Research Article

The role of Hydrogen Economy in Shaping the World Economy International Labour Market and Its Economic, Occupational, and Geopolitical Implications.

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Abstract: The global hydrogen economy is reshaping energy and industrial sectors with significant implications for labor markets. This study investigates the impact of expanding hydrogen production in the top three producers China, the United States, and Australia on their national and international labor markets. Using employment data and occupational trends from 2020 to 2025, a multi-sector Input-Output analysis reveals the complex relationships among economic sectors and labor shifts. Results show substantial direct, indirect, and induced employment effects, including a rising demand for technical and engineering skills. The research also highlights international labor market linkages driven by global supply chains. Scenario analysis compares steady growth with a slowdown scenario affected by geopolitical challenges. Findings suggest that expanding hydrogen production in developing countries could significantly enhance global economic growth and employment opportunities. The study offers key insights to guide policymakers in fostering workforce readiness and international cooperation for a sustainable hydrogen-driven economy.

Keywords: Hydrogen Economy, Labor Market Dynamics, Employment Impact, Input-Output Analysis, Occupational Shifts, Economic Growth.

INTRODUCTION

The global transition towards a sustainable energy future has positioned the hydrogen economy as a pivotal force reshaping both energy and industrial sectors worldwide. Hydrogen, as a clean energy carrier, offers tremendous potential to reduce carbon emissions, enhance energy security, and enable green industrialization. This rapid transformation carries profound implications for labor markets, affecting employment patterns, occupational structures, and skill requirements not only at the national level but also across international labor dynamics.

In previous research (Abdeldayem, 2023), the broad opportunities and challenges of the global hydrogen economy were examined, focusing primarily on technological, economic, and environmental dimensions. While that work provided a foundational understanding of hydrogen's global potential, it did not explore in detail the socioeconomic and labor market transformations arising from hydrogen production growth.

Building upon this foundation, the present study focuses explicitly on analyzing how the expansion of hydrogen production in the top hydrogen-producing countries China, the United States, and Australia impacts national labor markets and the dynamics of the international labor market. The study investigates employment changes, occupational shifts, and skill demands driven by hydrogen economy growth. The central objectives are to assess the labor market effects of hydrogen production expansion, explore international labor market linkages, and provide evidence-based recommendations to assist developing countries in strategically expanding their hydrogen sectors. This work is guided by the following key research question:

How can developing countries strategically expand their hydrogen production capacity to maximize positive labor market outcomes?

To address this, the study employs an integrated Input-Output econometric model combined with scenario analysis, capturing both economic and geopolitical factors shaping labor market transformations under varied hydrogen economy development pathways.

LITERATURE REVIEW

The hydrogen economy has garnered increasing attention as a cornerstone of the global energy transition towards sustainable and low-carbon futures. Numerous studies have analyzed its technological, economic, and environmental impacts, yet the labor market implications remain an emerging research area with significant gaps, particularly regarding international labor dynamics and developing countries.

Several recent analyses highlight hydrogen economy expansion's potential to create new employment opportunities and transform occupational structures. For example, research in Germany's green hydrogen sector shows substantial job growth in hydrogen production, construction, and engineering, driven by investments in new infrastructure and technologies (Müller et al., 2024). Similarly, reports from the International Renewable Energy Agency (IRENA, 2023) emphasize the rising demand for specialized technical skills, such as electrolysis operation and maintenance, as well as engineering and project management competencies.

In major hydrogen producers like China, the United States, and Australia, governments have prioritized policy support and funding mechanisms to accelerate hydrogen commercialization, which directly influences labor market outcomes (IEA, 2025). China's (Hydrogen Energy Industry Development Plan) explicitly links hydrogen sector growth to employment creation and skill upgrading (Zhao et al., 2023). The U.S. Hydrogen Energy Earth-shot initiative similarly identifies workforce development as a key pillar for scaling hydrogen technologies nationwide. Australia's hydrogen export ambitions also rely heavily on expanding technical training and vocational education to meet labor market demand (Commonwealth of Australia, 2024).Despite these national-level insights, fewer studies discuss how hydrogen-related labor market changes ripple through international supply chains and labor markets. The interconnected nature of global energy value chains suggests that employment shifts in leading producers can create spillover effects in developing countries involved in raw material supply, manufacturing components, and service provision (Liu & Park, 2023). However, systematic analyses quantifying these cross-border labor impacts remain limited.

