GREEN HYDROGEN DEMAND AND REFUELLING NETWORK FOR HEAVY-DUTY TRUCKING IN INDIA

June 2026

About HTWO Innovation Centre at IIT Madras

The Hyundai HTWO Innovation Centre (H2IC) is a Centre of Excellence in green hydrogen, established through a landmark partnership between Hyundai Motor India Limited, Hyundai Motor India Foundation, IIT Madras, and the Guidance Tamil Nadu. Anchored at the IIT Madras Discovery Campus in Thaiyur, Chennai, the Centre spans 1,11,000 sq. ft. of built-up area, deep-tech infrastructure across three functionally distinct zones- each designed to serve a precise role in the hydrogen technology development lifecycle.

The Centre brings together industry, academia, & policy makers under one integrated mission: To accelerate India's green hydrogen adoption by bridging the gap between laboratory innovation and commercial deployment.

H2IC adopts a comprehensive, end-to-end approach to hydrogen technology. Unlike traditional research facilities, H2IC integrates fundamental research with large-scale industrial demonstration and incubation

Core Pillars of Impact

H2IC operates through four strategic pillars designed to catalyse national-level impact in line with India's National Green Hydrogen Mission:

1. **Cutting-Edge R&D:** Driving applied research and advanced validation across the green hydrogen value chain. Any idea that enters as TRL 3- armed with experiments, simulations, and hypotheses; leaves as TRL 6/7 -validated, tested, and deployment-ready.
2. **Strategic Localisation:** Strengthening India's supply chain by collaborating with MSMEs and academic institutions to indigenize critical hydrogen components, reducing dependence on imports.
3. **Vibrant Incubation:** Supporting deep-tech startups through seed grants, pilot funding, and access to advanced testing infrastructure to turn hydrogen innovations into viable commercial products.
4. **National-Scale Skilling:** Addressing the talent gap by training 5000-10,000 hydrogen professionals by 2030, delivering hands-on technical expertise to primary technical staff (ITI/Diploma), specialised engineers and researchers, executive-level personnel & MSMEs.
5. **Policy & Regulatory Enablement:** Partnering with central and state governments, statutory authorities, and standards organisations to provide technical expertise, support policy formulation and accelerate creation of a robust regulatory framework for the hydrogen economy.

www.h2ic.in

HTWO INNOVATION

Table of Contents

Foreword

IIT Madras remains one of the finest technology players in the country for deep tech innovations. Aligning with our institute's vision in contributing to the Viksit Bharat, Hyundai HTWO Innovation Centre (H2IC)- A CoE in hydrogen, is committed to creating innovations relevant to hydrogen that bring in self-reliance in technology and make India a leader in the hydrogen space. There is an ever-increasing demand for creating finer guidelines for research areas/focus, with clarity on the market at the downstream. Research at academic institutes is curiosity and/or market requirements-driven. These two extremes don't apply to evolving technologies, as the requirements remain unclear and create ambiguities in the focus areas of R&D.

I still ponder around basic questions like,

- What could be the role of hydrogen in the power sector: long-duration energy storage fuel, emergency backup fuel, or other?
- Should I focus my centre's R&D on internal combustion engines or fuel cell-based engines for vehicles? What should be my priority?
- Can we solve the problem of pollution from agri-waste burning by carrying out systematic R&D (not just technical but also social) on converting it to hydrogen?
- Biomass or water or both- which option should I select for hydrogen production related R&D?

In our to-know/do-list, we have 100 such questions. When I want my centre to create an impact, I honestly do not want to start with an arbitrary R&D problem without clarity on the outcome in the market. So, we created a Market Research Wing at H2IC, which will give me clarity on the focus areas of R&D with a roadmap! This would guide me in deciding the critically important areas with quantitative numbers.

While we are doing this, we felt it's also important to make all our results open to the public to enable many of us to benefit from the market research we do. So, we are going to publish those outcomes as white papers, reports or concept notes, through our centre's website or social media handles. Please watch out for our disseminations!

The first one is on hydrogen and hydrogen refuelling station requirements for the heavy-duty trucking sector covering Indian National Highways. Over six months of efforts gave us surprising numbers. Now I know the total hydrogen requirement, if we have to convert all the heavy-duty trucks from diesel to hydrogen-powered. I also know the total number of hydrogen compressors required! This first white paper is already giving me directions on the critically important research areas. This paper has given me specific learnings on the critical but left out areas from today's R&D! The numbers are overwhelming, and I let you enjoy reading our document!

HTWO INNOVATION

Our partners, Hyundai Motor India Limited and Hyundai Motor India Foundation, backed us up heavily on this critical mission. Open information for the larger benefit is what my partner believes in, and we are doing through these reports. Our sincere thanks and appreciation to the Hyundai team for helping us guide us through this strategic activity. Guidance Tamil Nadu, the prolific wing of TN's Department of Industries, Investment Promotion & Commerce, has been our strongest partner. When it comes to tech development, we cannot ask for better support than what Guidance offers. We are indebted to their assistance.

