The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES

of **Roeland De Meulenaere**

The public defense will take place on **Tuesday 24th September 2024 at 2:30 pm** in room **D.2.01** (Building D, VUB Main Campus)

To join the digital defense, please click here
Meeting ID: 325 936 385 671
Passcode: qRq5Lb

RETROFITTING THERMAL POWER PLANTS TOWARDS RENEWABLE FUELS USING UNCERTAINTY QUANTIFICATION

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Abstract of the PhD research

In response to the adverse environmental effects associated with thermal electricity generation, continuous advancements in production technologies have been pursued. Rather than decommissioning existing power plants outright, it is pertinent to explore the potential transformation of these assets into cleaner production units by altering their fuel sources. This research investigates the conversion of a coal-fired power plant to a biomass Combined Heat and Power (CHP) system in a deterministic manner, providing insights into thermodynamic performance. Due to input data limitations, the deterministic approach is transitioned to a probabilistic framework using Polynomial Chaos Expansion with two uncertain input parameters. The study establishes the applicability of this method for such simulations. Subsequently, Sparse Polynomial Chaos Expansion is employed to assess power plant conversion, incorporating over 240 uncertain input parameters. The significance of each parameter is evaluated through Sobol indices, offering valuable insights for decision-making in the retrofitting process. As anticipated, the outcomes reveal a reduction in power production, energetic and exergetic efficiency. The Lower Heating Value (LHV) of the fuel emerges as the most influential parameter. Notably, attention is drawn to the impact on boiler operation following fuel alteration.

In the second phase of the research, the conversion of fuel from natural gas to e-fuels for gas turbines is examined. Specifically, the study investigates the impact of this conversion on NOx emissions during transient conditions. Normalised experimental transient data, coupled with stochastic processes, was employed to address uncertainties in input data for a one-dimensional combustion simulation model. A methodology integrating uncertainty quantification and expert judgment is proposed to provide reliable probability distributions for key performance indicators.