Modeling & Optimization of Hydrogen Hubs in Congested Electricity Grids

Boosting renewable hydrogen production in the Netherlands

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Background

1. Renewable energy generation is on the rise in the Netherlands. **However, this positive change for the environment, coupled with the electrification of the economy, strongly contributes to a growing technical challenge in the country: congested electricity grids.**

2. **Grid congestion happens when the grid cannot transport electricity from where it is generated to where it should be consumed.** Therefore, the growth of congestion can curb electricity availability and directly impact the economy.

3. Renewable hydrogen is an energy carrier with the potential to advance the Dutch energy transition. **Green hydrogen production can absorb excess renewable electric energy and store it for later use, easing grid congestion and fostering the national economy.**

4. **Hydrogen Hubs are a great solution for integrating renewable hydrogen production into the Dutch energy system and supply chains.** By combining different hydrogen production technologies, these hubs offer a reliable and efficient way to exploit their synergistic characteristics.

Objective

The developing renewable hydrogen industry needs to have an accurate assessment of prospective hydrogen hub projects' feasibility not only to secure, for instance, financing opportunities but also to check the impacts of possible technical challenges arising from the technological integration.

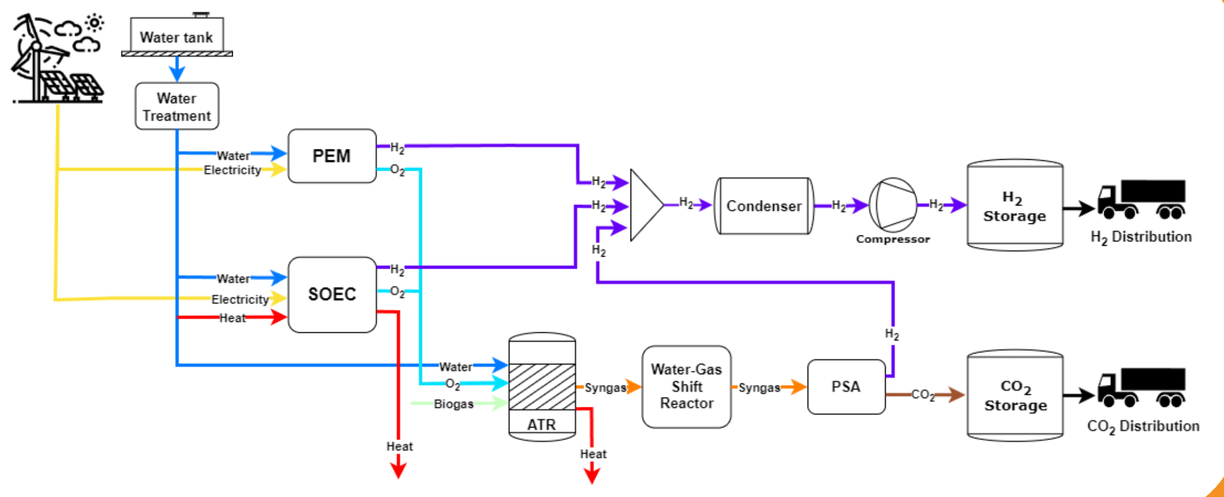
The present research project was designed to respond to this latent need by modeling, simulating, and optimizing hydrogen hubs for different locations in the Netherlands, enabling better business opportunities through technical, economic, and environmental analysis.

Methodology

The study will follow three main steps. First, analyze the state-of-the-art of hydrogen production technologies and their combination. Next is developing linked thermodynamic and financial models for different hub configurations. Finally, the optimization and comparison of the various configurations are based on their technical, economic, and environmental performance.

The base hydrogen hub concept focuses on using oxygen production from Proton Exchange Membrane (PEM) and Solid Oxide electrolyzers as the sole source of this chemical for an Autothermal Reforming (ATR) of biogas with carbon capture. Still, improvements will be sought through new hub designs, such as adding electrochemical and thermal energy batteries.

The computational models will be implemented in Python using a dynamic (quasi-steady-state) simulation tool.



Expected Results

Obtain a comprehensive and user-friendly simulation tool for techno-economic analysis of hydrogen hubs, enabling industry players better planning, optimization, and decision-making regarding operation and investments.

Assessment and comparison of the technical, economic, and environmental feasibility of different hydrogen hub configurations and the technical challenges resulting from the integration of technologies.

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Project

INTEGRATED RENEWABLE ENERGY SYSTEMS FOR HYDROGEN PRODUCTION IN CONGESTED TRANSMISSION GRIDS

Funding

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