# Editorial


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**Biographical notes:** Vahid Madani is a principal protection engineer at Pacific Gas and Electric Co. He is a registered electrical engineer with more than 25 years' academic and utility experience and the recipient of many honorary and distinguished citations, for his leadership and contributions to the power system industry and education. He has an extensive background in signal processing and power systems and has received his degrees from the University of Idaho in the USA. He has various technical, advisory, and leadership roles within the North America and internationally, and has contributed to the development of many advanced applications in power system protection and intelligent restoration. He is the author of more than 60 publications in refereed international journals in system automation, protection and controls applications, and practical wide-area monitoring systems with advance warning and fast restorations. Mr. Madani is a Fellow of IEEE.

Alfredo Vaccaro received his MSc in electronic engineering in 1998 from the University of Salerno. From 1999 to 2002 he was assistant researcher at the University of Salerno, Department of Electrical & Electronic Engineering. Since March 2002 he has been a research scientist and aggregate professor in Electric Power Systems at the Department of Engineering of University of Sannio. He is Associate Editor and/or member of the editorial board of *IET Renewable Power Generation*, the *International Journal of Electrical and Power Engineering*, the *International Journal of Reliability and Safety* and the *International Journal of Soft Computing*. His special fields of interest included soft computing and interval-based methods applied to power system analysis and advanced control architectures for diagnostic and protection of distribution networks. Mr. Vaccaro is a Member of IEEE.


We are pleased to present a series of papers in this issue of the *International Journal of Reliability and Safety* (IJRS) that span from methods for balancing resources to various reliability and security aspects of electrical grid, authored by a number of researchers and practitioners worldwide. This issue of the IJRS not only focuses on technological breakthroughs and roadmaps in implementing the technology, but also presents the much needed sharing of best practices.

The electrical power systems are, in general, amongst the most reliable systems worldwide. These large interconnected systems, however, often operate in critical conditions because of the increasing demand for electricity and the difficulty in improving the infrastructure, due to economic and environmental issues constraints amongst many other reasons. Some of the major challenges facing the electrical industry today include balancing between resource adequacy, reliability, economics, environmental and other public purpose objectives to optimise transmission and distribution resources to meet the growing demand. The capability of a power system depends on network constraints, amount of generated power, line ampacity, nodal voltage amplitudes and stability margins. If modern or enhanced facilities are not affordable, a renewed effort in assessing and rationalising the exploitation of the system capability is recommended.

Armed with this vision, the paper of Bontempi et al. proposes a new dynamic thermal model for overhead lines monitoring aimed to maximise infrastructure utilisation, while ensuring the reliable functioning of the power networks. In particular, the authors Bontempi, Vaccaro and Villacci present a gradient-based data driven technique for calibrating a conductor thermal dynamic model on the basis of observed measures. The approach relies on the computation of the dynamics of the sensitivity of the solution of a differential equation to variations of the parameters. The approach is assessed by calibrating the IEEE thermal model of an overhead power conductor, on the basis of a real dataset, recorded under a variety of operating and weather conditions.

Advanced thermal modelling techniques, if integrated with computational paradigms for online power system security analysis, could contribute to improving infrastructure exploitation and managing the consequent technical and economic risks.

In this connection, new computational paradigms for online power system security analysis are proposed in the papers of Patidar and Sharma. The authors present a model tree based approach, for the fast voltage contingency ranking of the most severe contingencies for online applications in energy management systems in the paper entitled 'Fast voltage contingency analysis of power systems using model trees'. Load shedding for voltage security measures is presented in another paper entitled 'Voltage security assessment and optimal load shedding of power system using case-based reasoning approach'. The proposed methods give fast and accurate voltage security information for unknown patterns and they are found to be suitable for online applications at energy management systems.

The integration of these new paradigms in existing power system control centres could allow system operators to obtain more realistic operational guidance in planning preventive and corrective actions, aimed to mitigate the effect of critical contingencies.

