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Motives in Motion: Low-Carbon Hydrogen Development in the Transportation Sector of China and Japan

Topic and Research Question

This Master's thesis examines how China and Japan develop low-carbon hydrogen in their transportation sectors as part of broader efforts to promote decarbonised mobility between 2015 and the present.

The central research question is:

"How do China and Japan approach the development of low-carbon hydrogen in their transportation sectors in the context of promoting decarbonised mobility?"

The topic is highly relevant given hydrogen's growing role as a potential solution for hard-to-electrify transport segments, such as heavy-duty road transport, ports, shipping and rail. By comparing two leading Asian economies with contrasting governance and industrial structures, the thesis contributes to debates on effective policy design, infrastructure sequencing and market creation in hydrogen mobility.

State of the Art

The literature on hydrogen development is dominated by analyses of early-leading jurisdictions, particularly the European Union, the United States and Australia, which are frequently used as reference cases. These regions attract scholarly attention because they represent distinct strategic models: regulation-driven market creation in the EU, export-oriented supply strategies in Australia, and incentive-based approaches in the United States.

In contrast, the literature on East Asia is more fragmented. Japan is widely discussed as an early hydrogen policy pioneer, with strong emphasis on institutional frameworks, certification and international supply chains, while China is increasingly analysed through the lens of rapid industrial scaling, sub-national experimentation and integration of hydrogen into broader climate and industrial policies. However, much of this research remains country-specific and descriptive.

Consequently, comparative studies that systematically link policy motives, governance structures and observable hydrogen deployment in transport remain scarce. This thesis addresses that gap by applying a unified analytical framework to China and Japan.

Methodology and Approach

The thesis employs a comparative case-study methodology grounded in a bespoke analytical framework termed by the author "Motives-in-Motion."

This framework evaluates hydrogen-for-transport development across six interrelated dimensions:

1. Governance and legal force
2. Sustainability assurance and certification
3. Supply structure and sourcing pathways
4. Economic viability and incentive alignment
5. Infrastructure readiness and spatial integration
6. Market uptake and industrial implementation

Together, the six dimensions reflect the key conditions required for hydrogen-based mobility to emerge: binding governance and legal force create policy certainty; sustainability assurance defines what qualifies as "low-carbon" hydrogen; supply and sourcing strategies determine availability and security; economic viability and incentives shape competitiveness; infrastructure readiness enables physical deployment; and market uptake reflects whether policies translate into real vehicles and projects. By applying the same criteria to China and Japan, the framework allows for a systematic and comparable assessment of how different national motives and institutional designs shape hydrogen deployment in transport.

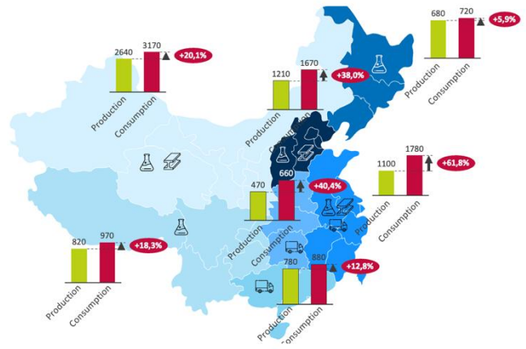
Main Facts

In China since 2015 hydrogen-related objectives have been embedded across dozens of central documents, which are subsequently operationalised by provinces through tailored subsidy schemes, demonstration zones and infrastructure programmes. Japan, by contrast, has constructed a statute-centred hydrogen regime, anchored in a few national strategies. The Basic Hydrogen Strategy and the Hydrogen Society Promotion Act provide a formal legal basis for defining low-carbon hydrogen, allocating long-term price-gap support and coordinating international supply chains.

China operates the world's largest hydrogen economy, producing 36.5 Mt H_2 in 2024 (≈one-third of global output), but remains overwhelmingly fossil-based: >99% grey hydrogen, mainly from coal and natural gas. By contrast, Japan's total hydrogen supply is much smaller at ≈1.9 Mt per year, but also almost entirely grey and largely self-consumed within heavy industry.

By September 2025, China had 422 operational hydrogen refuelling stations (HRS), accounting for roughly one-third of all HRS worldwide, with a strong bias toward 35 MPa, high-throughput stations serving buses and heavy-duty trucks in corridor-based industrial clusters. Japan operated around 160 HRS, concentrated in a few metropolitan regions, predominantly 70 MPa stations designed for passenger FCVs, many of which suffer from persistent under-utilisation.

Map of Green H2 Production and Consumption in China in 2030, 000 tonnes per year



Source: Author based on RMI. 2022. "Renewable Hydrogen 100 Roadmap of China 2030"

China has also become the largest FCV market in absolute terms, with 28,000 fuel cell vehicles in operation, representing about 27–30% of the global FCV fleet, yet still reaching only ≈56% of its 2025 target (50,000 FCVs). Deployment is heavily skewed toward commercial vehicles: in 2024, ≈79% of FCV sales were trucks and special-purpose vehicles, while passenger FCVs remain negligible. Japan, by contrast, operates only ≈8,000 FCVs, of which ≈96% are passenger cars, far below its original target of 800,000 FCVs by 2030, with recent sales declining sharply after 2021.

Results

China and Japan have developed two distinct models of hydrogen-based transport decarbonisation, shaped by different policy motives and institutional logics. China embeds hydrogen for transport within a broader developmental and industrial upgrading agenda, using flexible, multi-level planning and sub-national experimentation. This has enabled rapid deployment in cluster- and corridor-based settings, particularly for high-utilisation commercial segments such as buses, heavy-duty trucks, ports and special-purpose vehicles, but with uneven sustainability standards and significant regional variation.

Japan, by contrast, has constructed hydrogen-for-mobility as a clearly demarcated policy field, anchored in national strategies and dedicated legislation. Its statute-based model prioritises legal certainty, life-cycle carbon thresholds and long-term price-gap support, especially for imported hydrogen and ammonia. While this provides strong governance robustness and investor confidence, it has resulted in slower market uptake, persistent infrastructure underutilisation and a relatively small vehicle fleet.

Despite these differences, both countries converge on similar outcomes: hydrogen remains a niche solution for hard-to-electrify transport segments, delivers only modest emission reductions so far, and is constrained by high costs, uncertain demand and sequencing challenges between supply, infrastructure and fleets.

Across both cases, tighter sustainability assurance, corridor-based sequencing of supply and demand, and a clearer focus on genuinely hard-to-abate transport segments emerge as pragmatic strategies to enhance climate credibility, economic proportionality and policy resilience.

References

A full list of references and sources is provided in the complete MA thesis: "Motives in Motion: Low-Carbon Hydrogen Development in the Transportation Sector of China and Japan" (University of Vienna, 2025).

About the Author

Konstantin Matveenkov holds Master's and Bachelor's degrees with honours in international economics and international relations, complemented by extensive academic training in China. His academic and professional focus lies on green energy transitions, sustainable development and advanced technologies, with a particular emphasis on China.

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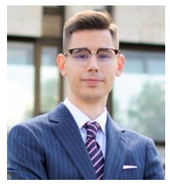

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