We strongly believe suggestions from readers would enable us to improve and do better. Please do share your thoughts at marketresearch@h2ic.in. Suggestions on some new topics are welcome. Let's collaborate and realise the VIKSIT BHARAT!

Aravind Kumar Chandiran

Head, Hyundai HTWO Innovation Centre - A CoE in Hydrogen at IIT Madras

Abbreviations and Units

Abbreviations

BAU: Business as usual

BEV: Battery electric vehicle

CO_2: Carbon dioxide

EV: Electric vehicle

FCEV: Fuel cell electric vehicle

GVW: Gross vehicle weight

HCV: Heavy commercial vehicle

HGV: Heavy goods vehicle

HMV: Heavy motor vehicle

HRS: Hydrogen refuelling station

H_2: Hydrogen

LCOH: Levelized cost of hydrogen

LCV: Light commercial vehicle

LHV: Lower heating value of the fuel

MCV: Medium commercial vehicle

NH: National highway

TCO: Total cost of ownership

VGF: Viability gap funding

VKT: Vehicle kilometres travelled

Units

GW: Gigawatt

kg: Kilogram

km: Kilometre

km/L: Kilometre per litre

L: Litre

MMT: Million metric tonnes

MJ/kg: Megajoules per kg

Mt: Million tonnes

TPD: Tonnes per day

Executive Summary

The transition of India's heavy commercial vehicle sector from a diesel-dependent one to a green hydrogen-based one is not merely a sectoral shift but a fundamental re-engineering of the nation's economic activity. This study presents a comprehensive, segment-wise assessment of HCV activity, diesel consumption, hydrogen demand and refuelling infrastructure requirements for decarbonising the national HCV fleet. Here, a bottom-up methodology anchored in toll plaza traffic data is employed, which involves the analysis of around *1,158* highway segments in the country.

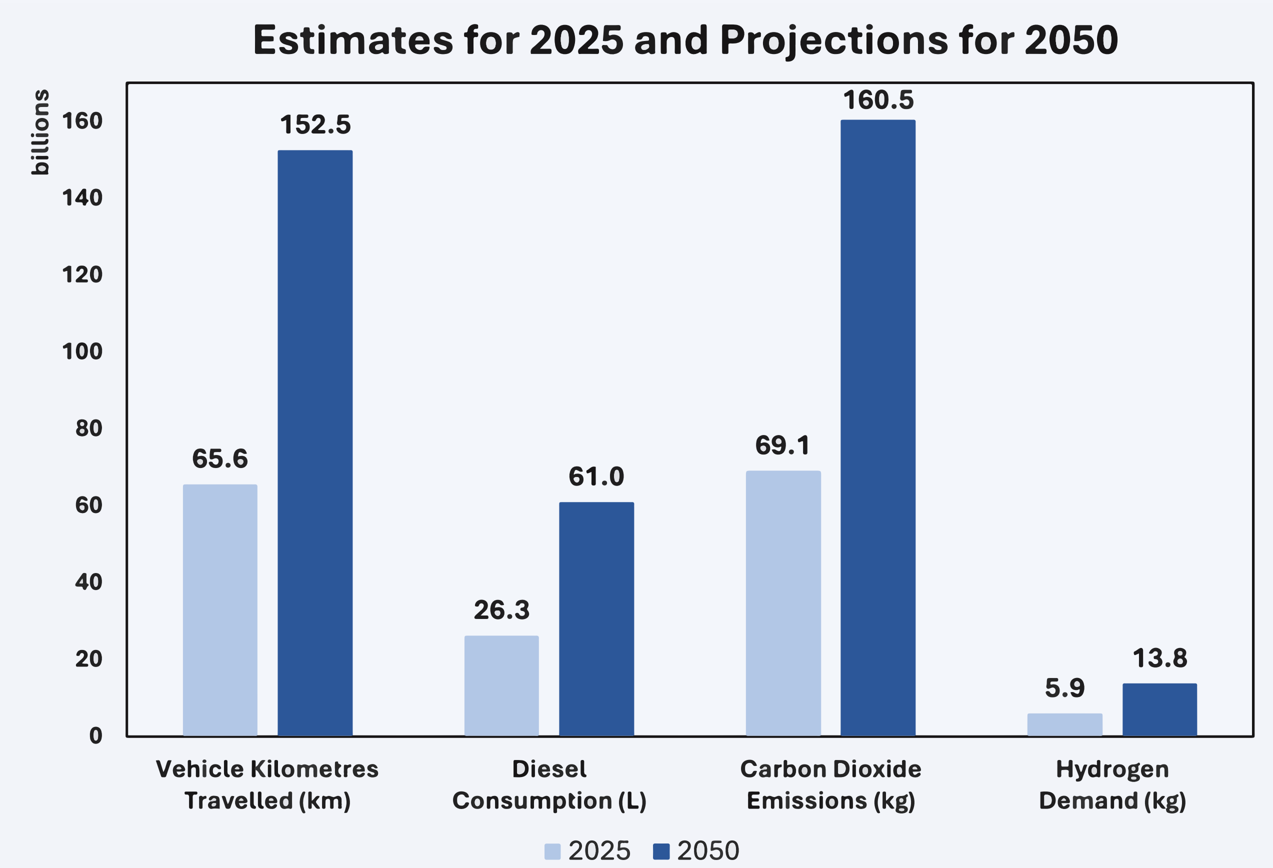
The annual vehicle-kilometres travelled by HCVs across India's national highway network is estimated to be approximately *65.6* billion kilometres in 2025. An annual diesel consumption of *26.3* billion litres is estimated, resulting in approximately *69.1* million tonnes of CO_2 emissions. These numbers underscore the scale of the decarbonisation challenge and position the HCV sector as a critical priority within India's energy transition.

