to networks. The main objectives of the workshop were:

- stimulate – on an international level – the cooperation of different communities of researchers, in particular application domains experts and scientists working in the field of complexity science applied to networks
- investigate potential applications of complexity science to carry out different analysis of electricity transmission grids, at different scale (country level, pan-European level, ENTSO-Europe together with IPS/UPS Russian Federation level)
- give an overview of a complex systems approach to large blackouts of electric transmission systems caused by cascading effect based on spread of topological failure
- investigate dynamical modelling of load shedding on sparsely interconnected networks

- explore the possibility of establishing a research network to coordinate, promote and connect the respective skills and research in the field.

Present limitations to topological aspects of the different measures and metrics proposed from the network theory pose severe limits to their application to dynamic systems like electricity transmission grid. On the other hand, it is very desirable that general network theory specialists and specialists on modelling and analysis of the largest man-made interconnected networks in existence, continue to exchange insights and viewpoints.

The workshop has highlighted the role that topological analysis might play in assessing several properties of a complex network, particularly those related to its robustness and fault-tolerance. These methods, when combined to spectral analysis, allow to producing an almost complete description of the topological response of the network. A number of other properties might be disclosed by a network analysis where the adjacency matrix is substituted by a load (or capacity) matrix. This can be used to evaluate both static (equilibrium problem) and the dynamic series of events which may be related to the overload of the network's components induced by some faults or terroristic attack.

The papers selected reflect the breadth of ongoing research in the field, addressing some of the most common open issues and challenges, like:

- Complex networks theory lies at the intersection of graph theory and statistical physics: how to validate the results of complex network analysis (CNA).
- Suitability of CNA to medium/low voltage smart grids.
- New metrics for addressing dynamical properties of the components represented by node and arcs of the graph representing the network.
- How to deal with mutual dependent networks.
- Use of complex networks analysis as a tool to support the design of electricity networks, including smart grids.
- Complexity vs. complicatedness: not to be confused.
- How we can make useful topological models avoiding to increase too much details.

All papers in this special issue were completely rewrote and thoroughly reviewed by several distinguished experts in a blind review process and have been revised to reflect these reviews.

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