frontiers | Frontiers in Energy Research

TYPE Editorial
PUBLISHED 24 October 2023
DOI 10.3389/fenrg.2023.1277261



OPEN ACCESS

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RECEIVED 14 August 2023
ACCEPTED 19 October 2023
PUBLISHED 24 October 2023

CITATION
Okedu KE (2023), Editorial: Hydrogen technologies integrated into smart grids. *Front. Energy Res.* 11:1277261. doi: 10.3389/fenrg.2023.1277261



# Editorial: Hydrogen technologies integrated into smart grids

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KEYWORDS

**renewable energy, hydrogen, smart grids, de-carbonisation, electrolyzers**

Editorial on the Research Topic
Hydrogen technologies integrated into smart grids

This Research Topic addressed the role of smart grids in enhancing de-carbonization, and production technologies, and storage of hydrogen in a cost-effective, sustainable and advanced way (Okedu, 2016; Okedu, 2021). The potential pathways and improve options, to achieving hydrogen production and storage were also presented.

The first paper on this Research Topic (Mariano and Urbanetz) proposed energy management schemes via energy storage integration, to enhance the demand profile of a university commercial consumer for compensation during peak hours. A pilot project that is composed of a10 kWp grid-tie PV system, bidirectional inverters, and battery bank, was used in this study. Variables of the demand and consumption, local energy pricing, PV generation profile as well as the interaction between PV generator and the energy storage system, and the variation in power fluctuations throughout the year, were analyzed and employed in carrying out this work. HOMER software environment was used in the technical feasibility study to evaluate consumer's optimal size. The daily analysis of the PV generation profile reflected that even if the PV source is quite variable, the scheduled dispatch operation is not affected by the variability and intermittency of the solar source, because of the parallel design topology of the electrical network. Also, very significant values of energy consumption were obtained, with July been the maximum consumption for the base year 2019, with a total monthly value of 48,670 kWh. A 10% discharge depth of the battery bank resulted in a life cycle of 2,500 cycles which can extend its useful life by approximately 9.5 years. The presented results in this paper show the various levels of 60.0, 33.6, and 2.7%, contributions of energy.

In the second paper (Han et al.), the flexibility margin of an electricity–hydrogen coupling energy block based on model predictive control was presented. The paper analyzed the power exchange features of heterogeneous energy schemes, along with the homogenization models of various heterogeneous energy sources. Three dimensions of flexibility margin evaluation indexes were considered based on the flexibility margin of the power system considering also, the dimension of system operation. This would enable a more robust electricity–hydrogen coupling energy block scheduling model to be established. With the help of the model predictive control algorithm, the electro–hydrogen coupling energy block optimization of the power balance operation and flexibility margin are evaluated quantitatively. The study reflects that, the numerical evaluation strategy used would help achieve both online power balance optimization of the electric–hydrogen coupling energy block and operation flexibility margin of the electric–hydrogen coupling energy block.

The third paper, a low-carbon economy operation topology of integrated energy system was proposed to help in optimization of equipment operational flexibility and mitigation of carbon emissions (Zhou et al.). The paper presented a scenario where the integrated energy system was an integral part of the carbon trading market, and the carbon trading mechanism was introduced to regulate the entire carbon emissions of the model. Furthermore, considering the basis of the working features of liquid air energy storage, organic Rankine cycle, and combined heat and power, the liquid air energy storage organic Rankine cycle combined heat and power topology was established to improve the flexibility and supply of heat and power. More so, in order to mitigate the system operation costs and carbon transactional costs, the paper proposes the low-carbon economy optimal dispatch model considering multiple scenarios of operation. The presented results show that the studied model proposed in this paper could balance the economy and low carbon level and the same time act as an effective reference for low-carbon economic dispatch operation of the system.

In order to reduce carbon emissions and improve the flexibility and security of the energy supply, paper four employs the strategy of bidirectional hydrogen-based vector coupling storage to provide services of primary frequency response in electrical network (Allahham et al.). A power hardware-in-the-loop simulation and digital twin scheme were proposed. A novel vector coupling storage composed of grid-scale electrolysers, fuel cells, and hydrogen storage was presented. Previous works do not have control over the storage of hydrogen, giving no guarantee that enough stored energy would be available to meet demands. The fourth paper presents the dynamic models of electrolysis, fuel cell stacks, and hydrogen storage as a digital twin, considering the key parameters that would affect the behaviours of the components of the system. The power hardware in the loop simulation was used for the power converters' accurate impact on the performance of the vector coupling storage and the controllers involved. The effect of vector coupling storage was analysed based on deployment of the environment. The presented results show that the vector coupling storage size has a major effect in regulating the frequency to the standard range. The frequency changes were also improved with the installation of more vector coupling storage, thereby offering better primary frequency response.

Finally, the contents of this Research Topic were able to improve the techniques of hydrogen gas production, use and storage in integrated smart power grids. The promotion of new studies would be required to effectively evaluate the quality and quantity of hydrogen gas production for sustainable development. These research topics would serve as a platform to enhance the design of smart power grids considering hydrogen technology in an efficient and cost-effective way, for sustainable development. The benefits from these research topics could be extended to the transportation sector where hydrogen gas is relevant.

## Author contributions

KO: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing–original draft, Writing–review and editing.

## Conflict of interest

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

## Publisher's note



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