A full transition from diesel to hydrogen fuel cell electric vehicles in India would require approximately *5.93* million tonnes of hydrogen annually (considering 2025 as baseline), equivalent to a daily demand of roughly *16,240* tonnes. A key finding of this study is the high concentration of freight activity; a small fraction of the corridors, representing only 5% of the analysed segments, accounts for nearly 31% of the total national hydrogen demand. Twenty-one analysed segments are expected to have a daily demand exceeding 100 tonnes. The top-priority corridors directly reflect the long-haul freight movement influenced by the presence of strategic ports and industrial hubs.

The assessment of refuelling infrastructure suggests that a nationwide network of approximately *3,384* hydrogen refuelling stations will be required under a full transition from diesel to hydrogen-fuelled trucks (baseline year 2025), with individual station capacities ranging between 1 and 5 tonnes per day.

The spatial distribution of hydrogen demand in the HCV sector across the country will be highly uneven, which allows for a targeted infrastructure rollout rather than a uniform nationwide deployment. Highway segments analysed here have been classified into four classes-critical, high, moderate, and low demand-based on both the number of hydrogen refuelling stations required and their proposed spacing. The critical demand segments as per this study belong to sections of national highways such as Surat-Dahisar, Gulabpura-Chittorgarh, Jaipur-Kishangarh, Gurgaon-Jaipur, Chennai-Tada, Garamore-Samakhiali, Barachatti-Gorhar, Chakeri-Usrania, Etawah-Chakeri, Kanpur-Ayodhya, Hosur-Krishnagiri, Delhi-Agra, and Agra-Gwalior.

Looking ahead, under a business-as-usual trajectory, the heavy commercial vehicle fleet is projected to expand to about *9.06* million units by 2050, resulting in approximately *152.54* billion vehicle-kilometres travelled annually. If powered entirely by diesel, this sector would consume nearly *61.02* billion litres of fuel each year, generating around *160.47* million tonnes of CO_2 emissions. In contrast, achieving full decarbonization employing green hydrogen would require an estimated *13.8* million tonnes of hydrogen annually.



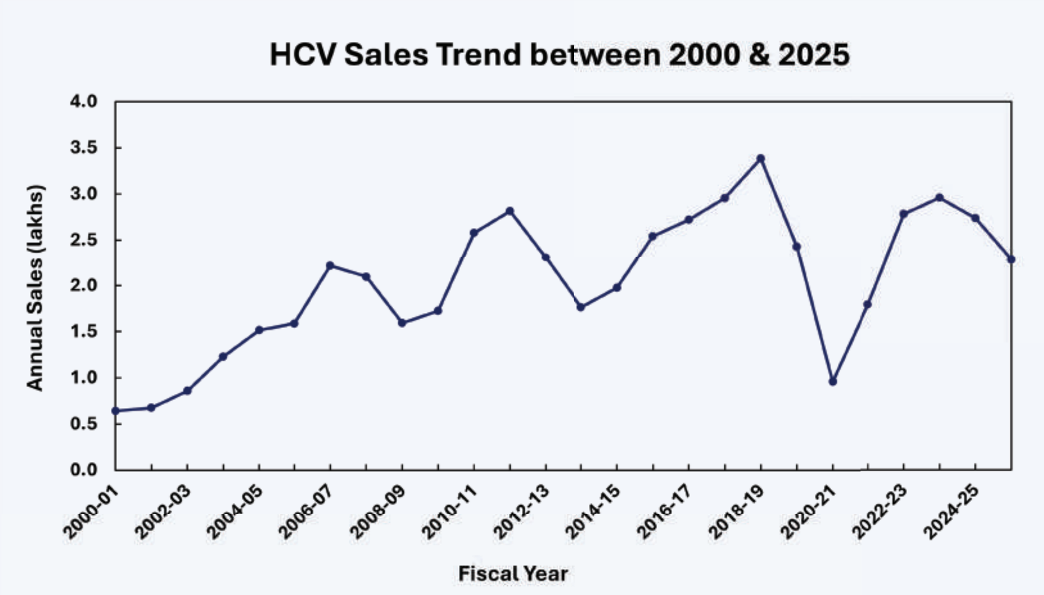
01

The Imperative for Change and Genesis of the Study

Heavy Duty Trucking in India

As the world's third-largest energy consumer, India hinges its pursuit of net zero by 2070 and energy independence by 2047 upon its ability to decarbonise the "hard-to-abate" transport segments, specifically heavy commercial vehicles. Freight transport plays a critical role in supporting economic growth and trade in rapidly developing economies. In India, freight demand is expected to grow substantially in the coming decades, further increasing fossil fuel energy consumption and greenhouse gas emissions significantly.

