
HABILITATION THESIS

Innovative solutions of using renewable energy resources, green hydrogen and water

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SUMMARY

Hydrogen production is not a new concept, and the technologies required to obtain it are well known. However, recent trends in hydrogen extraction technology focus on production from renewable resources. These methods, still in the testing phase, have the potential to give all citizens access to a clean, non-polluting source of energy at a reasonable cost. Water electrolysis, one of the most fundamental technologies in this field, has the potential to become essential for the production of hydrogen as an energy carrier. Hydrogen produced from renewable sources offers numerous advantages. First of all, its use as an energy source does not generate greenhouse gas emissions, thus contributing to the global goals of reducing carbon emissions. Second, hydrogen has a high energy density, which makes it ideal for use in sectors where electric batteries are less efficient, such as shipping and aviation. Hydrogen can also be easily stored and transported, providing a solution for managing the intermittency of renewable sources such as solar and wind power.

For all its advantages, green hydrogen production faces significant challenges, particularly related to cost and infrastructure. Currently, the production of hydrogen by electrolysis is more expensive than conventional methods such as methane reforming. However, technological advances and falling costs for renewable energy are expected to significantly reduce green hydrogen production costs in the coming years. In addition, the development of extensive infrastructure for the production, storage, transportation and distribution of hydrogen is required, including pipelines, fueling stations and storage facilities. Integrating hydrogen into the global energy mix is essential for the transition to a more sustainable energy system and for achieving decarbonisation goals. Hydrogen can be used in many applications, from generating electricity in hydrogen-based power plants and fuel cells, to fueling fuel cell vehicles and use in industrial processes. Hydrogen can also play a crucial role in large-scale energy storage, enabling better integration of intermittent renewables.

În studiul de față s-a investigat producția de hidrogen și conversia acestuia în energie electrică prin intermediul unui sistem autonom hibrid care utilizează resurse regenerabile precum energia solară și eoliană. Sistemul a fost conceput pentru alimentarea unei clădiri rezidențiale, oferind o perspectivă asupra modului în care hidrogenul poate fi produs la scară mică în România. În acest scop, au fost analizate cinci ipoteze privind amplasarea sistemului în locații cu disponibilitate variabilă a resurselor regenerabile. Energia regenerabilă a câștigat teren în ultimii ani ca soluție la schimbările climatice și la dependența de combustibili fosili. De exemplu, energia eoliană s-a dovedit eficientă în numeroase regiuni, precum China, SUA și Europa. Cu toate acestea, aceste sisteme prezintă provocări semnificative din cauza structurii lor

complexe și a parametrilor nesiguri. Studiul a propus tehnici de control avansate pentru a îmbunătăți performanța turbinelor eoliene, incluzând metode precum controlul anticipativ bazat pe LiDAR și filtrul Kalman adaptiv pentru estimarea fluxului și vitezei rotorului.

In addition to energy challenges, the study also addresses a key issue for rural peripheral, disaster-affected and polluted (PDP) areas. These regions are often neglected in public policies on access to drinking water, exacerbating the rural-urban disparity in living conditions. Romania's identity is closely linked to its rural areas, where around 30% of the workforce is employed in agriculture, compared to an average of 4%-5% in Western Europe. Although the revitalization of these areas is a strategic objective for Romania, the reduced access to drinking water remains an unresolved problem, often due to ineffective public policies and management practices. The study proposes a series of public policy options to address this problem, highlighting the need for sustainable solutions that reduce the disparity between rural and urban environments and ensure access to essential resources.