TRANSJOVAN CAPITAL
STRATEGY | M&A | ADVISORY

HFCV Industry – Economical and Environmental Impact

Is HFCV an Affordable Innovation with Environmental Sustainability?

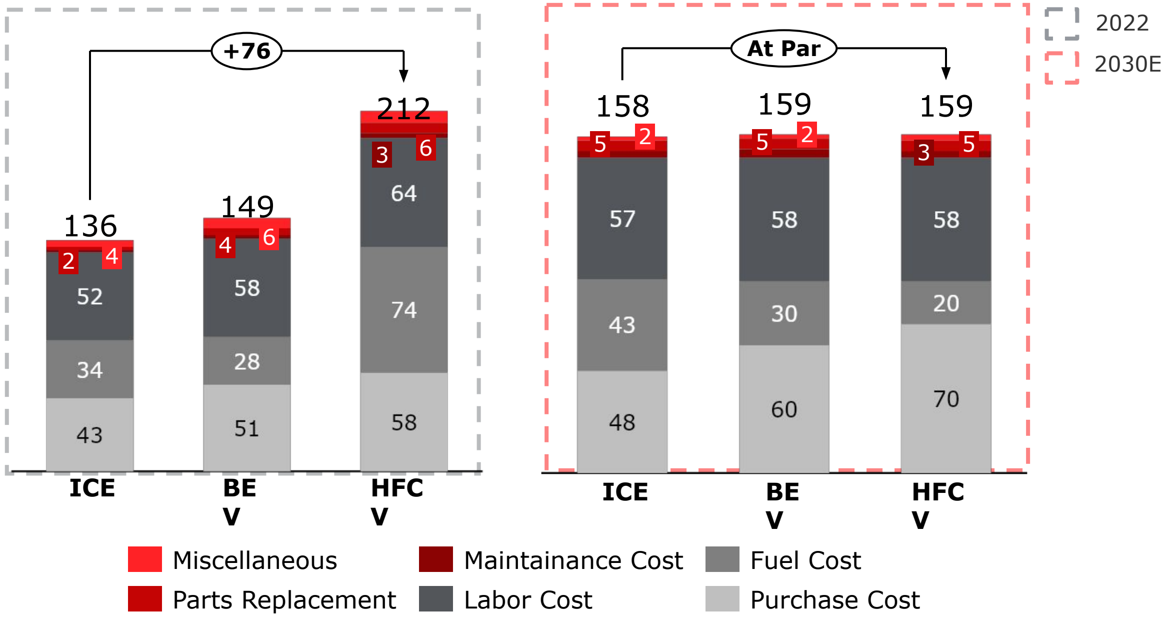
July 2024

HFCVs Closing in on ICE Vehicle Cost Parity

Advancements in HFCVs, combined with increased production scale and reduced costs, are expected to make fuel cell vehicles more cost-competitive with traditional ICE vehicles

ICE vs BEV vs HFCV Total Cost[1,2]

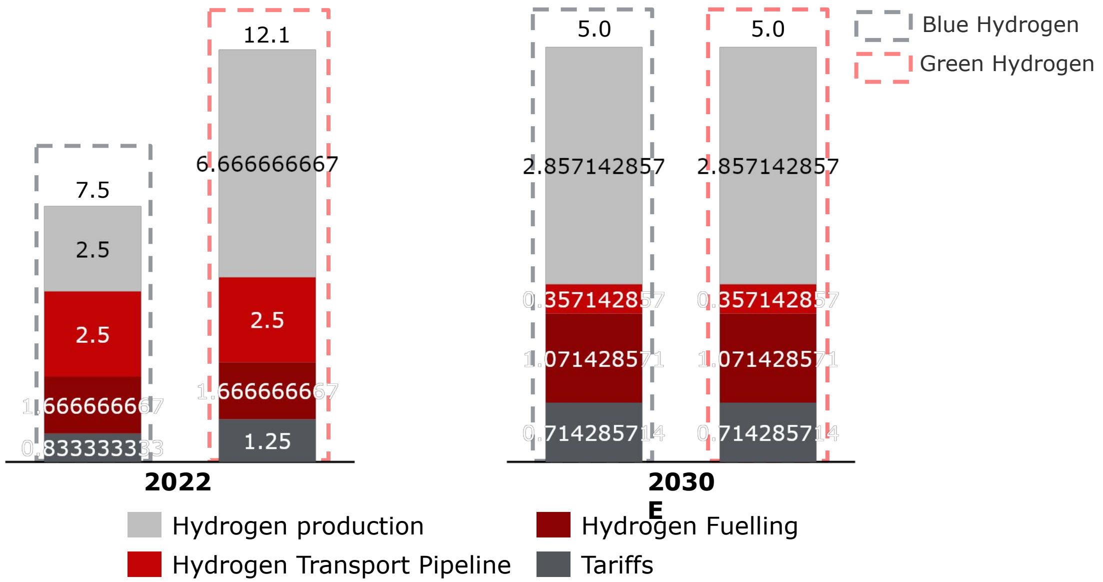
(USD/100 km)



