frontiers | Frontiers in Energy Research

TYPE Editorial
PUBLISHED 14 September 2022
DOI 10.3389/fenrg.2022.1014252

OPEN ACCESS

EDITED AND REVIEWED BY
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SPECIALTY SECTION
This article was submitted to Smart Grids,
a section of the journal
Frontiers in Energy Research

RECEIVED 08 August 2022
ACCEPTED 15 August 2022
PUBLISHED 14 September 2022

CITATION
Abdel Aleem SHE, Ali ZM, Zobaa AF, Ćalasan M and Rawa M (2022), Editorial: Energy hubs in modern energy systems with renewables and energy storage.
Front. Energy Res. 10:1014252.
doi: 10.3389/fenrg.2022.1014252

Editorial: Energy hubs in modern energy systems with renewables and energy storage

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KEYWORDS

energy hubs, energy management, energy storage, microgrids, optimization

Editorial on the Research Topic
Energy hubs in modern energy systems with renewables and energy storage

An energy hub is a multi-generator system in which many energy carriers are converted, stored, and supplied for several energy types to meet energy consumption challenges. In these systems, the energy conversion matrix changes over time due to the external impact of the surrounding environment (sun, weather, water, fuel, etc.), transmission line operating conditions, and operators' objectives. Thus, different energy infrastructures are used in terms of production, transmission, and distribution of energy, while the entire transmission is realized with the definition of clear benefits in terms of quality and economy of energy transmission. Therefore, as visualized in Figure 1, one of the big challenges in the efficient and economical operation of energy hub systems is the optimal management of both production and energy storage and transmission systems. This necessitates a practical distributed energy management framework for modeling and optimizing the functioning of these systems using powerful optimization algorithms to decide the duration, coordination, communication, and operation prediction of all individual elements.

This Research Topic "Energy Hubs in Modern Energy Systems with Renewables and Energy Storage," provides an overview and points out current and modern research directions in the field of energy hubs. The directions for addressing this topic were optimal management, modeling, energy quality testing, economical energy transmission, and similar parameters.

10.3389/fenrg.2022.1014252

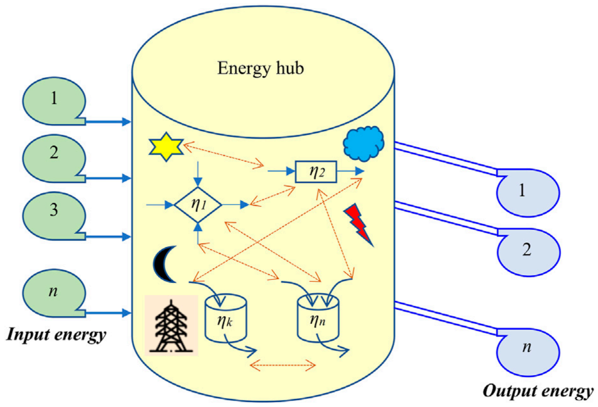

FIGURE 1
Visualization of illustrative energy hub system.

The Research Topic includes six articles. The operation of an energy hub system depends mainly on the condition of production facilities, which are increasingly based on renewable energy sources. However, as renewable sources are characterized by intermittent production, calculating optimal power flow necessitates using powerful, fast, and efficient optimization algorithms. Alghamdi introduces efficient and robust versions of the conventional firefly algorithm for optimizing various kinds of optimal power flow problems in the presence of traditional thermal power plants and renewable energy resources, considering several objective functions and the amount of carbon tax to examine the potential effects of renewables on the optimal scheduling of thermal power plants in a cost-emission-effective manner. In addition, modern energy hub systems are characterized by an increasing number of electric vehicles (EVs) representing consumers and energy storage systems. Energy hub configurations become incredibly complex when dealing with DC microgrids. Hadero and Khan propose the development of a direct current (DC) microgrid for EV charging stations using fuzzy logic controllers. However, managing energy hub systems with renewable sources becomes extremely complex if there are failures in energy transmission. Therefore, such transmission configurations also require the presence of flexible alternating current transmission system units. In this regard, Kumar et al. proposed an improved field-oriented control to investigate and manage faults in such systems. It should be emphasized that such energy conversions are increasingly realized at the DC level, so analyzing new inverter configurations is crucial, as addressed by Ahmed et al.

The security of management, data transmission, and forecasting of production and consumption are also, to a large extent, particular aspects of modern energy hub systems. Li et al. propose a communication equipment evaluation method based on node dynamic failure to deal with such problems. A communication equipment evaluation method based on "point-to-edge" interdependent networks is also proposed and tested. In addition, Lin et al. start with the basic concept of the Energy Internet and divide it into a system layer, regional layer, and device layer on a spatial scale. This then sets different optimization goals according to other scheduling subjects to achieve a "hierarchical control-global optimization" multilevel control mode, combined with the Energy Internet's current research status. A genetic algorithm-based approach was proposed to complete the proposed optimal scheduling model. The hierarchical optimization scheduling approach can solve distributed equipment system management and control problems.

Energy hub studies are the future of energy as today's energy systems are becoming more and more complicated, with every household tending to go towards the microgrid system. In other words, consumers are trying to be production centers by making money through selling energy to the connection network as well as using energy to satisfy their own consumption needs. In addition, every household is oriented towards using electric vehicles, which further complicates the management of the system. Along with previous components, there are telecommunication systems whose task is to import control, measurement, management, and signaling information into a single operating system. For this reason, the future of energy hubs also depends on the development of optimization methods, which, based on a considerable amount of information, should enable the efficient, safe, and most economical operation of each type of energy hub system.

Author contributions

MĆ and SA wrote the first draft, and all other authors revised and added to it.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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