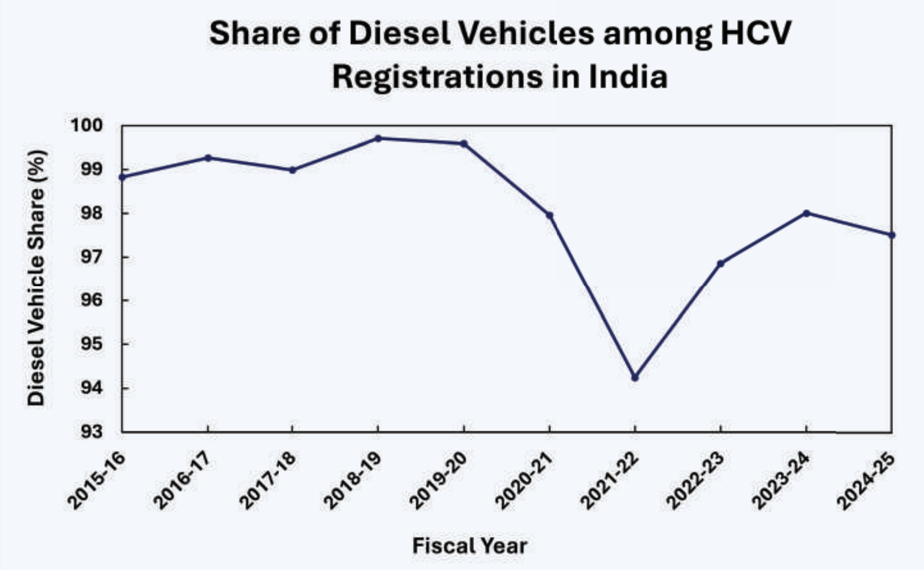
From 2000-2025, the total annual share of HCV among the total commercial vehicle registrations (which also includes LCVs and MCVs) in India averages at 7.1%[1]. In the HCV segment, diesel-powered vehicles accounted for an average 98.1% of all registrations from 2015 to 2025[1]. There is hence a near-total reliance on diesel in the HCV long-haul freight.



Between 2000 and 2025, cumulative registrations of heavy goods vehicles (HGVs) and heavy motor vehicles (HMVs) together surpassed 5.4 million units.

In India, the sales of diesel heavy-duty commercial vehicles or HCVs (having a gross vehicle weight or GVW exceeding 12 tonnes) have grown significantly since 2000, driven by infrastructure expansion, logistics demand, and industrial growth. Cumulative registrations of heavy goods vehicles (HGVs) and heavy motor vehicles (HMVs), which together represent the HCV sector, crossed 5.4 million units between 2000 and 2025[1].

Despite their relatively small share among commercial vehicles, the HCVs contribute significantly to national diesel consumption and CO_2 emissions, underscoring the need to shift the HCV segment towards other zero-emission alternatives.

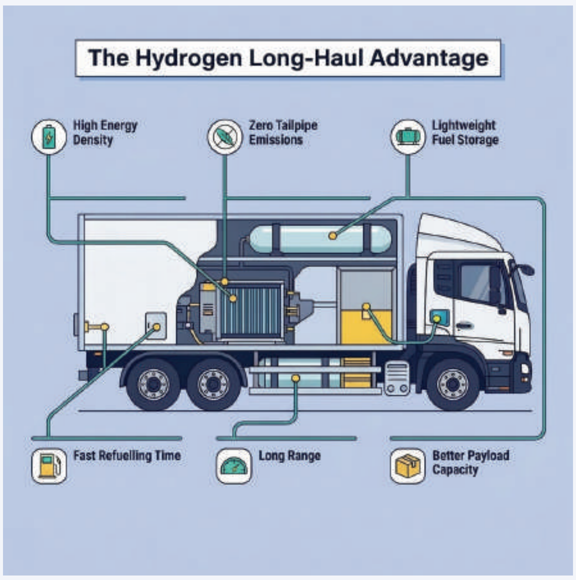


In the heavy commercial vehicle (HCV) segment, diesel-powered vehicles accounted for an average 98.1% of all registrations in India from 2015 to 2025

The growing demand for freight transport, driven by industrial activity, urbanisation, and e-commerce, has further increased energy consumption in the trucking sector. As a result, decarbonising heavy-duty freight transport has become a key priority in national and global climate strategies. Among the potential decarbonisation pathways for long-distance freight transport, hydrogen-fuelled trucks have emerged as a promising solution.

