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Smart energy-systems for large-scale integration of renewable electrical energy

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Smart energy systems are defined as an approach in which smart electricity, thermal and gas grids are combined and coordinated to identify synergies between them to achieve an optimal solution for each individual sector as well as for the overall energy system. The challenge of integrating the fluctuating renewable energy power sources such as wind, solar and ocean energy depends strongly on the share of the input. The following three phases of implementing renewable energy technologies can be defined as: (1) The introduction phase, (2) The large-scale integration phase and (3) The 100% renewable energy phase. The introduction phase represents a situation in which there is no or only a small share of renewable energy in the existing energy system. The phase is characterized by marginal proposals for the introduction of renewable energy, e.g., wind turbines are integrated into a system with only a limited share of wind power. The system will respond in the same way during all hours of the year and the technical influence of the integration on the system is easy to identify in terms of saved fuel on an annual basis. Moreover, the input of renewable power does not pose a challenge to the operation of the grid and the electricity balance. The large scale integration phase represents a situation in which there is already a major share of renewable energy in the system, e.g., when more wind turbines are added to a system which already has a high share of wind power. The phase is defined by the fact that further increase in renewable energy penetration will have an influence on the system and this will vary from one hour to another, e.g., depending on whether heat demand is high or low in the given hour, whether a heat storage is full or not or whether the electricity demand is high or low during the given hour. The integration of wind and solar power in the system becomes complex and requires consideration with regard to grid stabilization. The 100% renewable energy phase represents a situation in which the energy system is currently or is being transformed into a system. The system is characterized by the fact that new investments in renewable energy will have to be compared not to nuclear or fossil fuels, but to other sorts of renewable energy system technologies. These include conservation, efficiency improvements and storage and conversion technologies. The influence on the system is complex not only with regard to differences from one hour to another but also with regard to the identification of a suitable combination of changes in conversion and storage technologies. Moreover, the challenge of operating the grid in terms of ensuring frequency and voltage stability is of major importance.

Biography

Koksal Erenturk has received his BS degree from Yildiz Technical University, Turkey, MS degree from Istanbul University, Turkey and PhD degree from Karadeniz Technical University, Turkey all in Electrical Engineering. His work has focused on the smart grid, renewable energy systems and development and application of control theory to a variety of mechatronic systems with a focus on observation and estimation based control and also on the analysis and control of dynamical systems that arise in engineering applications.

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