Let There Be Brains! [Editor's Column]

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DOI
10.1109/MIE.2020.3007911

Publication date
2020

Document Version
Final published version

Published in
IEEE Industrial Electronics Magazine

Citation (APA)
Palensky, P. (2020). Let There Be Brains! [Editor's Column]. *IEEE Industrial Electronics Magazine*, *14*(3), 2. Article 9205675. https://doi.org/10.1109/MIE.2020.3007911

by Peter Palensky

Let There Be Brains!

Again, we feature an issue with smart solutions for the power system. The energy transition toward a more sustainable, but still reliable and affordable, energy system requires all participants to be increasingly adaptive, smarter, and flexible. This is usually achieved by smart design—supported by modern methods for planning, dimensioning, and validation—and by smart operations. The latter even requires smart elements—such as controllers and Internet of Things nodes—to be rolled out in our grid to make the power system and its members smarter. We are now at the beginning of this process, and slowly, we see the results of research entering the market. This issue of *IEEE Industrial Electronics Magazine* (*IEM*) features five articles that show you what we will see as enhancements of our energy system in the not-so-distant future.

In "Cyber-Physical Microgrids," Vu et al. describe a potential future of our power system. Microgrids pool local resources and can interconnect in a flexible way. The article discusses what impact this paradigm might have on resiliency, in a positive and negative sense, as the "cyber" part of a cyber-physical power system introduces solutions as well as challenges for obtaining resiliency. For instance, monitoring and state awareness are greatly improved with more sensors, but cyberattacks might constitute new sources of problems.

Digital Object Identifier 10.1109/MIE.2020.3007911
Date of current version: 23 September 2020

"Industrial Agents as a Key Enabler for Realizing Industrial Cyber-Physical Systems" by Karnouskos et al. introduces us to the principles of distributed control and management of such cyber-physical systems (CPSs). Here, industrial agents, forming a multiagent system (MAS), are the dominating paradigm. The origins, promise, and reality of industrial agents and MASs in CPSs are discussed, and their eight most important qualities are explained. Their industrial adaptation and acceptance are laid out, and promising current initiatives are discussed.

THE ENERGY TRANSITION TOWARD A MORE SUSTAINABLE, BUT STILL RELIABLE AND AFFORDABLE, ENERGY SYSTEM REQUIRES ALL PARTICIPANTS TO BE INCREASINGLY ADAPTIVE, SMARTER, AND FLEXIBLE.

The key enabling role of industrial electronics in the smart power system of the future is described in "Power Routing" by Liserre et al. Smartness, in this case more accurate mission profiles, leads to more reliable and cost-efficient solutions. Predictive maintenance is one of the reasons why the lights do not go out that often, and it originates from accurate lifetime estimations. The article presents an efficient maintenance scheduling method and shows how modular inverter topologies can contribute to fault tolerance and thus to availability.

Liu et al. go one step further in their article, "Protection Testing for Multiterminal High-Voltage dc Grid." If something breaks, it is usually grid protection that saves the situation. The article looks at multiterminal high-voltage dc systems and how to test all the new protection systems that we will need in the future. Such a highly dynamic system shows a situation where every millisecond counts, and advanced testing methods need to make sure that intelligent protection equipment does the right things at the right time.

Finally, "Advanced Fault Diagnosis for Lithium-Ion Battery Systems" by Hu et al. tells how intelligence can be brought to a new player in the power system: storage. Chemical storage can show various faults, and accurate diagnostics are needed to reach the operational reliability levels that are used in the power system. The article reviews the mechanisms, features, and diagnostic options for various faults in lithium-ion batteries.

This issue covers various aspects of bringing more intelligence into the largest man-made machine, making it a cyber-physical machine. Most certainly, it will not be the last issue on this topic. The brand new Clarivate *Journal Citation Report* confirms our direction: *IEM*'s impact factor grew again, now at 13.593, making it number three of all publications in this category.