Institute for Machine Tools and Industrial Management (*iwb*)
TUM School of Engineering and Design
Technical University of Munich

Development of a Flexible Simulation Model for the Renewable Hydrogen Supply Chain

Motivation

The European Union (EU) is steadily progressing from conventional fossil-based energy sources to sustainable and renewable alternatives. Driven by imperatives such as the Paris Agreement, governments and institutions worldwide are committed to carbon-neutral practices. In this changing energy landscape, hydrogen emerges as a promising candidate, primarily when produced carbon-neutral. Moreover, the regulations do not clearly state when hydrogen production and usage can be considered carbon neutral.

Hydrogen, as a clean and versatile energy carrier, has the potential to replace fossil fuels such as natural gas in various industries. Its role in the energy transition is critical to achieving ambitious sustainability goals. However, hydrogen's unique chemical properties present challenges, particularly in transportation and storage.

Hydrogen's low energy density and tendency to permeate materials pose complex challenges for efficient and safe transport and storage. The need for specialized infrastructure and technologies further complicates the decision-making process for establishing a robust hydrogen supply chain. In addition, the imperative of carbon neutrality is shifting the focus to producing renewable hydrogen to ensure that the entire lifecycle of hydrogen, from production to end use, is consistent with environmental sustainability goals.

Objective

The goal of the thesis is to develop a flexible simulation model to perform scenario simulations for various hydrogen supply chain configurations based on the VDI 3633. The work builds on an existing simulation model in Tecnomatix Plant Simulation. The project starts by getting familiar with the existing simulation model. Afterward, the simulation input parameters and

output key performance indicators should be challenged and categorized according to the categorization of the VDI 3633 into system load data, organizational data, and technical data. In the next step, the existing simulation model should be transferred to a flexible simulation model implemented in Python using Simply. The goal is to create simulation building blocks for hydrogen production, transportation, storage, and utilization. This allows for flexibility in creating, simulating, and evaluating supply chain configurations. Afterward, a suitable data structure and database structure should be developed to efficiently save the simulation results. The simulation model should be made accessible by creating a simple web-based user interface using Python and FastAPI as backend and Typescript/Javascript as frontend.

Qualifications

- Currently studying or showing keen interest in areas like renewable energies and market dynamics
- Some exposure or a strong interest in supply chain management
- Familiarity with Python, optionally Plant Simulation
- Demonstrated interest in self-directed learning and an openness to explore unfamiliar topics.
- Ability to convey thoughts and findings effectively in written form and verbally.
- Independent, determined, and structured way of working.
- Solid English communication and writing skills; German is beneficial.

Why *iwb*?

- Personal and thematic supervision
- Professional perspective at an excellent institute of the TUM

Contact

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