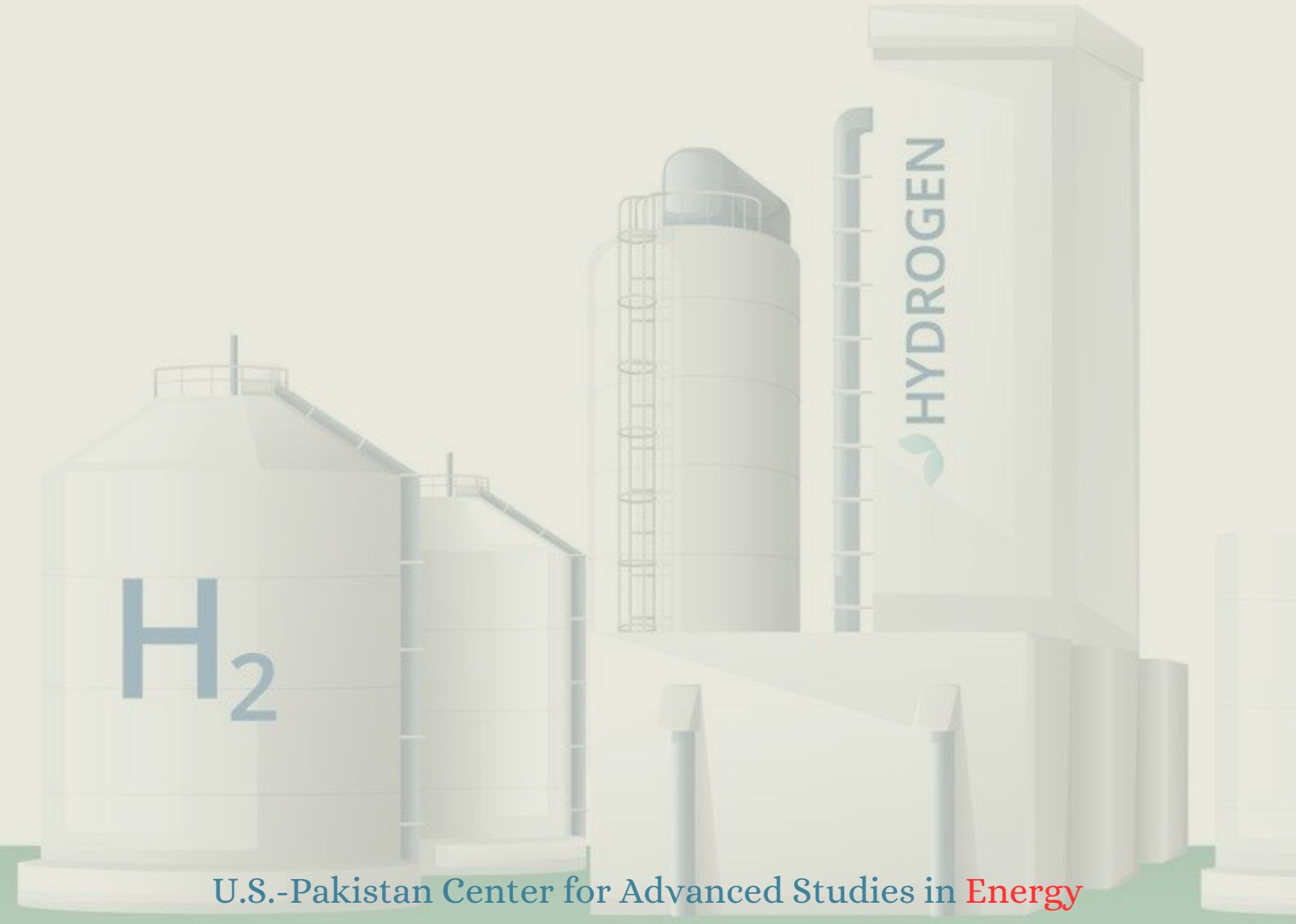
ENERGY AND CLIMATE
PANORAMA

Techno economic Analysis of Hydrogen Infrastructure to replace diesel for mobility applications in Pakistan



U.S.-Pakistan Center for Advanced Studies in Energy

About Us

Who we are

We are a dedicated team of researchers and experts who recognize the urgent need for action in addressing climate resilience and energy transition in Pakistan. Our mission is to develop and implement effective policies for cleaner, renewable energy sources like solar and wind, aligning with Pakistan's 2030 goal of 30% renewable energy in its electricity mix. As a multidisciplinary team, we leverage expertise in three key disciplines of study—Energy Systems Engineering, Thermal Energy Engineering, and Electrical Power Engineering—to drive our mission forward. We are united by a shared vision of creating a sustainable and resilient future for Pakistan, where cleaner energy sources play a pivotal role in reducing the nation's vulnerability to climate-related challenges.

