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Title: Special issue on developing and implementing smart grids : novel technologies, techniques and models

Year: 2020

Version: Publisher's PDF

Please cite the original version:

Siano, P., & Shafie-khah, M., (2020). Special issue on developing and implementing smart grids : novel technologies, techniques and models. *Applied sciences* 10(1), 350. https://doi.org/10.3390/app10010350 applied sciences

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Editorial

Special Issue on Developing and Implementing Smart Grids: Novel Technologies, Techniques and Models

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Received: 4 December 2019; Accepted: 24 December 2019; Published: 3 January 2020

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1. Introduction

Due to the rapid growth of technologies and communication systems, electricity demand must be supplied and have the highest quality and reliability. On the other hand, due to increasing concerns about the environment, sustainable energies are highly demanded. On this basis, the conventional energy systems should transition into smart systems to meet these requirements. Novel technologies, techniques, and models in the operation and planning of power systems should enable the current systems to move towards the smart grid. To this end, renewable energy resources, energy storage systems, electric vehicles, and demand response are key factors of the transition in different aspects of generation, transmission, and distribution levels. This Special Issue aims at encouraging researchers to address the technologies, models, and solutions to facilitate and speedup the transition into a smart grid.

2. Developing and Implementing Smart Grids

Taking into account the aim of the special issue, 38 papers were submitted among which 19 papers where accepted. Looking back to the special issues, the accepted papers have addressed the issue related to transition towards smart grids from various perspectives. Jia Ning et al. [1] proposed a schematic diagram from the perspective of a dispatching center managing smart appliances. The presented model schedules air conditioner, water heater, electric vehicle loads, and automatic generation control units in order to smooth the system imbalances stemming from wind power forecasting errors. An energy sharing management method of multiple microgrids (MGs) with a battery energy storage system and renewable energy sources was developed in a work proposed by Nian Liu et al. [2]. The optimal scheduling was suggested to be performed through the bidirectional interaction between microgrids and the energy sharing provider. Another energy management scheme (EMS) has been proposed by Saad Ullah Khan et al. which employed an off-board electric vehicle smart charger to support the grid during short-term variance of renewables and the reactive load onset [3]. In light of capturing uncertainties of renewable resources as well as reducing coal in the system, Deyou Yang et al. [4] proposed to deploy the electro-thermal integrated energy system with power to gas function. The simulation results illustrated that an integrated energy grid with power to gas function will save about 20 tons of standard coal per day and the abandoned wind rate can be regarded as zero. Dezhi Li et al. [5] presented a novel control algorithm for optimizing operational costs of a combined domestic micro-CHP (combined heat and power), battery, and heat storage system in smart grids. A case study proved that the proposed algorithm yields approximately 23% energy cost savings. Guido Carpinelli et al. as authors of [6] tried to address the problem of optimal allocation (siting and sizing) of storage resources in unbalanced three-phase low voltage microgrids. The planning problem was proposed to be solved by means of a genetic algorithm which includes an inner algorithm based on sequential quadratic programming. Claudia Zanabria et al. analyzed the complexity of the energy management system development process resulting from an evolving power utility automation in [7]. As a result, flexibility, complexity, interoperability, and overlapping issues were identified as main concerns to be faced during the design and implementation stages of battery energy storage system (BESS) control applications.

Considering the variability of solar power, Fei Wang et al. aimed to reveal how the applied classifiers and the training data impact the classification performance and to delineate the relation between classification accuracy and sample dataset scale [8]. Two commonly used classification methods, K-nearest neighbors (KNN) and support vector machines (SVM) were applied to classify the daily local weather types for the day-ahead short-term solar photovoltaic (PV) power forecasting. Silvano Vergura et al. introduced either a methodology to select the best performing mathematical tool to investigate the electrical behavior of the power distribution systems—depending on their linearity and stationarity—or an index to discriminate the power distribution systems on the basis of a different amount of PV penetration [9]. A grey wolf optimization algorithm based on the dynamic adjustment of the proportional weight and convergence factor was presented by Xin Zhang et al. to solve the operating model of the distribution network comprising the micro energy grid [10]. The simulation results demonstrated that the model and algorithm improved the economic benefits, and voltage stability of the distribution network, reduced the active power loss of the distribution network, and enabled the safe, stable, and economical operation of the distribution network comprising a micro energy grid.

To develop the bi-directional communication in smart grids, an enhanced version of effective filtering approach (EFA) called enhanced-EFA (eEFA) was proposed by Nguyen Xuan Tien et al. that does not forward unicast frames to nondestination doubly-attached nodes with high-availability seamless redundancy (HSR) protocol rings [11]. One of the features of the approach is that it does not use any control message to discover passive QuadBox rings in bidirectional communications. Yi Tang et al. [12] have summarized the construction method as an effective measure to describe the computation, communication, and integration processes of a power grid in the current research. Then, they proposed a platform providing an intuitive and accurate way to reconstruct the cyber-physical power system (CPPS) environment where the influence of the information side of the CPPS control effects was verified. A novel, wide-area measurement system (WAMS)-based optimal under-frequency load-shedding (UFLS) technique was proposed by Hassan Haes Alhelou et al. aiming to operating complex systems in a stable mode [13].

In order to absorb renewable power variations, one method can be to alleviate the error of forecast in smart grids. Thus, Jidong Wang et al. propose a new PV power prediction model based on the Gradient Boost Decision Tree (GBDT), which ensembles several binary trees by the gradient boosting ensemble method [14]. Simulation results stated that their proposed model has advantages of strong model interpretation, high accuracy, and stable error performance. For the purpose of load forecasting improvement, Murat Luy et al. tried to handle the problem that is caused by the growing knowledge base, and improves the load forecasting performance of fuzzy models through nature-inspired methods [15]. The proposed models has proved to sufficiently improve the performance of hourly short-term load forecasting.

The paper authored by Shiwei Xia et al. firstly presented a Doubly Fed Induction Generator with a two-lumped mass wind turbine model to analyze impacts of wind power generation on power system transient stability [16]. A new local Volt/var control strategy in a low-voltage smart grid was developed by Albana Ilo et al. [17]. They proved that the concentrated Volt/var control strategy eliminates the violation of upper voltage limit even in longer feeders, where both distributed local strategies fail. A novel method-based least absolute shrinkage and selection operator algorithm was built by Yahui Li et al. [18] to apply to online static security assessment (OSSA). The assessment was based on a security index applied to select and screen contingencies. The short-term variations of wind power that are mitigated by the wind curtailment were proposed to be investigated, and incorporated into a generation scheduling problem as the mixed-integer program (MIP) forms by Jaehee Lee [19].

3. Future Technologies, Techniques and Models

Although the special issue has been closed, there is a need for new types of research in technologies, techniques, and models of future smart grids. The research should address climate change issue and the role of smart grid for building greener cities.

Author Contributions: Writing—original draft preparation, P.S. and M.S.-k.; writing—review and editing, P.S. and M.S.-k.; All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: We would like to take this opportunity to record our gratitude to all authors, hardworking and professional reviewers, and dedicated editorial team of Applied Sciences.

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

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