energies

Editorial

Smart Grid as a Key Tool for the Future of Electrical Distribution Networks †

Vitor Fernão Pires [1,*], Ilhami Colak [2] and Fujio Kurokawa [3]

1 Polytechnic Institute of Setúbal, 2910-761 Setúbal, Portugal
2 Department of Electrical and Electronics Engineering, Nisantasi University, Istanbul 34398, Turkey; ilhcol@gmail.com
3 Nagasaki Institute of Applied Science, Nagasaki 851-0193, Japan; kurokawa_fujio@nias.ac.jp
* Correspondence: vitor.pires@estsetubal.ips.pt; Tel.: +351-965251692
† This article belongs to the Special Issue Selected Papers from the 9th International Conference on Smart Grid (icSmartGrid 2021).

Citation: Pires, V.F.; Colak, I.; Kurokawa, F. Smart Grid as a Key Tool for the Future of Electrical Distribution Networks. *Energies* **2022**, *15*, 3281. https://doi.org/10.3390/en15093281

Received: 22 April 2022
Accepted: 28 April 2022
Published: 29 April 2022

1. Introduction

A new paradigm has appeared in the electricity sector with the rapid development of new renewable energy sources, storage systems, information and communication technologies, and ways of integrating distributed energy sources. This is commonly named the smart grid and has changed the way that the electrical network is implemented and managed. Thus, through this new concept, the electrical network has changed in a way that allows for a two-way stream of electrical energy, as well as the use of data with digital communications technology. All of this has allowed us to react and proact to changes in usage and multiple issues. As a result, smart grids have self-healing capabilities and enable electricity customers to become active participants. All these aspects are fundamental to handle the current and future changes. The roles of smart grids are even more critical when viewed in a more global context such as the case of smart cities.

The ninth International Conference on Smart Grid (icSmartGrid 2021) took place in Setúbal, Portugal, between 29 June and 1 July 2021. The purpose of this conference is to bring together researchers, engineers, manufacturers, practitioners, and customers from all over the world to share and discuss advances and developments in smart grid research and applications. There were 84 papers submitted from 26 countries. However, only 42 papers were presented from several countries at the icSmartGrid 2021 conference. The conference program was the right mix of keynote and invited talks and oral presentations on essential aspects related to smart grids. Five internationally reputed keynote and invited speakers—two from Japan, one from Austria, one from the UK, and one from the Netherlands—presented contemporary and inventive developments in the area of smart grids. Mr. Masayuki TOBITA, Vice President of TMEIC, Japan, delivered a keynote speech on "Contributions to Carbon Neutral through PEiE, Power Electronics in Everything". Professor Thomas STRASSER, AIT Austrian Institute of Technology, Austria, addressed a keynote speech on "Recent Research Trends in Designing and Validating Smart Grids". Prof. Kazuto YUKITA, Aichi Institute of Technology, Japan delivered a keynote speech on "Study on AC/DC microgrids at Aichi Institute of Technology Eco-Electricity Research Center". Dr. Khaled AHMED, Strathclyde University, Glasgow, UK, highlighted a keynote speech on "Unlocking Opportunities for DC Grids by Fault-Tolerant DC–DC Converters". Professor Peter Palensky, TU Delft, the Netherlands, addressed a keynote speech on "IEC61850 and Cyber–Physical Security of Power Systems". In addition, Professor Seref Sagiroglu from Turkey delivered a tutorial on "Big Data and Cyber Security Issues in Smart Grids".

The icSmartGrid's main goal for the future is to continue promoting and disseminating the knowledge concerning several topics and technologies related to smart energy systems and sources. It is therefore aimed at assisting researchers, scientists, manufacturers, companies, communities, agencies, associations, and societies to keep abreast on new developments in their specialist fields and to aid in finding alternative energy solutions to current issues such as the greenhouse effect and sustainable- and clean-energy issues.

As Guest Editors of this Special Issue, it is our concern to ensure that important contributions for the area of smart grids that were presented in this conference are now widespread through their publication in this Special Issue. Thus, a selection of some of the best submitted and presented works was put together. This was not an easy task since the number and quality of the works were very high. However, although this Special Issue consists of a selected number of papers, their main goal is achieved, since they address the wide range of advances realized in the area of smart grids among engineers, scientists, and scholars. The selected papers focused on a broad area associated with smart grids, such as regulations, standards, and network codes; EVs in penetrated distribution (PV) networks; power quality; and residential power management.

A brief description of the published papers is presented in the next section. This description allows them to be framed within the conference topics, as well providing a brief overview of their content.

2. A Short Review of the Contributions in This Issue

As mentioned in the previous section, the selected papers focus on areas that are related to the smart grids. One of the topics associated to these areas is residential power management. This topic was addressed by Heider et al. [1]. The work presented a methodology as a power management system (PMS) extension that calculates a short-term reliable flexibility potential out of in-time operation conditions and end-user inputs to reduce uncertainty in local flexibility calculations. The applicability of the developed methodology was shown through a use-case scenario on working days in the spring with a reduced set of end-user inputs that were easy to derive and implement into the PMS interface. It was verified that the approach was able to give detailed insights into short-term flexibility potential in the flexibility operator-connected energy system.