Hydrogen is favoured over battery EVs (BEVs) for long-haul trucking because it offers higher energy density (storing more energy per unit weight), lighter storage, and faster refuelling (a few minutes). This enables trucks to travel longer distances with heavier payloads, while batteries are better suited for short-haul or urban logistics where charging infrastructure matters as well. Hydrogen can also be produced centrally and distributed along highways (via refuelling stations).

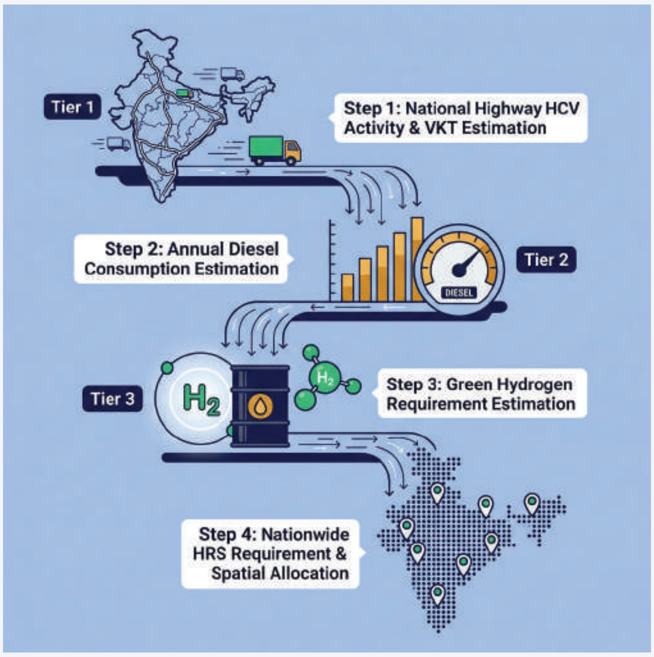
Why are hydrogen-fuelled trucks suitable for long-haul freight applications?



National initiatives, including those led by NITI Aayog[2], have identified hydrogen as a key component of India's long-term energy transition strategy. Under the National Green Hydrogen Mission[3], the country envisions the development of green hydrogen production capacity of at least 5 MMT per annum by 2030, with an associated renewable energy capacity addition of about 125 GW and abatement of nearly 50 MMT of annual greenhouse gas emissions in the country. Hydrogen adoption in the HCV sector, thus, becomes an indispensable necessity for India's net-zero target for 2070. Major global manufacturers are actively developing hydrogen-powered trucks, which have increased interest in hydrogen as a viable alternative to diesel for long-haul freight transport. In parallel, several countries are exploring the development of hydrogen freight corridors and refuelling infrastructure to support large-scale adoption of hydrogen-powered trucks

Despite growing interest in hydrogen-based freight transport, a major challenge lies in estimating the scale of hydrogen demand required to replace diesel consumption in the trucking sector. Accurate estimation of hydrogen demand requires a detailed understanding of freight activity patterns, vehicle usage, and fuel consumption. Many existing studies estimate hydrogen demand for HCVs using top-down energy projections or aggregate transport energy statistics. While these approaches provide useful insights, they often fail to capture the spatial characteristics of freight activity. Comprehensive bottom-up estimates of HCV activity and associated hydrogen demand remain limited in the Indian context.

In this study, a bottom-up framework has been adopted to estimate vehicle kilometres travelled (VKT) by HCVs across India using highway toll plaza-level traffic data for the year 2025. By combining these fleet statistics with vehicle usage patterns and fuel economy data, it is possible to estimate diesel consumption and assess hydrogen demand under different technology transition scenarios. The complete methodological details and underlying assumptions are presented in the Technical Annex.



The key characteristic of this study is that it breaks down the NH into segments and analyses these segments independently for the different metrics such as diesel consumption, CO_2 emissions, and hydrogen requirements for complete substitution of diesel HCV trucks. The results provide regional-level insights into the distribution of hydrogen demand and its implications for hydrogen refuelling station (HRS) infrastructure planning. As hydrogen technologies continue to evolve and policy initiatives accelerate the transition toward low-carbon energy systems, such assessments can support decision-making in the design of sustainable freight transport systems.