On the other hand, this process should be supported by a sensible upgrading of the existing power system facilities, with an increased pervasion of intelligent electronic devices and distributed data measurements. Power system technological upgrading is a complex task that should be harmonised with the principles and the guidelines developed by the international working groups and task forces. Implementation of technology requires developed methods for testing. A specific aspect of this issue is addressed by Apostolov in 'Testing of complex IEC 61850 based substation automation systems'. This paper covers in detail the main issues deriving from the integration of multifunctional Intelligent Substation Devices in complex substation or power plant automation systems. This integration requires the development of methods and tools for power equipment testing that will ensure the correct operation of protection, control, monitoring, recording and metering functions under normal and abnormal system conditions.

Power system equipment is sometimes very complex, incorporating many different components, often at widely separated places, and often requiring high-speed communications for proper operation. The inherent reliability of such complex systems is a concern of protection engineers and presents a relevant analytical problem. Fault tree analysis represents an important tool, widely adopted in numerous operative contexts, from accident investigation to design prototyping and has demonstrated benefits for protection and control related applications. It is also useful for decision making. A brief introduction on the application of fault tree analysis in power systems protection applications is presented and discussed in the paper of Beresh et al. The authors Beresh, Ciufo and Anders describe how fault tree analysis could represent a strategic tool in analysing power system protection failures. It could also be used for sensitivity analysis, in order to determine what solutions are best for power equipment design purposes.

The development of theoretical and practical aids for the proper selection of reliability models for power system equipment represents another relevant area of research. Renewable energy resources are receiving considerable attention in the continued deployment, growth and development of bulk electric power systems. The most promising electrical energy generating source at the present time is wind power, and governments around the world are making commitments to add considerable wind power to the existing power grids. The increasing use of wind power as an important electrical energy source clearly indicates the importance of assessing the reliability of composite power systems containing significant amounts of wind energy. To address this issue Billinton and Gao propose a procedure to create an analytical model of a multi-unit wind farm that can be used in conventional generating capacity or composite generation and transmission system reliability evaluation, using analytical techniques or state sampling simulation analysis. The studies covered in this article corroborate the common expectation, that multiple wind farms can make a more significant reliability contribution than a single wind farm in a composite generation and transmission system with a strong transmission system and a relatively weak generating system.

A critical review of the main power equipment reliability models proposed in the literature is presented in the paper of Chiodo and Mazzanti. The properties of these models, as well as their practical consequences, are discussed and it is shown that the direct fitting of failure data may have a poor or uncertain outcome, due to the limited amount of data. This paper shows, by means of numerical and graphical examples, that seemingly similar reliability models can possess very different lifetime percentiles and hazard rates. This is a very practical consequence of the model selection which must be carefully accounted for, since it involves completely different maintenance actions and costs.

The integration of power equipment reliability models in maintenance policy planning is addressed by Stopczyk et al. In their paper, authors Stopczyk, Sakowicz, and Anders define optimal maintenance policy models based on semi-Markov processes. Optimal policies are found by means of multi-objective optimisation and modified simulated annealing algorithm. The adoption of this methodology allows power system operators to assess the deterioration stage of the equipment (or even better – the remaining lifetime) and to make a decision concerning further exploitation, repair of individual elements or replacement with new ones.

Careful study and understanding of the complexities of the interconnected power grid and the need for proper planning, good maintenance, and sound operating practices is the key to preventing the problems of tomorrow for this modern-day necessity. Examination of the root causes, the resulting effects on neighbouring systems, and implementation of proven solutions to help prevent the propagation of such large-scale events should help us design reliable power delivery infrastructures for today and in the future. In 'Strategies to meet grid challenges for safety and reliability', Madani and King offer practical solutions to meet a host of power system infrastructure challenges. Implementation of proven solutions, to help prevent the propagation of large-scale events, should help us to design reliable power delivery infrastructures for today and in the future.

The issue also includes a comprehensive suite of reference material for further readings, which we are certain will be of value to our researchers and readers. We thank the authors for providing such a comprehensive listing of analytical and technological roadmaps of industry best practices.

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