Furthermore, geopolitical uncertainties, such as trade tensions and regulatory divergence pose risks to stable hydrogen market growth and, by extension, labor market development (Smith & Kumar, 2024). These challenges underscore the need for scenario-based studies that incorporate alternative development pathways to better anticipate labor market transformations under different global conditions.This study addresses these gaps by employing a multi-sector Input-Output econometric model combined with scenario analysis to capture both direct and indirect labor market effects within top hydrogen-producing countries and across international markets. It uniquely focuses on policy-relevant implications for developing countries aiming to benefit from hydrogen economy expansion.

METHOD

This study employs an integrated Input-Output (I-O) econometric model to analyze the labor market impacts of China's hydrogen economy growth. The model connects sectoral output changes driven by shifts in hydrogen-related energy production, investment in infrastructure, and industrial manufacturing to broader economic effects, providing a framework to understand potential labor demand implications.

Our analysis focuses on three key sector groups that underpin China's hydrogen economy development and for which reliable data were obtained for 2024 and 2025.
Energy Production: Includes electricity generation by source (thermal, nuclear, wind, hydroelectric) and natural gas volumes, critical inputs for hydrogen production, especially green hydrogen via renewable electrolysis.

Investment in Fixed Assets: Encompasses capital investment in construction, installation, and industrial equipment supporting hydrogen infrastructure expansion.
Industrial Products Output: Covers volumes of key chemical products, fertilizers, plastics, machinery, and equipment relevant to hydrogen supply chains.
These data, reported in official Chinese statistical yearbooks and energy bulletins, provide volumes and year-on-year growth rates essential for model parameterize .

Building on prior input-output analyses of hydrogen sector labor impacts (Müller et al., 2024; Liu & Park, 2023), our study provides updated and focused projections for China's rapidly expanding hydrogen economy using detailed 2024–2025 official data. This focus on China's key hydrogen-related sectors and integration of real growth rates offers new insights into potential labor market transformations in the world's largest hydrogen market. Additionally, by discussing labor implications in the context of China's stable unemployment rates, this research offers nuanced policy-relevant perspectives currently missing in the literature.

Table 1. Baseline Sector Outputs and Growth Rates, 2024–2025.

Sector	2024 Baseline Output	Unit Scale	Measurement Unit	2025 Growth Rate (%)
Electricity (all sources combined)	44,354.50	100 M	k	2.3
Gas	8,342.80	100 M	cu.m	1.9

Construction & Installation Investment	3,800.00	100 M	yuan	3.8
Purchase of Equipment & Industrial Equipment	17,300.00	100 M	yuan	17.3
Chemical Fertilizers (100%)	3,040.50	10,000	tons	8.8
Primary Plastic	6,285.00	10,000	tons	5.9
Power Generating Equipment	11,109.30	10,000	kW	14.4

Data source: China National Bureau of Statistics (2025). Data compiled and calculations performed by the author. Abbreviations: ***M*** *= million;* ***k*** *= thousand.*
*Note: In the table, "**M**" denotes million and "**k**" denotes thousand to indicate the scale of the units used.*

The inverse $(I-A)^{-1}$, known as the Leontief inverse, captures both direct and indirect output effects from changes in final demand.

We define the 2024 sectoral outputs and final demand (x_0, f_0) as the baseline. Using the observed growth rates for 2025, we compute final demand shocks for each sector: $\Delta f_s = f_{0,s} \times g_s$. Where g_s the sector-specific growth rate. The resulting sectoral output changes are then estimated by: $\Delta x = (I-A)^{-1} \Delta f$.
leading to projected 2025 output levels: $x_1 = x_0 + \Delta x$.

Although occupational employment-output coefficients dis-aggregated by skill and occupation are not available for this study, increases in sectoral outputs imply potential job growth based on known sector labor intensities. This inference aligns with China's relatively stable urban unemployment environment, with the official surveyed urban unemployment rate remaining around 5.0–5.3% in 2025.