- By 2030, HFCVs are projected to reach economic parity with ICE vehicles, driven by advances in fuel cell technology and hydrogen storage
- Hydrogen infrastructure will undergo significant enhancement, especially through the expansion of pipeline networks for efficient distribution to consumption points
- The increased utilization rate of refueling stations will significantly reduce the cost of hydrogen, making HFCVs more financially and commercially viable for transportation use case

Breakdown of at-the-pump Hydrogen Costs[3]

(USD/Kg)



- By 2030, green hydrogen production costs will be **$3.7/Kg** in the U.S. and **$5.6/Kg** in the EU under a central technology improvement scenario
- By 2030, green hydrogen costs are expected to drop significantly due to cheaper renewables and electrolyzers, while blue hydrogen costs will stay high due to reliance on fossil fuels
- Hydrogen and Fuel Cell Technologies Office (**HFTO)** aims to provide hydrogen for vehicles at less than **$7/kg by 2028**. This cost reduction will enhance hydrogen fuel's appeal to consumers and fleet operators

Sources: 1. European Commission, 2. Nada, 3. ICCT, 4. Arup

Comparing Energy Efficiency and Environmental Impacts

The overall energy efficiency of HFCVs depends majorly on hydrogen production, transportation, and the fuel cell technology, converting stored hydrogen energy into vehicle propulsion

Evaluating Vehicle Propulsion Types from Well-to-Wheel

Energy Efficiency	Well → Tank		Tank → Wheels	Overall WTW Energy Efficiency
	Production	**Delivery**	**Use**	
HFCV	**23-69%[1]** - Variability in the range arises from variances in hydrogen production methods - Production efficiency = feedstock extraction efficiency x fuel-to-hydrogen efficiency	**54-80%[2]** - Energy loss occurs during compression, transportation and storage	**36-45%[2]** - Converting hydrogen to electricity and mechanical energy results in energy loss - Higher energy loss while hydrogen-to-electricity-to-mechanical energy conversion	4-25%
BEV	**35-60%[3]** - The range fluctuates based on various methods of electricity production - Composition of the grid can differ significantly between countries	**81-85%[3]** - The typical conversion rate during electricity transmission ranges from 90% to 94% - During the charging process, there is ~ 90% energy efficiency	**65-82%[2]** - Energy dissipates during transmission when electricity is converted to power a vehicle - Incurring losses in the motor, AC conversion and transmission system	18-42%
ICE	**82-87%[3]** - There's a 13~18% energy loss during the mining and refining processes of fossil fuels	**~99%[4]** - Energy loss occurs during transportation due to various factors	**17-21%[5]** - The bulk of energy is dissipated as heat - Despite enhancements, current efficiency of ICEs is nearing its limit	14-18%

The percentages indicate the energy conversion efficiency at various stages, including production, delivery, and usage, for different fuel types

Key Insights

- HFCVs show lower energy conversion efficiency at all stages than BEVs, resulting in higher emissions
- Integrating CCUS is crucial for reducing carbon emissions in hydrogen-based transportation and climate change mitigation efforts
- Emissions from HFCVs without CCUS are 105 gCO2e/mile, increasing to 247 gCO2e/mile without CCUS, representing a 150% increase
- Using green hydrogen results in HFCVs achieving over a 99%[5] reduction in carbon emissions
- H2-ICEs and biofuel/synfuel internal combustion engines are other sustainable options
- Green hydrogen and CCUS integration are crucial for achieving substantial emission cuts

Well-to-Tank typically pertains to the production of fuel from feedstock until its delivery to the vehicle's energy carrier

Tank-to-Wheels refers to the energy consumed during the vehicle's operational phase

Sources: 1. Ivl, 2. Cleantechnica, 3. 360doc, 4. Wenku Baidu 5. Maxbook 6. OSTI

Global Policies and Progress in HFCVs

Governments worldwide are actively promoting hydrogen as a clean energy solution, backing its production, infrastructure development, and various applications