Nouri et al. [2] focused on the problem of the variability of renewable energy, in which they indicated the necessity of the integration of energy citizens, as the new sources of flexibility, into the energy systems. In this context, this paper focused on the identification of gaps and barriers in regulations, standards, and network codes that hinder the sustainable engagement of energy citizens in the energy transition. It also summarized the challenges to citizen engagement in the energy transit and considered the enablers that make the engagement of citizens viable, e.g., demand response (DR), renewable energy resources (RESs), and modern designs for local energy markets (LEMs).

The problems of electric vehicle (EV) chargers, in the context of their integration in the distribution networks, were also addressed in reference [3]. Thus, the paper presented the effects on the grid according to different session times for 50 EVs with 30 different models. The results were analyzed with a SOC-based dynamic charge coordination method proposed by the authors and based on real-world charging profiles. In addition, in the grid with PV and BES systems, the authors observed that the method reduces the peak load of the grid by 0.8 kW per EV by load balancing the peak load by 0.36 kW per EV.

Another aspect that was also focused on this Special Issue is related with power quality improvement in hybrid renewable energy source (HRES) grid-connected systems. Thus, in reference [4], an intelligent control strategy was presented that suggests the optimum power quality enhancement (OPQE) of grid-connected hybrid power systems with solar photovoltaic, wind turbines, and battery storage. To achieve this improvement, a unified power quality conditioner with active and reactive power (UPQC-PQ) was designed with atom search optimization (ASO)-based fractional-order proportional integral derivative (FOPID) controller in the proposed HRES system.

Mehmet Yesilbudak in reference [5] focused on the photovoltaic generators, more specifically on the parameter extraction of photovoltaic cells and modules. More specifically, it implements and evaluates the grey wolf optimizer with a dimension learning-based hunting search strategy to extract the internal parameters of the diode circuit models of photovoltaic cells and modules. The proposed algorithm showed considerable effectiveness in terms of its accuracy, robustness, and solution quality aspects in solving the parameter extraction problem of PV cells and modules.

Another aspect focused on was the lack of a reliable and robust power supply in the oil and gas field area. This problem was addressed by Bishnoi et al. [6], who proposed a hybrid energy system (HES) that utilizes waste gas flares to generate electricity. In this way, it solved both the aforementioned problems. In this context, a systematic framework was also established to obtain the optimal size and design of the HES. A novel dispatch algorithm was used to simulate the real-time operation of the HES to suit the requirements of oil and gas fields.

3. Future Developments

Although many studies and investments have already been carried out, there are many challenges to be faced. These challenges are related to several aspects, such as their reliability, the telecommunication systems, security, Internet of Things (IoT), and demand-side management systems. However, one of the important challenges that needs a lot of research, development, and investment is related to the integration of electric vehicles into these grids. We are currently witnessing a very rapid transition from combustion vehicles to electric vehicles. However, what has been seen is that the infrastructure is not often prepared and that its reinforcement cannot be carried out in a simplified way. Consequently, that integration must be realized in an intelligent way and in the context of the smart grid. Another important aspect is the existence of energy routers associated with intelligent automation systems to manage several components of the grid, such as generators, storage systems, and loads.

4. Conclusions

We found the task of editing and selecting papers for this collection to be both stimulating and rewarding. It was a challenge since many excellent papers were submitted. Besides choosing them for their quality, we also sought to select papers that covered the various areas related to smart grids. In this way, it is possible to be aware about the research and new contributions on several areas of smart grids provided through this conference.

Author Contributions: V.F.P., I.C. and F.K. contributed equally to this work. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Heider, F.; Jahic, A.; Plenz, M.; Schulz, D. Extended Residential Power Management Interface for Flexibility Communication and Uncertainty Reduction for Flexibility System Operators. *Energies* **2022**, *15*, 1257. [CrossRef]
2. Nouri, A.; Khadem, S.; Mutule, A.; Papadimitriou, C.; Stanev, R.; Cabiati, M.; Keane, A.; Carroll, P. Identification of Gaps and Barriers in Regulations, Standards, and Network Codes to Energy Citizen Participation in the Energy Transition. *Energies* **2022**, *15*, 856. [CrossRef]
3. Akil, M.; Dokur, E.; Bayindir, R. The SOC Based Dynamic Charging Coordination of EVs in the PV-Penetrated Distribution Network Using Real-World Data. *Energies* **2021**, *14*, 8508. [CrossRef]
4. Reddy, C.R.; Goud, B.S.; Aymen, F.; Rao, G.S.; Bortoni, E.C. Power Quality Improvement in HRES Grid Connected System with FOPID Based Atom Search Optimization Technique. *Energies* **2021**, *14*, 5812. [CrossRef]
5. Yesilbudak, M. Parameter Extraction of Photovoltaic Cells and Modules Using Grey Wolf Optimizer with Dimension Learning-Based Hunting Search Strategy. *Energies* **2021**, *14*, 5735. [CrossRef]
6. Bishnoi, D.; Chaturvedi, H. Optimal Design of a Hybrid Energy System for Economic and Environmental Sustainability of Onshore Oil and Gas Fields. *Energies* **2022**, *15*, 2063. [CrossRef]