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DESIGN STRATEGY AND OPTIMIZATION OF A RENEWABLE-BASED ENERGY MIX IN LATVIA REGION

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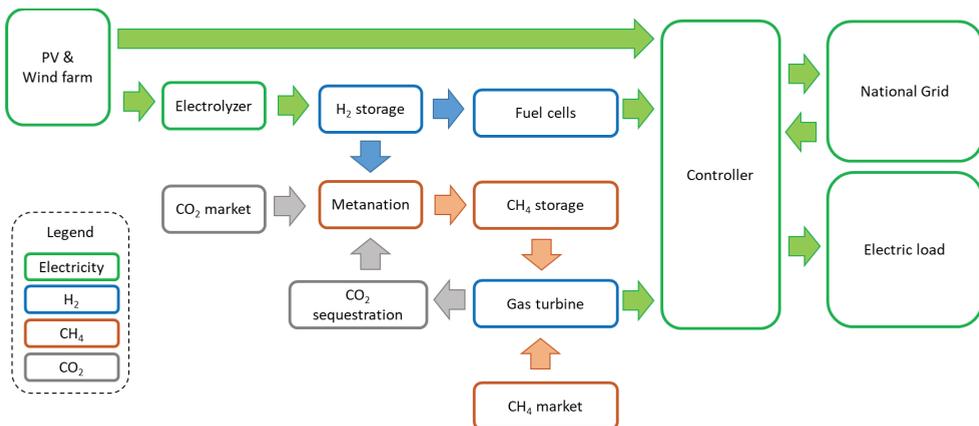
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Abstract – The global increase in energy consumption is forcing the energy sector to evaluate the energy transition from fossil-based systems to renewable energy sources. Unfortunately, the impact of non-dispatchable generation affects grid stability and the ability to meet night time loads. In addition, a shift from summer to winter is required to increase the penetration of renewables. The introduction of storage technologies and the energy mix could overcome some of the problems associated with the green revolution. The aim of the work is to assess the best combination of generation systems and storage to meet the electricity needs of a 100 MW peak load city in the Latvian region with an annual energy load of 700 GWh. The energy hub considered, shown in the figure, represents a valuable evolution of a traditional gas-fired power plant coupled with the most cost-effective renewable resource generators: photovoltaic and wind turbines. To exploit the renewable surplus, part of the electricity is converted into hydrogen, which drives a fuel cell and a methanation system linked to the gas turbine. The method used is Trnsys-based numerical modelling coupled with multivariable particle swarm optimization to minimise the levelized cost of electricity under different renewable penetration scenarios. The LCOE is 0.96 EUR/kWh for a 50% RES production and doubles for a fully renewable system. The optimised energy mix includes an electrolyser with a capacity equivalent to 24 % of the renewable capacity. The results of the analysis show the crucial role of the H₂ system, which is 20 times larger than the CH₄ system.

Keywords – Energy efficiency; energy modelling; energy storage; hydrogen; intermittent power production; renewables; transient simulation



Energy hub layout with power generation and gas flows