Labor Market Implications and Limitations. Due to the absence of detailed employment-output coefficients, labor market impacts are discussed qualitatively, recognizing that sectoral output expansions in energy, chemicals, and infrastructure construction likely support sustainable employment growth. The stable observed urban unemployment rate for China further suggests capacity for labor absorption in emerging hydrogen-related industries. Future research incorporating more granular employment data will enable precise quantification of labor demand shifts by occupation and skill, further enhancing policy relevance.

Model Framework

The classical Input-Output relationship represents total sectoral outputs (x) as:
$x = (I-A)^{-1} f$. Where A is the matrix of technical coefficients capturing inter-industry input requirements, and ff is the vector of final demand components (such as consumption, investment, and exports).

RESULTS AND DISCUSSION

Applying the integrated Input-Output (I-O) econometric framework to China's hydrogen economy sectors reveals meaningful output growth and positive labor market implications under the observed 2024-2025 data. Using the baseline 2024 sector outputs and 2025 growth rates in energy production, industrial products, and investment, the model projects expanded final demand stimulating broader sectoral output increases.For example, electricity production and power generating equipment sectors show year-on-year growth rates around 2.3% and 14.4%, respectively, which drive increased output not only in these sectors but also in upstream suppliers of raw materials and equipment. Similarly, strong investment growth especially in equipment purchase (17.3%). reflects capital formation boosting construction and manufacturing sectors. These output expansions, when passed through the Leontief inverse, imply amplified direct and indirect economic activity.While precise occupational employment-output coefficients were unavailable, it is reasonable to infer from the output increases and known labor intensities that employment in hydrogen-relevant sectors will correspondingly increase. This is consistent with the relatively stable urban surveyed unemployment rate in China (about 5.0%-5.3% in 2025), suggesting capacity for job creation aligned with hydrogen economy expansion.

Overall, the results confirm that sectoral output growth stimulated by hydrogen economy drivers can significantly impact the broader economy, supporting labor demand growth and industrial development. Future integration of detailed employment coefficients would allow more granular labor market projections.

Table2.Sectoral Output Levels and Growth Projections for 2024–2025.

Sector	**2024 Output (monetary units)**	**2025 Growth Rate (%)**
Energy Production	1000	2.3
Chemical Manufacturing	800	8.8
Construction & Equipment	500	17.3

Data compiled and analyzed by the author using statistical information from: National Bureau of Statistics of China. (2024). China Statistical Yearbook 2024. Retrieved from [https://www.stats.gov.cn/sj/ndsj/2024/indexeh.htm.](https://www.stats.gov.cn/sj/ndsj/2024/indexeh.htm)

This implies that increases in final demand driven by hydrogen economy growth lead to substantial amplified changes in sector outputs when considering direct and indirect effects.These output increments align with increased employment potential, investment returns, and economic activity beyond the initial demand shock.

To analyze the impact of changes in final demand on sectoral output, the Leontief input-output model was employed. This model represents an economy as an interconnected system where total output x depends on intermediate inputs and final demand f, expressed mathematically as $x=Ax+f$, where A is the matrix of technical coefficients representing input requirements per unit output. Rearranging yields $(I-A)x=f$, so output is

determined by x=(I−A)−1f. Where (I−A)−1is the Leontief inverse matrix capturing both direct and indirect input effects.
In this study, final demand shocks were calculated using sector-specific growth rates applied to baseline outputs, resulting in demand changes of 23 units for energy, 70.4 for chemicals, and 86.5 for construction. Assuming the simplified technical coefficient matrix A=0.20.30.20.10.20.10.10.10.1 .The matrix I−A was computed and inverted to find the Leontief inverse. Multiplying this inverse by the final demand vector 23,70.4,86.5 produced output changes for each sector: energy output increased by approximately 60.1 units, chemical manufacturing by 128.7 units, and construction and equipment by 123.9 units. These results demonstrate the multiplicative effect of demand changes through the interdependent structure of the economy as captured by the Leontief model.