02

India’s Heavy-Duty Freight Reality: What the Study Reveals

National HCV Activity in 2025

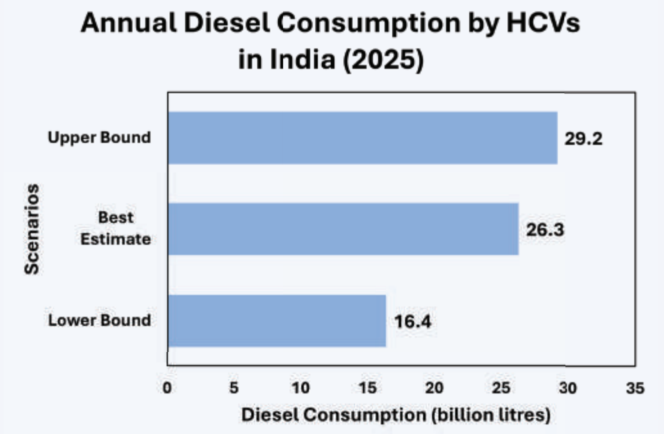
The top 10 toll plazas in India which recorded the maximum annual HCV traffic in 2025[7,8] are Mandva Plaza (Vadodara-Surat, 6.92 million HCVs), Samakhiali (Samakhiali-Gandhidham, 6.59 million HCVs), Surajbari (Garamore-Samakhiali, 5.72 million HCVs), Kishangarh (Jaipur-Kishangarh, 4.76 million HCVs), Boriach (Surat-Dahisar, 4.35 million HCVs), Mokha (Gandhidham/Kandla-Mundra Port, 4.16 million HCVs), Choryasi (Bharuch-Surat, 4.15 million HCVs), Palsit (Budbud-Palsit, 4.04 million HCVs), Bhagwada (Surat-Dahisar, 3.9 million HCVs) and Daffi (Varanasi-Aurangabad, 3.81 million HCVs).

In the absence of origin-destination level freight data, vehicle kilometres travelled (VKT) is derived by combining observed traffic volumes with representative road segment lengths, thereby quantifying total vehicle movement on the network rather than individual trip distances. In this study, a total of 1158 segments are analysed throughout the country, belonging to different highways. The total VKT by HCVs in India in 2025 is estimated to be approximately *65.6 billion km*. Segment-level analysis enables the identification of the top freight activity corridors in India as well as their annual VKT. The results highlight that a relatively small number of corridors carry a disproportionately large share of freight activity. For example, the estimated annual VKT in the segment pivoted by Charoti toll plaza in the Surat-Dahisar route is approximately 1.34 billion km. Shahjahanpur plaza pivots a major segment in the Gurgaon-Kotputli-Jaipur route, having an annual VKT of approx. 0.83 billion km.

The Nallur plaza pivots a key segment in the Chennai-Tada route, having an annual VKT of approx. 0.78 billion km. The Badauri plaza pivots a segment in the Chakeri-Usrania route, having 0.77 billion km annual VKT. The Surajbari plaza, pivoting a segment in the Garamore-Samakhiali route, has an estimated annual VKT of 0.72 billion km. Similarly, Rasoiya Dhamna plaza, pivoting a segment in the Barachatti-Gorhar route, has an estimated annual VKT of 0.69 billion km. A list of the top 25 analysed segments with regard to annual VKT is summarised in the Technical Annex.

Diesel Consumption Baseline

Based on estimated NH activity and representative fuel economy values, the total annual diesel consumption in the HCV sector along the NH in 2025 is estimated to be approximately *26.3 billion litres* (best estimate), with a lower bound estimate of 16.4 billion litres and an upper bound estimate of 29.2 billion litres.

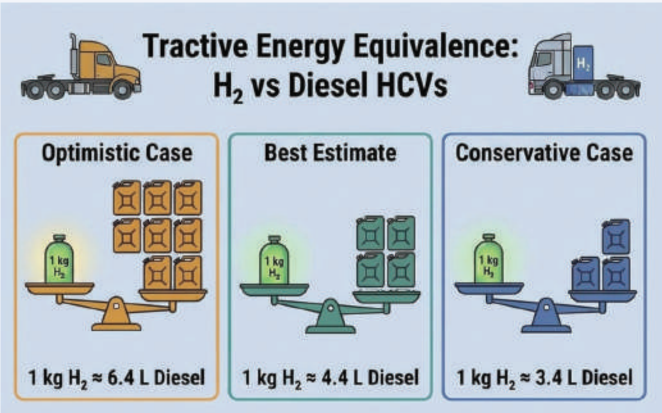


Total annual diesel consumption in the HCV sector along the Indian national highways in 2025 is estimated to be approximately 26.3 billion litres.

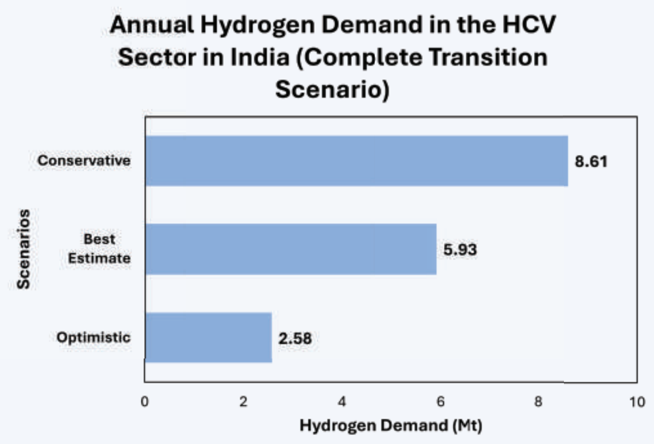
National diesel consumption rose to 91.4 million tonnes (108.8 billion litres) in the 2024-25 fiscal year, according to provisional data released by the Petroleum Planning and Analysis Cell (PPAC) of the Oil Ministry[4]. The results indicate that HCVs account for a significant share (~25%) of India's diesel demand, underscoring their importance in the country's energy system. Higher diesel consumption is observed in long-haul, high-capacity truck segments due to both higher utilisation rates and longer travel distances.

