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EXISTING POWER PLANT DECARBONIZATION IN LATVIAN REGION

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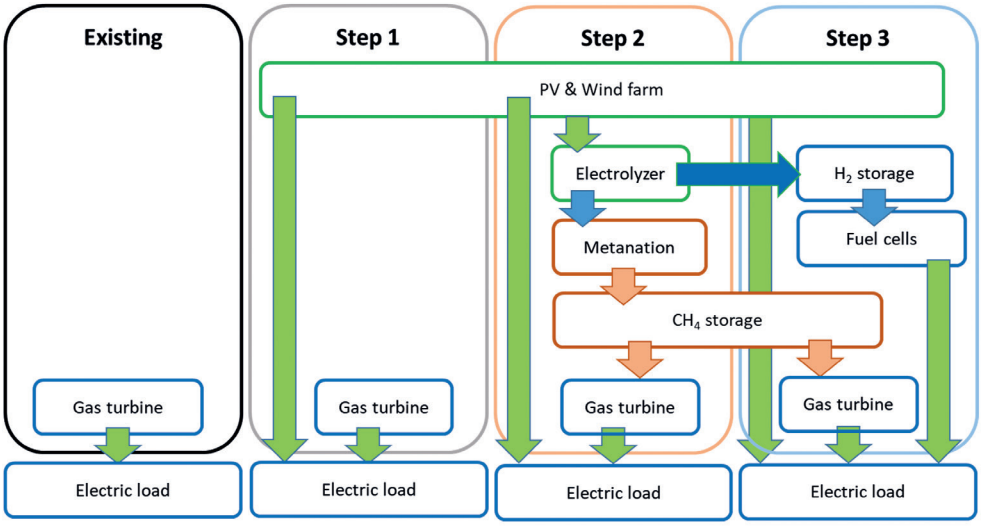
Abstract – The global rise in energy demand is compelling the energy sector to reassess the transition from fossil fuel-based systems to renewable energy sources. However, the variability of non-dispatchable generation poses challenges to grid stability and to reliably meeting nighttime demand. Moreover, a seasonal shift from summer to winter production is necessary to further increase the share of renewable energy. Starting from previously developed model, the work proposes a path to decarbonize an existing power plant in Riga adopting a techno-economic optimization. Starting from a gas turbine power plant the 100 % decarbonization is achieved in different steps. The work aims to identify the optimal combination of power generation and storage technologies to supply the electricity demand of a city in the Latvian region with a peak load of 100 MW and an annual consumption of 700 GWh considering the best techno-economic solution. The decarbonisation path, proposed in Fig. 1, combines existing conventional gas-fired power plant integrated with the most cost-effective renewable generation technologies, namely photovoltaic systems and wind turbines adopted in Step 1. By this way the decarbonization reach only 35 % of the annual load and represents the actual achievement in most European country. To fully decarbonize power generation, the only



Decarbonization steps for existing power plant

way is to supply green methane to the power plant. The proposed solution, in step 2, included methanation starting from CO_2 capture and hydrogen from renewable electricity surplus. Step 2 reach 100 % of renewable energy sources but the price reach 0.24 EUR/kWh. The step number 3 proposes the most advanced hydrogen storage with fuel cell ion the aim of gas turbine substitution at the end of gas turbine operation reaching a 0.19 EUR/kWh. The analysis is based on TRNSYS numerical modelling combined with multivariable particle swarm optimization to minimize the levelized cost of electricity (LCOE). Overall, the findings highlight the critical role of the hydrogen system, whose capacity is approximately twenty times greater than that of the methane system.

Keywords – Decarbonization; energy storage; hydrogen, renewables; transient simulation