Progress in Hydrogen Adoption by Geography[1,2,3]

Description	Strategy and Policies	Deployment	HFCV Support	⚙	🚀	🤝
USA	• Aiming for 20MT and 40MT of hydrogen production by 2040 and 2050[1] respectively • Allocation of funds for R&D in hydrogen technology • Project worth $750M[1] announced by US government in March 2023	• In 2023, US electrolytic hydrogen production capacity was 5.9KT • Projects with a production capacity of 153.7KT are nearing completion[1]	• $42M was granted to Nikola to establish six hydrogen refueling stations (HRS) in California[1] • But HRS growth increased by only 10% from 2019, slower than leading nations[1]	◑	◔	◑
China	• Since 2019, more than 12 provinces have set hydrogen targets for 2025 • Budget and guidance integrated for HFCV into the 14th five-year energy plan	• China's electrolyser- based capacity is projected to reach 1.2 GW[1] • Hydrogen production doubled from 16MT to 33MT between 2012 and 2021[2]	• HFCVs constitute more than 50% of hydrogen used in road transport, majorly in heavy-duty applications[1] • China has 300 out of 1100 global HRS, with plans for adding 70 more in Shanghai[1]	◑	◕	◕
Europe	• The EU and member nations are investing €195M in clean hydrogen initiatives • EU in 2023, adopted regulations defining renewable hydrogen and its production	• Spain, Denmark, Germany, and the Netherlands account for 55% of Europe's electrolytic production[1] • In 2022, EU unveiled 35 projects for hydrogen production, storage, and transportation for €5.2B[1]	• Germany and UK deployed 80 buses in major cities, expanding HFCV fleet • EU ranks second to China in terms of refueling stations[1]	◔	◕	◑
Australia	• The government allocated $1.4B in the 2023-24 federal budget for large-scale hydrogen projects[1] • Developing regulations for hydrogen certification and standardization[1]	• By 2030, 20% of global production will be from electrolysis • In 2022, Australia exported its inaugural shipment of liquefied hydrogen to Japan[1]	• In 2022, the government focused on HFCVs for heavy transport • Initiating scalability projects in New South Wales • Allocating AUD 80M for hydrogen refueling infrastructure under the ARENA program	◑	◑	◑

◔ Low Focus ◑ Medium Focus ◕ High Focus ● Priority ▨ Progress

Sources: 1. IEA, 2. China National Coal Association, 3. Department of Climate Change, Energy, the Environment and Water, Australia

Conclusion

HFCVs have significant potential for future mainstream transportation, while BEVs act as a bridge between ICE vehicles and the adoption of hydrogen as an alternative fuel

Innovations in transportation, such as expanding pipeline networks and advancements in fuel cell technology, are driving improvements in harnessing hydrogen's high energy efficiency as a fuel source. The cost of hydrogen fuel is also anticipated to decrease to the level of gasoline by 2030.

In addition to high costs, HFCVs currently demonstrate lower energy conversion efficiency during production, delivery, and usage stages compared to BEVs, resulting in wastage and increased emissions. Integration of CCUS can mitigate carbon emissions in HFCVs, while another viable option involves utilizing green hydrogen, resulting in HFCVs achieving over a 99% reduction in carbon emissions.

Many countries also aim to enhance the competitiveness of HFCVs against traditional ICE vehicles through various initiatives. Europe and China are leading in deployment of hydrogen production facilities and supporting infrastructure and applications, while the US provides strong financial support to firms and organizations focusing on hydrogen technology R&D.

However, widespread adoption will face initial challenges due to the need to transition from existing alternatives, which will require further support and strengthening via governments and industry leaders.

Authors

Vaibhav Ranjan

Principal | Head - International Business

Ameesha Mehta

Senior Analyst

Strategy and M&A consulting

Sanskar Sharma

Analyst

Strategy and M&A consulting

Important Sources

- NADA
- ICCT
- IEA
- Department of Climate Change, Energy, the Environment and Water, Australia
- OSTI

About Transjovan Capital

Transjovan Capital is an upstream strategy and M&A consulting firm with hubs in New Delhi, Los Angeles, Dubai, and Sydney. We partner with our clients to create exponential value with high-quality analysis and robust recommendations. Our clients span across industries and feature in top Fortune 50 companies of the world.

Transjovan Capital is industry agnostic with a focus on North America, Western Europe, and APJ regions. Our offerings include development of corporate strategy, business wargaming, M&A strategy, commercial due diligence, and market entry strategy. We focus on delivering tangible results by bringing together consulting expertise and global experience for our clients.