Title: Digital twins for sensor data-based drying of biomass under changing outdoor weather conditions

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Abstract:
The storage and natural drying of bulk biomass in agriculture such as wood chips from agroforestry in open-air piles can be related to high dry matter losses, quality losses and microbiological contamination. Ventilation and active drying with ambient air is a common technology for drying of bulk products, but its energy-efficient implementation places high demands on process control. Particular challenges are above all: The overall system operates with high delay times, thermodynamic processes overlap with biological ones, wood chip piles are very inhomogeneous with respect to porosity and wood properties and at the same time, the system is exposed to changing weather conditions.

The aim of the PhD project is to develop AI-based control strategies for active wood chip drying that link the fundamental physical relationships of heat and moisture transport in bulk materials with real-time sensor data, data from sampling and weather forecasting. Based on data-driven- and physical-models a digital twin of the drying system is to be developed for testing these control strategies and optimisation in terms of energy efficiency in dependence to raw material properties and weather conditions. Sensor and sampling data on drying processes under different weather conditions are already available from several years of trials of active wood chip drying with ambient air at practice scale.

Desired skills of the applicant:

- An above-average university degree (MSc or equivalent) in data science, computer science, mathematics or a related discipline
- preferable a strong interest and knowledge in agriculture and thermodynamics
- Sound background in AI/data-driven modelling, mathematical modelling
- Knowledge in data fusion and machine learning
- Programming skills (preferably Python)

References:

Lühr, C.; Pecenka, R.; Lenz, H.; Hoffmann, T. (2021). Cold air ventilation for cooling and drying of poplar wood chips from short rotation coppice in outdoor storage piles in Germany. Biomass and Bioenergy 146, 105976. https://doi.org/10.1016/j.biombioe.2021.105976