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Flexible bioenergy system integration into energy supply systems of urban areas

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Bioenergy is nowadays by far the most important renewable energy source. In order to achieve high sustainability of bioenergy utilization under the increasing requirements of future-oriented energy supply, the performance of biomass plants has to be increased and used "smarter" as before. The highest efficiency of the utilization of biomass potentials is currently achieved in decentralized systems, as they can be characterized by relatively high conversion efficiencies, high flexibility, and reasonable investment costs. Due to their system characteristics, decentralized bioenergy plants are operated in a heat-driven mode, which leads to problems to achieve the designed conversion efficiency if an urban area with fluctuating heat demand serves as the heat sink. Resulting from this difficult operating conditions of bioenergy plants, the aim of the study is the development of innovative system applications that will enable optimal integration of bioenergy plants with the objective of optimal exploitation of their system potential in the context of future-oriented energy supply. In the case of decentralized bioenergy plants, the available options for the application of effective process control technology are limited due to the scaling effects. This usually leads to fluctuations of the process parameters and consequently to significant losses in system efficiency. To solve this problem, an optimization concept developed in the context of the presented study, consisting of new hardware components for combustion air management and fuel parameters control will be described in the paper. The presented approach includes also the implementation of model-based improvement of the system control, which will lead to a significant increase in the system stability and process efficiency. In order to achieve optimal integration of modern bioenergy plants within sustainable energy supply systems, the infrastructure requirements of the supply areas must also be taken into account. For this purpose, a 3D CityGML model of the building infrastructure was developed by using a GIS system. The simulation platform created in this way was extended by a heat network model. This platform can be used to predict the evolution of heat demand of the supplied urban area, which will make the operation of bioenergy plants more efficient. Furthermore, this platform can be applied to remedy infrastructure deficits, which can additionally increase supply efficiency. The comprehensive system application presented in the study, consisting of new hardware components, model-based system optimization, and an infrastructure integration platform, can be universally used to improve the operation of existing and new planned bioenergy plants. With respect of a large number of bioenergy plants as the most important producer of regenerative energy, the utilization potential of this effective system application can be estimated as very high.

Biography

Rafal Strzalka has been working at the Stuttgart University of Applied Sciences since 2002. As part of his work, he was involved in numerous national and European projects. Since 2013, he has been coordinating the research activities of the university in the field of energetic use of biomass as a project manager. The core competencies of him includes the optimization of energy production processes, the comprehensive analysis of biomass energy infrastructure and specialized, simulation-based efficiency enhancement measures for biomass-fired energy generation systems.

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