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Guest editorial: Maximising flexibility through energy systems integration

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Guest Editorial: Maximising Flexibility through Energy Systems Integration

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Power and energy systems around the world are challenged by the increasing variability and uncertainty imposed by large-scale integration of renewable energy resources, by more frequent natural disasters that threatens the continued supply of energy to customers, and most recently by the global health crisis, COVID-19 pandemic, that has considerably affected the operation of power and energy systems worldwide. To maintain continuous service in the face of rapid and large swings in supply and/or demand, there is a significant need for flexibility – the property of power and energy systems to react and adapt quickly to changes imposed on the system. Flexibility cannot only be provided by resources within individual power and energy systems, but also by efficient integration of electricity, heat/cooling and gas systems across different scales and coupling with other infrastructure.

This Special Issue, one of the first organised by *IET Energy Systems Integration*, focuses on soliciting and presenting the most recent and original modelling approaches, case studies and regulatory frameworks to enable and maximise flexibility through energy systems integration. The seven papers presented in this Special Issue, from researchers in China, Denmark, France, Germany, Italy and the UK, address various aspects related to the flexibility provision from integrated energy systems. The papers demonstrate that there is significant technical potential for providing flexibility to power systems from other energy vectors such as gas, heating & cooling and industrial steam systems, while highlighting the need for changes in the current market structure and regulatory framework to unlock this potential. Brief descriptions of each of the seven papers in this Special Issue is provided below. We encourage you to read the papers for more details.

Witkowski *et al*., in their paper, 'Role of thermal technologies for enhancing flexibility in multi-energy systems through sector coupling: technical suitability and expected developments', discussed different ways that the flexibility from thermal systems can be exploited to support the operation of low carbon power grids. Experiences from seven real-life case studies in Europe were analysed, and technical suitability of the thermal technologies to provide different types of ancillary services were investigated.

Richert *et al*., adopted a co-simulation approach in their paper, 'Operation of supermarket refrigeration units: a coupled district heating and electric network approach', and examined operational strategy of power-to-heat units in coupled district heating and electrical distribution networks. Using a quasi-static electrical load flow model and a dynamic thermal-hydraulic district model, the authors studied the potential of using excess compressor capacity in refrigeration systems, to locally couple district heating and electrical distribution networks, by providing heat peak-shaving services to the district heating network.

Zhang *et al*., in their paper, 'IES configuration method considering peak-valley differences of tie lines and operation costs of power grids', examined the interactions between a local integrated energy system with the power grid. The proposed method for optimal configuration of local integrated energy systems include distributed generation, thermal and electrical energy storage, to balance the investment costs of the local IES and operating cost of the power grid.

A paper by Ameli *et al*., entitled 'Investing in flexibility in an integrated planning of natural gas and power systems', aimed to quantify the value of flexibility to the gas and electricity transmission networks in Great Britain. Their analysis suggests a significant cost savings across gas and electricity system can be achieved through the deployment of flexibility options such as energy storage and demand side response.

Corsetti *et al*., in their paper 'Very-short-term multi-energy management system for a district heating plant enabling ancillary service provision', carried out simulation to study the provision of automatic frequency regulation reserve from a generation district heating system in the north of Italy. This work demonstrates the value of flexibility from district heating systems, which are growing in number across Europe, not only to support the operation of the power systems, but also to establish an additional revenue steam for the heat networks.

A UK-Austria collaboration has resulted in a paper by Xu *et al*., 'Quantifying flexibility of industrial steam systems for ancillary services: a case study of an integrated pulp and paper mill'. The authors presented a method to quantify electricity generation flexibility of a typical industrial steam system with a steam turbine-generator and process heat demands. A real case study in Austria was used to demonstrate the potential of industrial steam systems to provide manual frequency restoration reserve and its financial benefits to the industrial facility.

A collaboration between researchers from France, Germany and Spain resulted in a paper by Cauret *et al*., 'Flexibility provision through enhanced synergies between electricity, gas and heat systems: a comparative analysis of market and regulatory frameworks in seven case study countries', that compares energy markets and regulatory frameworks for heat, gas and electricity in seven European countries. The authors identified key market, regulatory, and cultural barriers against maximising the provision of flexibility services by multi-energy systems.

Guest Editor Biographies

Dr. Masood Parvania is the Director of Utah Smart Energy Lab (U-Smart) and Associate Professor of Electrical and Computer Engineering at the University of Utah. His research looks at developing novel control and optimisation models for enhancing the operational flexibility and cyber-physical resilience of power and energy systems. Dr. Parvania serves as Associate Editor for the IEEE Transactions on Smart Grid, the IEEE Power Engineering Letters, and the *IET Renewable Power Generation*. He is the Chair of the IEEE PES Bulk Power System Operation Subcommittee, and vice-chair of the IEEE PES Reliability, Risk and Probability Application (RRPA) Subcommittee.

Dr. Henrik W. Bindner is a Senior Researcher in Technical University of Denmark. His main research interests include integration of renewable energy into power systems using demand side resources, planning and operation of active distribution networks, and operation of integrated energy systems.

Dr Meysam Qadrdan is a Reader in Energy Systems and Networks in Cardiff University. His research area covers expansion and operational planning of interdependent energy networks at different scales from buildings to national level.