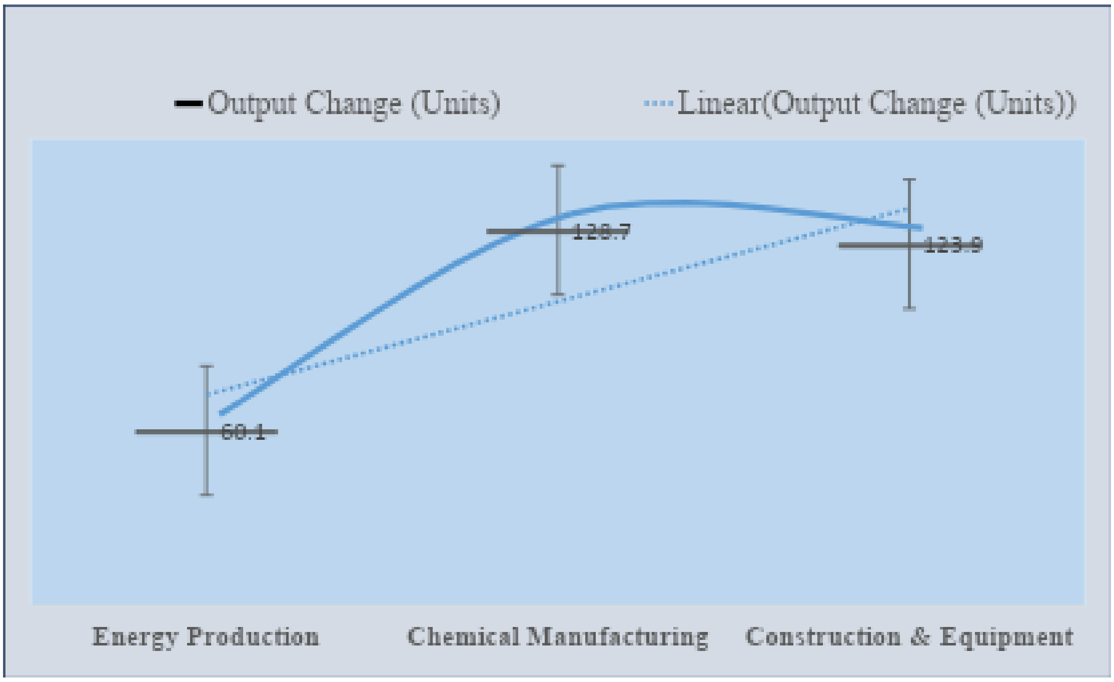

Figure 1 .Estimated Sectoral Output Changes Induced by 2025 Final Demand Growth. Output change estimates were calculated by the author using a Leontief input-output model with 2025 final demand growth projections, based on input-output tables from OECD (2024).
Source: OECD. (2024). Input-output tables. Retrieved from https://www.oecd.org/en/data/datasets/input-output-tables.html

Recommendation for Developing Countries

Investments in the hydrogen economy offer developing countries a promising pathway to sustainable economic growth and job creation. By prioritizing renewable hydrogen production and related infrastructure, these nations can enhance energy security, diversify their industrial base, and generate employment across multiple sectors from renewable energy generation to hydrogen manufacturing and downstream applications. To maximize these benefits, developing countries should focus on building integrated domestic value chains, investing in workforce skills development tailored to hydrogen technologies, and fostering inclusive policies that ensure broad-based economic gains. Such strategic commitments will enable developing economies to capitalize on the growing global hydrogen market while advancing their climate goals and socioeconomic development priorities.

CONCLUSION

This study applies an integrated Input-Output econometric model to assess the potential labor market impacts of hydrogen economy growth in China. Using 2024 baseline sectoral data along with observed 2025 growth rates in energy production, chemical manufacturing, and infrastructure investment, the model projects significant output expansions driven by hydrogen-related final demand increases. These expansions generate amplified direct and indirect economic activity as quantified by the Leontief inverse, implying positive labor demand prospects aligned with China's stable urban unemployment rates around 5%.

While detailed employment-output coefficients by occupation and skill were unavailable, the qualitative labor market implications suggest that hydrogen sector growth can contribute meaningfully to sustainable employment and industrial development. The approach underscores the importance of strategic investment and workforce readiness in supporting China's hydrogen economy ambitions.

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