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Book Review on "Antonio Moreno-Munoz; Neomar Giacomini; Energy Smart Appliances: Applications, Methodologies, and Challenges (2023)"

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***Abstract*—Recently, the integration of new industrial technologies is significantly increased into the utility grid such as renewable energy sources (RESs), distributed energy resources (DERs), energy source systems (ESSs), electric vehicles (EVs), and multi-carrier energy systems (MESs). So, robust energy management strategies are required to regulate the power-exchange between the generations and end-users for improving the power system's reliability and stability and reducing the energy costs. Thus, the demand-side management (DSM) strategies and demand response (DR) programs are utilized to control the energy smart appliances for residential building which achieving by various strategies, required infrastructure, energy market signals, etc. Several textbooks and articles investigate this important topic. However, the book entitled "Antonio Moreno-Munoz; Neomar Giacomini; Energy Smart Appliances: Applications, Methodologies, and Challenges (2023)", is the most recent prominent comprehensive reference for DSM strategies in smart grids. Hence, this article proposes a book review and discussion of its most important contributions to DSM strategies by dividing them into four main contributions. Which helps the reader in realizing the recent developments on DSM strategies based on this book's contents.**

Keywords*— *Demand-Side Flexibility, Smart Grids, Energy Smart Appliances

I. INTRODUCTION

With the incremental penetration of renewable energy sources (RESs), distributed energy resources (DERs), energy source systems (ESSs), electric vehicles (EVs), and multi-carrier energy systems (MESs); to provide the required energy demands and eradicate the usage of fossil fuels, several dominant impacts and challenges are performed in modern power systems, which influence system reliability and stability [1], [2]. So, it is crucial for energy management, especially on the distribution level to fulfill the consumer requirements [3]. Thus, the term demand-side flexibility is widespread spreading which is defined as the capability of modern power systems to reliably and cost-effectively manage the variability and uncertainty of demand and supply at each instant of time or long-term aspect [4]. To specify the acceptable level of the demand-side flexibility, the demand-side management (DSM) strategies and demand response (DR) programs are utilized which are based on applying various strategies such as peak clipping or shiftting, as depicted in Fig. 1.

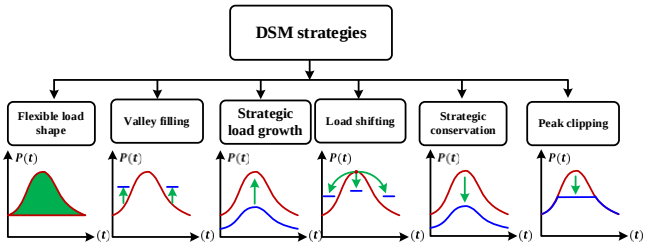

Fig. 1. Classifications of DSM strategies

In this perspective, demand-side flexibility in smart grids is considered a critical concept in the field of electrical engineering as well as energy management. Specifically, it refers to the ability of end-users to adjust their electricity consumption patterns in response to signals or incentives provided by the grid operator, to balance supply and demand in a dynamic manner [5]. This methodology can be implemented by advanced communication and automation technologies. Which empower consumers to make informed sets about when and how they utilize electricity, promoting a more efficient and sustainable energy system [6]. Demand-side flexibility can play a vital role in optimizing grid operations, reducing peak loads, and integrating renewable energy sources, thus enhancing grid reliability and resilience [7]. It is a favorable avenue for achieving a more sustainable and resilient energy infrastructure while accommodating the growing adoption of DERs, such as rooftop solar panels and electric vehicles [8]. This field continues to evolve, with ongoing research and development efforts focusing on enhancing demand response strategies, real-time communication, and the integration of demand-side flexibility into the overall smart grid management framework.

This book covers an important topic as it investigates the flexibility concept regarding demand-side energy management for smart homes and their appliances to satisfy the consumer's necessities with the spreading of new industrial technologies integrated into the utility grid and developments on their infrastructure [9]. Furthermore, this book provides utilities as well as appliance manufacturers with new methods to better understand real-world related problems, assess actual energy merits, and adapt each technology according to the requirements of their customers.

Besides, this book illustrates that the existing standards, topologies, and technologies required for fostering collaboration among various domains of home appliances in the context of smart energy utilization are readily accessible. Consequently, the challenge is no longer about bridging knowledge gaps but rather allowing the market the necessary time to align with the present state of these technologies.

