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ENERGY HUB INTEGRATION POSSIBILITIES IN ENERGY PORTFOLIO OF LATVIA BASED ON EXAMPLES IN EUROPE

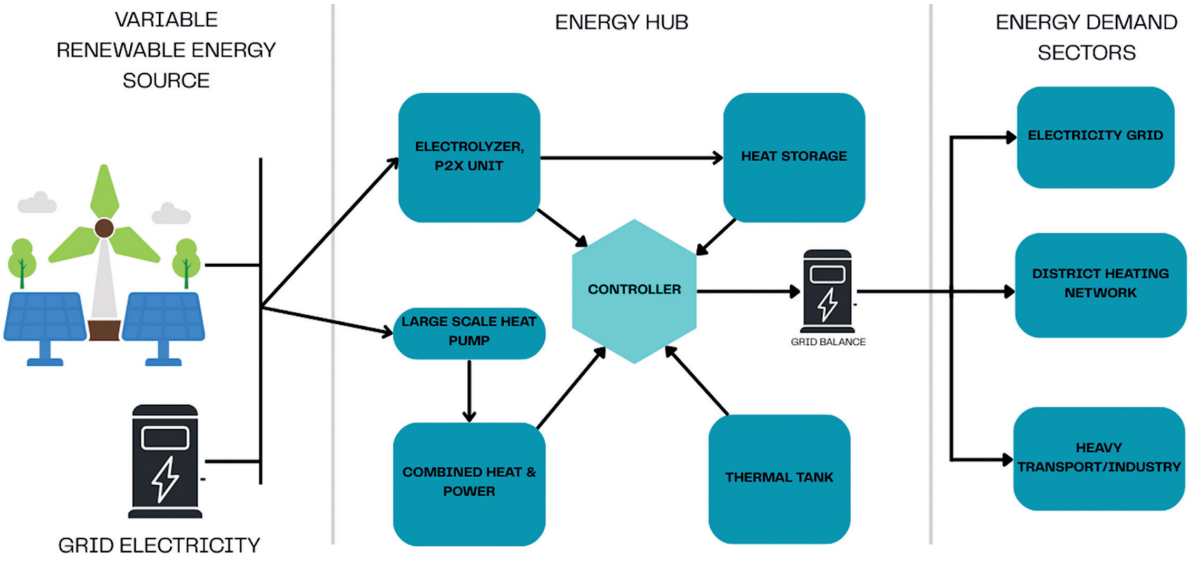
Marta VIEGLINA[1*], Haralds SIKTARS[2], Vladimirs KIRSANOVS[3], Ivars VEIDENBERGS[4]

[1–4] *Institute of Energy Systems and Environment, Riga Technical University, Azenes iela 12/1, Riga, LV-1048, Latvia*

[*] ***Corresponding author.*** *Email address: haralds.siktars@rtu.lv*

Abstract – Increasing energy demand, rising greenhouse gas emissions and limited fossil fuel reserves are creating critical global energy challenges. To address these issues, a fundamental shift in energy management is needed, moving towards innovative solutions like energy hubs. This concept is designed to model and optimize multi-energy systems, integrating electricity, heat and gas to achieve carbon neutrality and improve system flexibility. The research focuses on the conceptual development of energy hubs and their potential implementation in Latvia by conducting a comparative analysis of leading European examples, such as energy islands in Denmark and sector coupling projects in Germany. The methodology of the study is based on three core pillars: ESG criteria evaluation, technological parameter analysis and GIS based modeling to identify the most suitable locations for a potential energy hub implementation in Latvia. Technological investigation focuses on the synergy between conversion technologies like electrolyzers for green hydrogen and large-scale thermal storage, meanwhile allowing to introduce more RES in the energy portfolio. While the study is ongoing, preliminary comparative analysis of European examples suggests that energy hubs significantly enhance system flexibility through sector coupling, particularly by transforming surplus renewable energy into storable energy forms. The results of this study aim to provide a strategic roadmap and a spatial suitability map for the deployment of the first-generation energy hubs in Latvia, specifically considering the integration of wind and the modernization of district heating networks. The research will conclude with specific recommendations for stakeholders to facilitate a decentralized, resilient and carbon-neutral transition that aligns with European Green Deal and national energy and climate plan of Latvia.

Keywords – Energy hub; energy transition; ESG criteria; grid balance; hydrogen; multi-energy system; Power-to-X; sector coupling



Conceptual framework of an energy hub, integrating multi-energy sectors and H2 technologies

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