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EDITORIAL

IEEE ACCESS SPECIAL SECTION EDITORIAL: THE INTERNET OF ENERGY: ARCHITECTURES, CYBER SECURITY, AND APPLICATIONS

The energy crisis and carbon emissions have become two critical concerns globally. As a very promising solution, the concept of Internet of Energy has appeared to tackle these challenges. The Internet of Energy is a new power generation paradigm developing a revolutionary vision of smart grids into the Internet. The communication infrastructure is an essential component for implementing the Internet of Energy. A scalable and robust communication infrastructure is crucial in both operating and maintaining smart energy systems. The wide-scale implementation and development of Internet of Energy into industrial applications should take into account the following challenges:

- **Integrating highly scalable and distributed alternative energy generating sources with other available power grid systems:** To promote a green-energy-based industry and society and realize the optimization of energy utilization, the efficient gathering, transportation, and storage, and how to integrate these into the existing power grid are great challenges.
- **Advanced metering, monitoring and controlling systems:** Since the observability, controllability and predictability are three critical aspects in the Internet of Energy, real-time monitoring and controlling are faced with great challenges in order to collect precise energy consumption data, give deep analysis and provide rich user information. Thus, users can adjust their energy consumption intelligently with optimization as a main goal.
- **Cyber Security and Privacy-aware data management for Internet of Energy:** Among many applications in Internet of Energy, energy consumption data could be linked and mined to gain useful insights for optimization of energy utilization. At the same time, privacy and security concerns can prevent the information disclosure, energy waste and disaster. Further safeguards are needed to build trust in the data, which is instrumental for making critical decisions for the development of Internet of Energy.

While there are several well-established senior journals, such as the IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS, IEEE TRANSACTIONS ON SMART GRID, and IEEE SYSTEMS JOURNAL, this Special Section in IEEE ACCESS focuses on the architectures, cyber security, and applications in the Internet of Energy. Nine high-quality articles have been accepted from leading groups around the world after a rigorous peer-review process. IEEE journals are considered as the flagship journals in the engineering field. IEEE ACCESS is a new multidisciplinary, application-oriented, all-electronic archival journal which continuously presents the results of original research or development across all the IEEE's fields of interest. Because of its open access nature, this Special Section is freely accessible to all readers all around the world.

Due to global warming and energy crisis, renewable distributed energy resources, such as wind turbines, are integrated into the grid. As the microgrids are located on customer's premises or remote areas, its condition needs to be monitored in real-time. In the article by M. Rana, "Architecture of the Internet of energy network: an application to smart grid communications," the author models an AC microgrid with generating units, local loads and electronic devices. Then, the set of nonlinear differential equations is expressed as a state-space model, which is easy to analyze and estimate.

Multiple microgrid clusters allows much higher flexibility, availability and reliability compared to singular microgrids. However, their proper coordination requires communication interfaces which are often disrupted by massive data flows, diverse traffic patterns and inadequate infrastructure. K. Boroojeni *et al.* in their article "A novel cloud-based platform for implementation of oblivious power routing for clusters of microgrids," describe the general framework of using the oblivious routing algorithms to deal with this problem.

One of the main envisioned conceptions of the Internet of Energy is to make full use of RERs (renewable energy resources) to meet the load demand with high reliability and quality. To achieve these objectives, in "A multi-agent system based event-triggered hybrid control scheme for energy

Internet,” C. Dou, *et al.* are concerned with event-triggered hybrid control for the energy internet based on a multi-agent system approach, with which renewable energy resources can be fully utilized to meet load demand with high security and quality.

How to preserve user’s privacy is an important issue in Internet of Energy. However, most of the existing privacy-preserving works consider less about the data utility. In the article by Z. Guan, *et al.*, “Utility-privacy tradeoff based on random data obfuscation in Internet of Energy,” a utility-privacy tradeoff scheme based on random data obfuscation is proposed.

Most cases of energy shortage occur during peak energy load, and hence previous works focused on shifting peak load to address energy shortage. However, few of these works took the IoE (Internet of Energy) framework into account. In the article by C. C. Lin *et al.*, “Peak load shifting in the Internet of Energy with energy trading among end-users,” the authors create the peak load shifting model of an energy storage system in the framework of Internet of energy where end-users can adopt their respective energy storage facilities to charge and discharge energy, to minimize the total operating costs, and trade their respective stored energy in the energy market.

Global energy can be managed and controlled efficiently by information and communication technologies in Internet of Energy. In the article by Z. Zhou *et al.*, “Game-theoretical energy management for energy Internet with big data-based renewable power forecasting,” they focus on the coordinated management of renewable and traditional energy. The authors consider a conventional power system; i.e. the utility company, the energy storage company, the microgrid, and electricity users.

The existing PV (Personalized Ventilation) systems face several challenges that prevent their large-scale deployment. To solve this problem, J. Yan *et al.*, in the article “Modeling and implementation of electroactive smart air-conditioning vent register for personalized HVAC systems,” present a novel Heating, Ventilation, and Air Conditioning (HVAC) system that can achieve more than 30% energy savings compared with conventional methods in building conditioning.

As an important part of the Internet of Energy, a complex access environment, flexible access modes and a massive number of access terminals, dynamic and distributed mass data in an active distribution network will bring new challenges to the security of data transmission. In the article by S. Deng *et al.*, “Distributed mining for content filtering function based on simulated annealing and gene expression programming in active distribution network,” the authors propose a content filtering function mining algorithm via simulated annealing and gene expression programming.

Based on a heterogeneous ring domain communication topology, a clustering algorithm and an event-driven cluster

head rotation mechanism is proposed in the article by W. Zhang *et al.*, “E2HRC: an energy-efficient heterogeneous ring clustering routing protocol for wireless sensor networks.” An energy-efficient heterogeneous ring clustering (E2HRC) routing protocol for wireless sensor networks is proposed. Related messages are designed and analyzed in detail.

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