What we do

We conduct in-depth, evidence-based research to analyze and improve energy policies in Pakistan. Our focus is on advancing renewable energy solutions and engaging stakeholders to ensure effective policy implementation. Our methodology involves a critical examination of current energy policies to pinpoint areas of improvement and formulate strategies for the widespread adoption of renewable energy sources across various levels.

In line with our commitment to fostering sustainable practices, we have established a fellowship program as part of our broader initiatives that aims to facilitate evidence-based research for promoting energy transition in Pakistan. Through research studies, surveys, and forecasting, we plan to assess various aspects of energy transition, including the adoption of renewable energy technologies and their impact on climate change. Our approach involves active engagement with stakeholders to address their concerns and facilitate the effective implementation of policies, fostering the growth of renewable energy manufacturing and marketing facilities.

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Executive Summary

Energy demand has been increasing globally due to population growth, urbanization and economic development. World population is expected to touch 9.7 billion by 2050, which directly indicate the increase in energy demand in future. Currently, 80% of world energy is fulfilled by exploiting fossil fuels, which liberate large amount of greenhouse gases (GHGs). In response to growing environmental concern, various countries have started to invest in renewable energy resources. Clean energy resources such as wind, hydroelectric and solar helps to reduce the carbon footprints of energy sector. Similarly, hydrogen energy resource also has potential to contribute to global transition towards low-carbon and more sustainable. First world countries have formulated their targets regarding hydrogen economy and net zero emissions, and Pakistan's hydrogen strategy is also expected in near future. Pakistan is dealing with a number of energy-related issues, such as significant climatic catastrophes, a heavy reliance on imported fossil fuels, and energy insecurity. Unbelievably, 30% of Pakistan's total energy consumption is attributed to the transport industry. Pakistan is heavily dependent on imports for transportation fuels, which leads to a $1.3 billion monthly import bill. As the number of automobiles rises quickly, the need for petroleum keeps rising. This poses difficulties not just with regard to energy security, but also with regard to air quality and the environment. Pakistan's whole greenhouse is about 167.2 tetragrams (Tg) of CO_2 released into the atmosphere, as a result of transportation alone, making up more than 22.7% (37.7 Tg of CO_2 equivalent) of the nation's overall emissions of greenhouse gases. Green hydrogen is a potential solution for current climate change scenarios. Hydrogen production from renewable sources offers a sustainable alternative to fossil fuels. Incorporating green hydrogen in the transport sector of Pakistan can bring notable improvement in environment as well as it well saves the massive amount of bill for importing fuel. In order to keep pace with the world and the current challenges as mentioned, this study serves as a pilot project to introduce green hydrogen in Pakistan transport sector. Pakistan is blessed with exploitable potential of solar resources, which brighten the chances of hydrogen projects. The objectives were accomplished by pointing out locations with good solar and wind resources for building green hydrogen infrastructure and a techno-economic analysis of green hydrogen produced for the replacement of diesel vehicles. In order to carry out this study the methodology was devised and a software Hybrid Optimization of Multiple Energy Resources HOMER PRO is used to analyze different parameters like Net Present Cost (NPC), Levelized Cost of Hydrogen (LCOH), Levelized Cost of Energy (LCOE), Capital Expenditure (CAPEX), Operating Expenditure (OPEX), power, electricity and hydrogen generation. The route NH-5 was selected for this project and along the route 7 stations Peshawar, Gujrat, Sahiwal, Bahawalpur, Gotki, DaulatPur and Gharo were marked as a sight for Hydrogen Refueling Station (HRS). 50 Xcient Hyundai trucks were introduced as a replacement for diesel trucks. The comparative analysis was done which shows that diesel being the major contributor of emissions and replacing diesel with green hydrogen is not only technically feasible and also economically viable. The results also revealed that different station show various benefits, for instance, Peshawar has LCOE $0.14/kWh that is lowest of all and $0.386/kWh in Gotki that is highest. Gotki has lowest CAPEX and OPEX of $2.66 million and $39,523 respectively. Peshawar has highest NPC of 13.96M but lags in hydrogen production with 86,653Kg/year. Gujrat seems most environmentally friendly with only 442kg of CO_2 emissions per year. Detailed analysis of results of this study and policy recommendations are provided in the end to help policy makers and researchers to develop a better understanding of green hydrogen production, economy infrastructure and policy formulation.