Hydrogen Demand: Scale and Distribution

The useful tractive energy equivalence between diesel-powered and hydrogen-fuelled HCVs, along with the parameter bounds, yields three different replacement cases:



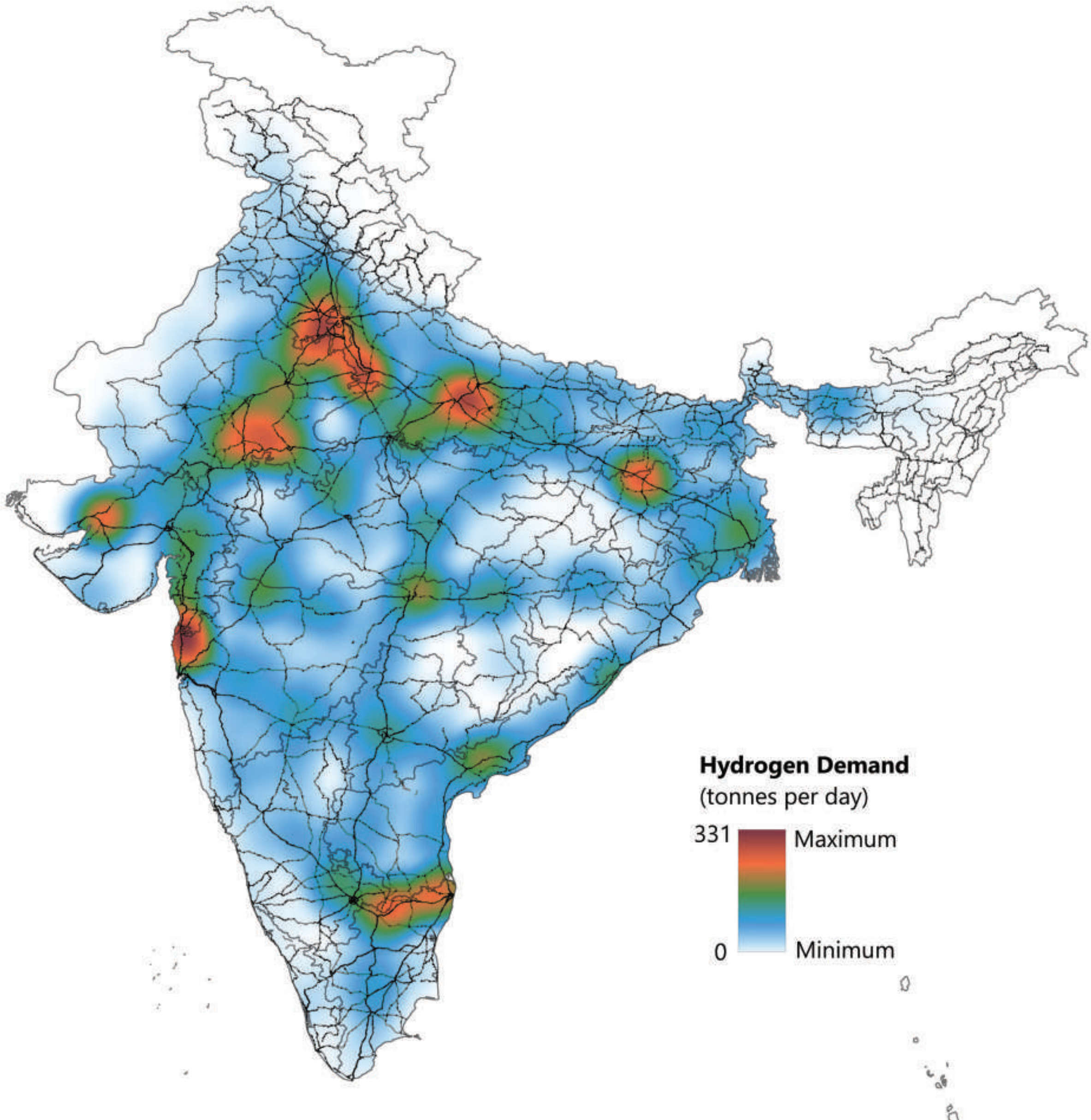
Assuming a complete transition from diesel-powered HCVs to hydrogen FCEVs, the total hydrogen demand is estimated at approximately *5.93 million tonnes per year*, with a lower bound estimate of 2.58 million tonnes and an upper bound estimate of 8.61 million tonnes per year (considering 2025 as the baseline). This translates to a national daily demand of roughly 16240 tonnes (best estimate).