This book is valuable for various readers, such as academic researchers, post-graduate students, distribution system operators and investors, and network planners, with regard to the demand-side management and smart home appliances research field. So, it is considered a vital comprehensive resource for this research trend into such a specified topic.

This book involves 11 chapters which discuss various pivotal topics and key findings, as summarized as follows:

- Developments of demand-side flexibility in smart grids: overview, methodologies, standards, applications and challenges. These are represented in chapters 1, 4 and 5.
- Smart energy home: energy demand and management, standards and communication protocols, appliances, and scheduling approaches. These are denoted in chapters 2, 3, 6, 7 and 8.
- Developments of Electric vehicles (EVs): topologies, charging configurations, impacts, standards, and others. These are expressed in chapters 9 and 10.
- State of the art of induction heating applications in terms of history, configuration, and challenges, as discussed in chapter 11.

II. Overview of Book Content

The presented chapters are organized in detail as follows:

- Chapter 1: discusses the demand side flexibility based on smart grids. Firstly, the concept of energy transition is investigated as a global direction to adapt to the adverse impacts of climate changes and energy consumption and crises. In section 1.2, the share of various generation sources such as fossil fuels and renewable energy sources, in the global energy consumption at various applications, is evaluated based on the power grid. This is followed by a general description of the smart grids in terms of definition, configuration, and challenges compared to the conventional power plants in regard to the deployment of new energy sources and measurement, monitoring and communication devices. In section 1.4, the concept of power grid flexibility is involved in terms of definition, its importance, and different sources. Further, demand-side management is discussed and classified to highlight the pivotal applications of both energy efficiency and demand response programmes. In addition, section 1.5 gives an overview of the power quality, reliability, and resilience indices of modern power systems, then their adverse consequences on the economy and energy market are illustrated in section 1.6. Moreover, the role and applications of the Internet of Things (IoT) and submetering devices for various energy-smart applications in modern power systems are described to highlight the importance of communication infrastructure, smart meters, data availability, security, and privacy, cost-effectiveness, power quality and reliability in sections 1.7 to 1.9, respectively.
- Chapter 2: initially, the smart home ecosystem is investigated regarding smart gadgets or appliances, available technologies, and communication tools according to traditional and modern smart home building. Also, the growth penetration rate of smart homes is highlighted along with their benefits and restrictions. Therefore, sections 2.2 and 2.3 give a list of available technologies, such as Wi-Fi and Bluetooth, that are applied to smart homes considering their benefits, limitations, and challenges. Finally, the future vision and projections of energy management systems in smart homes are demonstrated in terms of the development of infrastructure and applied technologies.
- Chapter 3: the intelligence energy DSM and automation systems of smart households are studied in terms of energy efficiency, applications, and tools whilst highlighting the developments and solutions of DR programs to deal with energy efficiency challenges. Further discussing the available communication infrastructure and protocols for implemented software and hardware platforms in smart grids and IoT applications supported with the technical and marketable opportunities, security concerns as well as obstacles for both DSM systems and DR programs.
- Chapter 4: the DSM and DR strategies, as tools of end-user demand planning, are investigated in sections 4.4 and 4.5, in terms of their concepts, requirements, applications, and challenges for smart household appliances. In section 4.6. the important role of the home communication facilitates in DSM is highlighted based on their configuration, and sorts, followed by the explanations of the use of the smart meters in DSM. The rest of the chapter mentions the energy usage and forecast patterns for power consumption over seasons and how it is crucial to apply the DR and their options and factors. Moreover, the bidirectional influences of DR on regulating the energy production from distributed generation resources with their uncertainties, and the expenses of energy use in smart homes concerning consumers' stratifications. Finally, the profits and benefits of utilizing g both DR, and DSM for energy markets, utility investments, and prices are depicted in both production and consumption levels.
- Chapter 5: First, it discusses briefly the state of the art of both DR and DSM respecting their applications, configurations, and control processes. Then, bidirectional communication services among system operators, end users, and the energy market, are involved using OpenADR alliance framework as an example of DR and DSM tools. All specifications, cyber security concerns, advantages, versions, and applications of the OpenADR are investigated by highlighting the interactions among cloud controllers, other standards, and IoT with OpenADR. Finally, various DR and DSM programs are mentioned such as Direct Load Control and Ancillary Services Program in terms of their applications, functions, applied standards, and energy market aspects.
- Chapter 6: provides a discussion about the various energy smart household applications which can be classified into many groups such as large and small applications, entertainment, security, monitoring, and other

applications. These applications are critical loads that can be controlled for shifting priority in peak demands and high prices based on home energy management systems which are illustrated in terms of configuration, process etc.

