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Editorial

Demand Response in Smart Grids

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1. Introduction

The Special Issue "Demand Response in Smart Grids" includes 10 papers [1–10].

Demand Response (DR) and Smart Grids (SG) are two rather broad key topics in the operation of power and energy systems. Although new DR approaches are introduced daily, more work is needed to reach its full potential, offering advantages for all involved. Successful implementation of SG requires widespread use of DR, taking advantage of the flexibility of large- and medium-size consumers as well as targeting small-size consumers. Effective approaches are needed to implement adequate strategies and methods to design and manage DR. As part of the power and energy ecosystem, DR is a very valuable resource which, when coordinated with the increasing penetration of renewable energy and market-driven business models, can significantly increase the system efficiency while keeping energy costs reasonable. The Special Issue "Demand Response in Smart Grids" addresses aspects related to demand flexibility, DR, and their importance for efficient SG operation.

The topics of this Special Issue include:

- Demand response.
- Electricity markets.
- Electric vehicles.
- Energy storage.
- Real-time simulation.
- Smart grids.

Nine research papers and one review have been published in this Special Issue, with the following statistics:

- Submissions: 18; published: 10; rejected: 8.

2. Published Papers Highlights

This paper provides a summary of the *Energies* Special Issue, covering the published articles [1–10], which address several topics related to demand response and smart grids. Table 1 identifies the most relevant topics in each publication. These topics have been selected by the Editors as the most relevant.

As seen in Table 1, most of the publications focus on demand response and load patterns and profiling, while two papers include electric vehicles. Most of the research is dedicated to the end-user aspects and their comfort, and operation and control.

In [1], Devarapalli et al. explore non-intrusive identification of load patterns. The percentage Total Harmonic Distortion (THD) is used for DR management from a Power Quality perspective. The results demonstrate that percentage THD identifies a different combination of loads, as well as alternate load combinations. Recommendations are provided to the consumer to reduce harmonic pollution in the distribution grid.

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Table 1. Topics covered in each publication.

Topic	Publication									
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Demand response	x		x	x	x	x	x	x		x
Distributed generation					x			x	x	
Electricity markets			x	x	x		x			
Electric vehicles							x		x	
End-user and their comfort	x	x		x	x		x	x		
Energy storage		x					x	x	x	
Load patterns and profiling	x	x	x		x	x	x			x
Operation and control	x			x	x	x	x		x	x
Total	4	3	3	4	6	3	7	4	4	3

In [2], the authors propose a cyber–physical approach to the prediction of electricity consumption of a solid electric thermal storage (SETS) system. The prediction error of the physical model is used as an input of the cyber model to calibrate the prediction. K-means and support vector machine are used. The proposed solution receives the temperature as input, where the case study used a 1 MW SETS system, obtaining a reduction in the maximum relative errors (MRE) to 4.8%.

A pilot study is presented in [3], which proposes a new clustering method for consumer segmentation. The focus is on residential consumers participating in DR. The approach is a two-stage k-means procedure including consumption features and load patterns. Segmentation results are used to identify groups for participation in DR. In a pilot study implemented in Korea, the proposed method shows demand reduction increased by 33.44% with the proposed methodology, DR programs issuers, such as retail utilities or independent system operators, can select targeted customers, improving the economic efficiency.

In [4], two stages are implemented in a method that considers the bounded rationality of residential users, utilizing a dynamic model to decide whether to participate in the DR programs. The evolutionary process of consumers participating in DR is analyzed. DR participants compete to maximize profit, for which a non-cooperative game model is proposed. A distributed algorithm is used to achieve the Nash equilibrium.

The methodology presented in [5] addresses several groups of consumers being sequentially activated to reach the desired consumption reduction by an aggregator. Real-time simulation is used to obtain more accurate results in what concerns the electric grid components modeling. With the provided model, an aggregator is able to efficiently manage the available Dr resources, dispatching them by groups according to the actual response of each group.

The problem of energy allocation in an optimization model is proposed in [6], and is supported by social welfare metrics. Multi-objective optimization is used to obtain Pareto sets of solutions. Commercial greenhouse growers are considered in the case study. The solution maximizes the social welfare among the solutions in the Pareto set. In the end, the impact of each social welfare metric on the optimization outcome is investigated, which will affect energy allocation.

Quantification of the flexibility provided by electric vehicles is analyzed in [7], for a case study on Germany and California. Fixed and dynamic prices are considered for three charging power levels. The vehicle charging is optimized, and the flexibility of each vehicle is calculated every 15 min. Flexibility is mostly available during the early morning or in the evening.

Focusing on industrial systems, [8] identifies the available energy flexibility opportunities in industrial environments. The implemented methodology is flexible, as it can be used for any type of industry. Qualitative and quantitative aspects are tackled in an audit with experts working in the facility. With the obtained flexibility mapping, participation in DR programs becomes easier.

A review on energy management approaches is provided in [9]. The control aspects in microgrids are summarized where relevant. The findings include the need for more predictive approaches to improve energy management in buildings.

Finally, in [10], the optimal operation of a transformer is addressed in conjunction with DR programs. According to the proposed methodology, when a violation in the transformer operation parameters is reached, the minimum DR use is determined to ensure normal operation.

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