## Editorial

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## **Energy status data**

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Future energy systems are fundamentally important for our society; this includes virtually all aspects of their planning, design, operation, maintenance, and evolution. In particular, there have been significant efforts to shift energy systems towards renewable energy sources, in any part of the world. Renewable sources will make up big shares of the energy production in many countries in the near future. Next, recent technological advances have given way to the proliferation of electric vehicles, large batteries, combined heat and power, and solar energy production into private households and thus closer to the center of society and our day-to-day lives. Together, these developments change the way we have to think about energy systems. They require more flexibility in the production and consumption of energy alike.

As a result, data that relates to energy systems, dubbed energy status data, is becoming more and more important. Energy status data is vital for planning, controlling, maintaining, and optimizing energy systems. The term stands for very different types of information that is generated by any kind of energy system. Examples are physical properties such as load or voltage profiles of private households or industrial sites. Other data concerns environmental properties such as the outside temperature at the locations of the system. This kind of data is often available as time series or data streams, i.e., recurring measurements of the same property at different points of time. Energy status data can also describe how consumers interact with energy systems and each other in their context. Here, data that describes the movement and charging state of electrical vehicles on roads is as interesting as information on processes and participants in energy markets or events in production systems such as the failure of machines. A further type of data that is subsumed under the term "energy status data" is about the structure of systems. To illustrate, information on possible load flows in the grid or on the placement of prosumers is essential for modeling and op-

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timizing the energy system. It can support decision scenarios such as determining the size of new storage solutions to cope with fluctuating supply or when designing energy markets.

Naturally, energy status data can only be analyzed and used if measurement technology as well as methods to plan and implement the computing and communication infrastructure are available. New developments in these areas lead to challenges for data analysis. For example, modern meters provide accurate and high-resolution data, modern computing systems allow the timely analysis of large and varied data sets, and new analysis and feature extraction methods become available for structural as well as for time series data.

Overall, the lifecycle of energy status data consists of three phases: collection, analysis and exploitation. Collection is concerned with the actual measurement of energy status data from its respective source and bringing it together for downstream analyses. A further aspect of collection is defining which data is actually needed for subsequent analysis and exploitation. Analysis is broad, the respective phase includes methods that extract information from the data, like finding interesting data points or time spans, or finding out which different data sets and measurement series are related in an interesting way and which ones are not. Finally, the phase "exploitation" tries to derive insights and strategies from the data or from earlier analysis results. To illustrate, a data exploitation method is one that suggests a suitable battery size for a manufacturing plant, based on data on its energy consumption in the past.

All three phases pose interesting challenges for research, and there is room to improve methods currently in use. When looking at the breadth of the types of data and the ways of using it, it is evident that tackling the respective challenges requires a strong collaboration of different disciplines. To illustrate, electrical engineers might be interested in improving measurement methods, or they might want to find out how to deploy battery systems in practice in a data-driven manner. Economists can design markets that lead to interactions between consumers and producers so that the energy grid runs in a way that is stable.

In the Research Training Group 2153 "Energy Status Data – Informatics Methods for its Collection, Analysis

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and Exploitation", funded by the German Research Foundation (DFG) since May 2016, the research questions just pointed to are investigated from the perspectives of economics, engineering, law, and computer science, in close collaboration.

For this issue, we are very glad to have collected a number of articles on the topic of energy status data, which we deem very interesting. This special issue features the breadth of the research topic 'energy status data', from two different points of view in particular. The first three articles in the issue deal with energy markets. As such, they are concerned with the phases 'collection' and 'exploitation' of energy status data. The last two articles focus on the effect of time series reduction methods on data analyses; they fall into the second phase, which has been analysis.

"Perspectives on Data Availability and Market Approaches to Congestion Management" by Bent Richter and Philipp Staudt presents different congestion management techniques and discusses the importance of data and data availability for this topic area. The authors also present different research questions for data-oriented congestion management. The paper particularly highlights the interdisciplinary aspects of energy status data between economics and computer science.

"Design of a Microgrid Local Energy Market on a Blockchain-Based Information System" by Benedikt Kirpers and colleagues introduces a system architecture for building decentralized local energy markets and the underlying information systems based on a well-established standard model, the Smart Grid Architecture Model. The authors collect and discuss a comprehensive of requirements for different aspects of such a system and evaluate them against a real world case study.

In "Tracing Local Energy Markets", Esther Mengelkamp, Julius Diesing and Christof Weinhardt investigate the current scientific research and current research gaps for local energy markets in a structured literature review. They carve out commonalities and differences between different approaches, both on an implementation, as well as on a conceptual level. Based on their research, the authors also present future research directions.

"Understanding the Effects of Temporal Energy-Data Aggregation on Clustering Quality" by Holger Trittenbach and co-authors takes clustering, a method that has frequently been applied to energy status data before, and provides insights into how aggregation affects the clustering result. In their experiments, the authors find significant relationships between the type of clustering algorithm and the aggregations method on the one hand and clustering quality on the other hand. The authors then propose guidelines for choosing an aggregation scheme.

In the paper "Reducing Energy Time Series for Energy System Models via Self-Organizing Maps", Hasan Ümitcan Yilmaz and his co-authors concern themselves with the execution of energy-system models. This is difficult if the underlying amount of data is large. The authors propose an approach to facilitate this, by using a specific kind of neural network for time series reduction as a preprocessing step.

## Bionotes



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