- Chapter 7: commits a specific discussion about the progress of the European Telecommunications Standards Institute (ETSI) Smart Applications REFerence (SAREF) ontology for smart applications (building, city. etc.) regarding the following main aspects:

a. The urgent importance of standard ontology requirements based on the IoT industry in all life aspects.
b. Historical developments of SAREF ontology.
c. The prominent requirements, specifications, design patterns, classes, and features of SAREF ontology which can be applied for smart applications supported the discussion with various examples, findings, and future technologies.

- Chapter 8: illustrates the scheduling aspect of shiftable smart household appliances for DSM using optimization (metaheuristic) algorithms to ensure complete controllability, robust reliability, and energy balance for distribution systems, especially in peak demands. The chapter is interested in highlighting the main following points:

a. Presenting the DSM concept with sufficient literature review in terms of definition, and classifications especially for residential loads in smart homes. In addition to involving a time-shiftable load as the main topic.
b. Classification of residential appliances according to time-shiftable topology.
c. Application of smart metaheuristic algorithms for DSM is elaborated.
d. Optimization algorithms' comparison with respect to convergence performance is included.

- Chapter 9: it presents the urgent concerns that should be considered as associated with the EVs (V2X) wide-spreading and their incremental integration consequences on distribution systems. In addition, investigates the main control schemes for regulating EV charging /discharging modes with individual entities or aggregators along with their interactions and obligations towards the energy market. Further, it proposes two residential dispatching strategies with decentralized control for smart home energy management systems supported with simulation results.
- Chapter 10: reviews some significant points related to the increased penetration of EVs, as follows:

a. Their impact on the distribution systems and current challenges.
b. EV charging standards and protocols, and EV communications protocols besides highlighting the requirements and recommendations of EV charging infrastructure.
c. Classifications of smart charging strategies in terms of topology, location, etc. and their implementation requirements.
d. Overview of residential smart energy management.

- Chapter 11: discusses the induction heating applications in terms of working principles, historical developments, benefits, design configuration, control schemes, challenges, and future technologies.

III. Discussion

In general, the book succeeds in handling some important topics in this research field which makes it suitable for basic, and top-up researchers besides other readers and specialists. However, some raised topics are not well-covered and require more investigation in future editions, as follows:

- Reviewing new technologies as robust solutions for increasing demand-side flexibility.
- Discussing the advanced forecasting approaches for demand side flexibility.
- Other energy management schemes can be discussed such as energy hubs (EHs) that deal with the electrical, thermal, and cooling demands.
- Other scheduling approaches such as deterministic, stochastic, and data-driven methods should be investigated besides optimization-based approaches with a comprehensive comparative study of their advantages, performance and challenges.
- Besides load shift strategy, other methodologies for DSM and DR should be covered.
- Not only the influences of EVs on smart grids but also the impacts of various DERs and ESSs on the demand-side flexibility management should be involved.
- Both chapters 9 and 10, are recommended to merge in order to avoid repeating pieces of information.

Energy market perspectives and future vision of smart appliances should be included.

- Barriers and challenges faced by aggregators and cybersecurity of communication protocols are recommended for more investigations.
- Current chapters are suggested to cover modelling, estimation, improvement and forecasting of demand-side flexibility, as separate chapters.
- Considering the role of Green Hydrogen in Smart Grids
- Concluding Regulatory Frameworks and Policy Considerations for Demand Response
- Studying impacts of Demand-Side Flexibility on Grid Resilience
- Covering Advanced Metering Infrastructure (AMI) and Demand-Side Management
- Showing the impact of Demand-Side Flexibility on Grid Resilience
- Investigating the Impact of Demand-Side Flexibility on Grid Resilience.

IV. Conclusion

Regrading the DSM strategies, this article presents a book review and discussion of most recent published book and its contents. This book covered the DSM strategies and DR programs that utilized to regulate the electrical smart appliances to achieve the power system flexibility and reliability. Its main contributions can be divided into four topics which not only give the latest developments of DSM strategies applied into smart home appliances but also provide illustration about the existing standards, topologies, and technologies required for fostering collaboration among various domains of home appliances in the context of smart

energy utilization are readily accessible. In particular, the book accomplishes successfully with its objectives with the aid of recent references and citations that are well-relevant according to this research field and discussed topics.

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