

Abstract of Habilitation Thesis

Applications for smart metering systems and management in power engineering

[Aplicații privind sisteme inteligente de măsurare și management în ingineria energetică]

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The proposed work for my thesis „ *Applications for smart metering systems and management in power engineering*” emerged from the present technological and energy policy context in power engineering and from my personal expertise in the field. The thesis is structured in four parts that address the technological and energy policy context, my academic and research background, the results of my research activity after obtaining a PhD degree, and my objectives for future development. References and a list of publications are included at the end of the thesis.

Context

Present technological achievements available at decreasing prices are reshaping the energy system and its interaction with society. The modern world is information oriented, technology dependent, and interconnected. Moreover, the energy system is experiencing a major transformation in the ways energy is produced, used and managed. Its challenge is to assure the balance between energy production and demand (after including various renewable energy sources, demand response, and storage), and to link the different energy sectors (electricity, heat, gas).

To address this issue, efforts are being made towards modernizing the entire energy chain, from generation to distribution, supply and demand. Focussing on digital technologies and web-networking, the goal is to build a smart, integrated but flexible and decentralised digital energy system that performs under constraints of sustainability, security and competitiveness. In this regard, steps are being taken to assure the interoperability of components and systems coming from different sources, to handle a high amount of data in an acceptable time, to develop new applications, and to ensure privacy and security under a clearly defined legal framework.

The implementation of smart energy systems will enable access to real-time energy data, a better control of energy use, operational savings, effective network management (including use of renewables, load-curve flattening etc.), and improved maintenance (by developing predictive maintenance). The overall achievements would be higher energy efficiency and safety, and reduced greenhouse gas emissions.

On the demand side, technology is redefining the role of the consumer. The future system will address a smart energy consumer, who is well educated and engaged. The consumer will become an active player in the energy market by adjusting his consumption and even by participating in the energy production (a prosumer). Moreover, the smart consumer will be able to connect the smart meter and smart appliances to a home network through the Internet of Things. The transdisciplinary concept of smart city is meant to integrate efficiently within society smart energy systems and smart consumers, along with other connected sectors (transport, etc.). The goal is to obtain an efficient energy system focussed on the needs and expectations of the consumer. This is also the goal that motivates the habilitation thesis and which I intend to follow.

Background and results of research

The second part of the thesis presents briefly the main achievements I obtained in the last 28 years of activity in the field of power plants operation, design, research, and academic education. By presenting my background, I demonstrated my personal skills to organize and manage teaching activities and work-teams, to use modern technologies, and to approach new directions of research. In addition, I showed my capacity to engage in research and coordinate national and international research projects (as project manager, energy consultant or member of the team).

My professional experience covers a large range of activities in the energy field:

- maintenance (as Junior Engineer at the Giurgiu Power Plant, ISPE, between 1987-1990),
- design and consultancy (as Design Engineer at the Institute of Power Studies and Design of Bucharest, between 1990-1999),
- education and research (as Lecturer between 1999-2017 and Associate Professor starting 2017, at the University POLITEHNICA of Bucharest, Faculty of Power Engineering, Department of Power Use and Generation),
- NGO work (Executive Director at the Romanian Energy Policy Association, APER, starting 2006).

Results of my work have been presented at workshops and conferences or were published in journals or conference proceedings. My research activity is summarised by the following synthetic indicators: PhD thesis in the field of power plant modelling and simulation (at the University POLITEHNICA of Bucharest); 10 books, courses and handbooks (on non-electrical parameters measurement, numerical methods, modelling and simulation); 23 articles published in scientific journals (20 indexed in international data bases out of which 5 indexed ISI Web of Science); 35 articles published in proceedings of national and international conferences (10 indexed ISI Web of Science); 4 national grants (member); 2 international grants (project manager); 22 research contracts in power engineering (1 international); 28 communications at workshops and unpublished conferences; member in 4 technical committees of IEEE conferences; reviewer for 2 ISI journals; organizer of 16 workshops and forums.

Researcher Ids and links: Scopus Author ID: 55819288500 and 6602342767; ResearcherID: M-9861-2013; ORCID Number: <https://orcid.org/0000-0002-1916-8167>; Google Academic: https://scholar.google.ro/citations?user=_8B6FjgAAAAJ&hl=ro Research Gate: https://www.researchgate.net/profile/Ioana_Opris

Research activity undertaken after obtaining my PhD degree in May 1997 has been in close connection to my professional work as design engineer, teacher, executive director, project manager and energy consultant. With these positions, I explored, analysed or developed applications in a broad range of subjects. The main directions of research in power engineering which were detailed within my habilitation thesis are:

1. Modelling and simulation of power plant equipment and systems,
2. Software applications for smart devices and smart metering systems,
3. Web applications (e-learning and use of augmented reality),
4. Analysis of energy policy and social issues,
5. Innovative solutions in education.

Objectives of future development

My future objectives are designed and based on my research experience and point towards the technological, political and social tendencies in power engineering. The two core priorities for my future direction of research and innovation are highlighted within the title of the habilitation thesis:

1. smart systems: advanced research on smart metering systems and management in power engineering,
2. energy consumers: integrated & flexible solutions oriented towards energy consumers within the Internet of Things.

The focus on these issues is in line with the research and innovation plan of the EU. The digitalization of the energy system and the deployment of smart metering will soon enable the building and sharing information throughout the national and pan-European smart-grids, introducing new models and software applications for the management and maintenance of the young smart system. The consumer will be an active part in the `energy game` and will receive more valuable services. Rendering thus the energy issue into a transdisciplinary subject, by involving both the public and the interested stakeholders.

To conclude, the overall goal of my research is to contribute to the development of a highly efficient energy system centred on the consumer.

Bucharest, 21 March 2018