An Energy 4.0 Vision: Embracing Smart Technologies

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Call for submission. This editorial introduces the issue of 2024 for *Embedded Selforganising Systems (ESS)* journal. This issue focuses on a discussion about *An Energy 4.0 vision: Embracing smart technologies* in different areas of engineering solutions.

Our journal uses electronic publication, which provides a flexible way to submit and review the contributions of authors from all countries. The advantages of such an e-journal are multifarious. We replace the classic review and creation process with a new Sliding Issue model compared to traditional paper journals. Each issue starts with an initial editorial and an official call for papers. The submitted articles will be reviewed and, if accepted, published as soon as the committee receives the final version. Based on this process, each sliding issue can be filled successively until the maximum number of articles is reached. During this period, other researchers can already read accepted papers while other papers are still in the reviewing process—accordingly, the time to publish shrinks to a minimum. In addition, multiple issues with different focuses can co-exist at the same time, which provides completely new possibilities to react to the latest research topics. The journal also allows the integration of discussions and other reactions to published articles in the same journal issue.

We are welcoming fresh ideas, on-going research technical reports and novel scientific works. We also intend to create a promising platform for creative and constructive discussions.

An Energy 4.0 vision: Embracing smart technologies

Energy is no exception to the Fourth Industrial Revolution, often referred to as Industry 4.0, in how deeply it transforms many sectors. Core to Industry 4.0 is the integration of high-end technologies within the Internet of Things, artificial intelligence, big data, and blockchain in traditional industrial procedures. Energy 4.0 is the next big transition of the energy sector toward a smarter, more efficient, and sustainable future. For the global energy challenge of the 21st century, embracing smart technologies is no less than an urgency. We would like to point out the following pillars of Energy 4.0 in this issue:

Smart Grids and Digitalization: Smart grids are the backbone for the Energy 4.0 paradigm. These advanced systems use digital communication technology to detect and respond to local changes in usage. Unlike the traditional grids that prefer centralized power generation and one-way communication, smart grids provide both parties, the utilities and consumers, with two-way communication. It helps in more efficient management of electricity supply and demand, reduces energy losses, and integrates renewable energy sources seamlessly. The other important benefit brought into the grid by digitalization is its ability to improve the grid's reliability and resilience. Precise sensors and automatic control systems can detect and isolate faults rapidly, hence reducing outages and time needed to restore service. The predictive maintenance that is achieved by these technologies means that potential issues can be addressed well before they lead to significant disruptions.

The Internet of Things: The IoT revolution extends to the energy sector because of the way connected devices and smart appliances are being deployed. This ranges from smart thermostats to advanced metering infrastructure, which have the ability to collect and transmit data that might be used to optimize patterns of energy consumption. In the end, IoT devices provide real-time feedback and enable consumers to make automatic adjustments in a bid to lower energy usage, thereby reducing cost and contributing to grid stability. IoT also enables the inclusion of DERs, such as rooftop solar and battery storage, and makes possible the remote monitoring and control of such resources, allowing them to be managed rationally as part of the overall energy ecosystem. This decentralization of energy generation and storage contributes to a resilient and flexible energy system.

Artificial Intelligence (AI) and Machine Learning: Analyzing the huge amount of data created by these smart grids and IoT devices is where AI and machine learning algorithms come into play. These technologies can pick out patterns and trends that human operators would hardly

uncover, which should make demand forecasting more accurate and energy management more efficient. For instance, AI could predict a period of high demand for electricity, allowing utilities to plan generation and distribution accordingly. AI-driven systems can also optimize the operation of renewable energy sources to ensure that supply is well-matched with demand on a real-time basis. Machine learning models can also optimize the operation of energy storage systems by forecasting when to charge and discharge batteries based on expected usage and price trends.

Blockchain Technology: Blockchain provides an enabling technology for secure and transparent energy transaction processing. In an energy system being decentralized, and consumers can become prosumers by selling energy; blockchain, in such a case, makes sure that all transactions are recorded and verified correctly. In this way, blockchain enables peer-to-peer energy trading, where individuals and businesses can buy and sell energy directly with one another, using surplus energy. This immutability and transparency of blockchain records enable trust among the members of the energy market, hence reducing the need for third parties and lowering the costs of transactions. This democratization of energy trading encourages the use of renewable sources of energy and, hence, helps in the transformation to a more sustainable energy system.

Adoption of smart technologies is not merely a choice but a necessity for the energy sector. The vision of Energy 4.0 presents an opportunity for revolutionizing the way energy is produced, distributed, and consumed into a far more efficient, sustainable, and resilient energy system. Smart grids, IoT, AI, and blockchain are but a few possible approaches in trying to solve the most urgent challenges regarding climate change, energy security, and economic sustainability. The journey towards Energy 4.0 is a transformative journey laden with challenges and opportunities. By embracing smart technologies and working together, we can unlock the full potential of the fourth industrial revolution and create an energy system that serves the needs of all, today and for generations to come.

We would like to express deep gratitude for your attention and support in presenting the current issue, which shows some remarkable research results carried out at the Department of Electric Techniques, Power Engineering School, Mongolian University of Science and Technology.

We once again express sincere gratitude to Prof. Hardt, members of the teaching staff, and colleagues within the department for their support toward the presentation of this current issue. We are convinced that the research findings shared herein will help set the stage for further progress in the field and lead to future discoveries.

SUBMISSION INSTRUCTIONS

Submissions for the journal must be made as complete papers (there is no abstract submission stage) submitted as PDF documents. Authors are requested to submit papers reporting original research results and experience. The page limit for regular papers is 4 to 6 pages and short papers are from 2 to 4 pages. Papers should be prepared using the IEEE two-column template. An MS Word template or ESS online journal is available here https://www.bibliothek.tu-chemnitz.de/ojs/index.php/cs/information/authors

Papers should submit the following link of the journal:

https://www.bibliothek.tu-chemnitz.de/ojs/index.php/cs/about/submissions

Submission period: Opening July 2024 and closing 10th December 2024.

There is no charge for submission. Accepted papers are publishing free. Review in two weeks after submission. Camera-ready paper for publication should be submit in two weeks after review notes.

Thank you for Your Contribution!