The total hydrogen demand corresponding to a 100% transition from diesel-powered HCVs to hydrogen FCEVs is estimated to be approximately 5.93 million tonnes per year (considering 2025 as baseline year)

There are about 21 segments where the daily hydrogen demand is expected to exceed 100 TPD (Technical Annex). The highest daily demand of 330.3 TPD is estimated at a segment pivoted by Charoti toll plaza in the Surat-Dahisar route. A consolidated map of hydrogen demand on the Indian National Highways for the HCV sector is shown below for visualisation. It is to be noted that in this study, the toll plaza dataset is assumed to capture the majority of freight movement on major national highways. Non-tolled roads and minor freight routes where the traffic data is not available are not explicitly included, and therefore, the hydrogen demand in such routes is not represented in the heatmap.

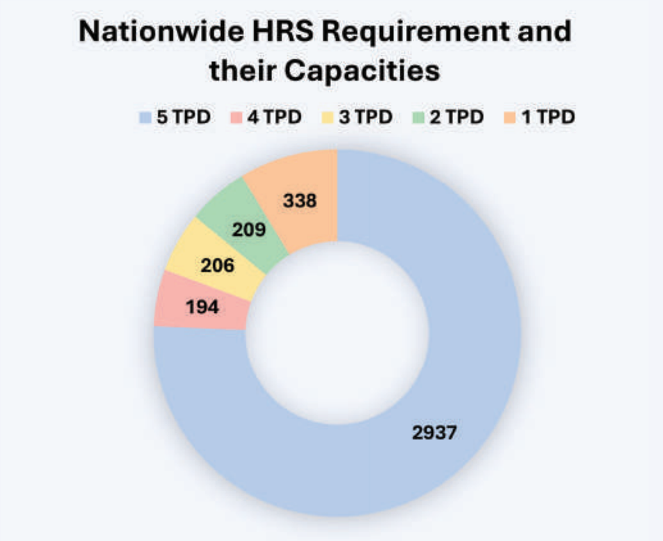
Spatial Distribution of Hydrogen Demand for HCVs in India



The Surat-Dahisar corridor, a section of one of the busiest trucking routes facilitating movement between the industrial hubs of Gujarat and the Mumbai metropolitan region, records the highest hydrogen demand nationally. The other major routes where hydrogen demand is expected to be significant involves Gurgaon-Jaipur (a major artery for northwestern freight movement), the Chennai-Tada (southern India's prominent freight network which connects to Chennai's port), the Garamore-Samakhiali (vital corridor connecting to the Kandla and Mundra port regions in Gujarat), and Barachatti-Gorhar (crucial to transporting coal, minerals, and industrial raw materials from Jharkhand to northern and eastern India).

Hydrogen Refuelling Infrastructure Estimation

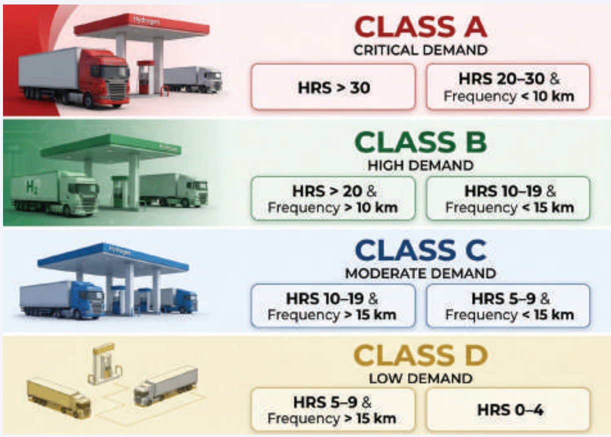
To translate hydrogen demand into refuelling infrastructure requirements, a segment - capacity-based allocation model was developed. The approach determines the number and size distribution of HRS required to meet spatially distributed daily hydrogen demand along each segment. For the estimation of the number of hydrogen refuelling stations required, maximum rated capacities ranging from 1 to 5 tonnes per day are proposed. In order to meet the hydrogen demand for 100% transition from diesel to hydrogen-based HCVs (considering 2025 as the baseline year), the total number of HRS required is estimated to be approximately *3384* nationwide. Among these, roughly 76% will have to be operated at a capacity of 5 TPD. On a nationwide scale, the current estimate suggests a maximum installed capacity of 16835 TPD. The relative overcapacity of this allocation is around 3.7%. This means that the total hydrogen refuelling capacity of the estimated HRS is 3.7% higher than the actual demand, indicating a close match between installed capacity and demand. This lower overcapacity indicates a near-optimal nature of the allocation method.



To enable a complete transition from diesel to hydrogen in the HCV segment, the nationwide requirement for hydrogen refuelling infrastructure is projected at roughly 3,384 stations (considering 2025 as the baseline) of maximum capacities ranging from 1 to 5 tonnes per day

Classification of segments based on demand

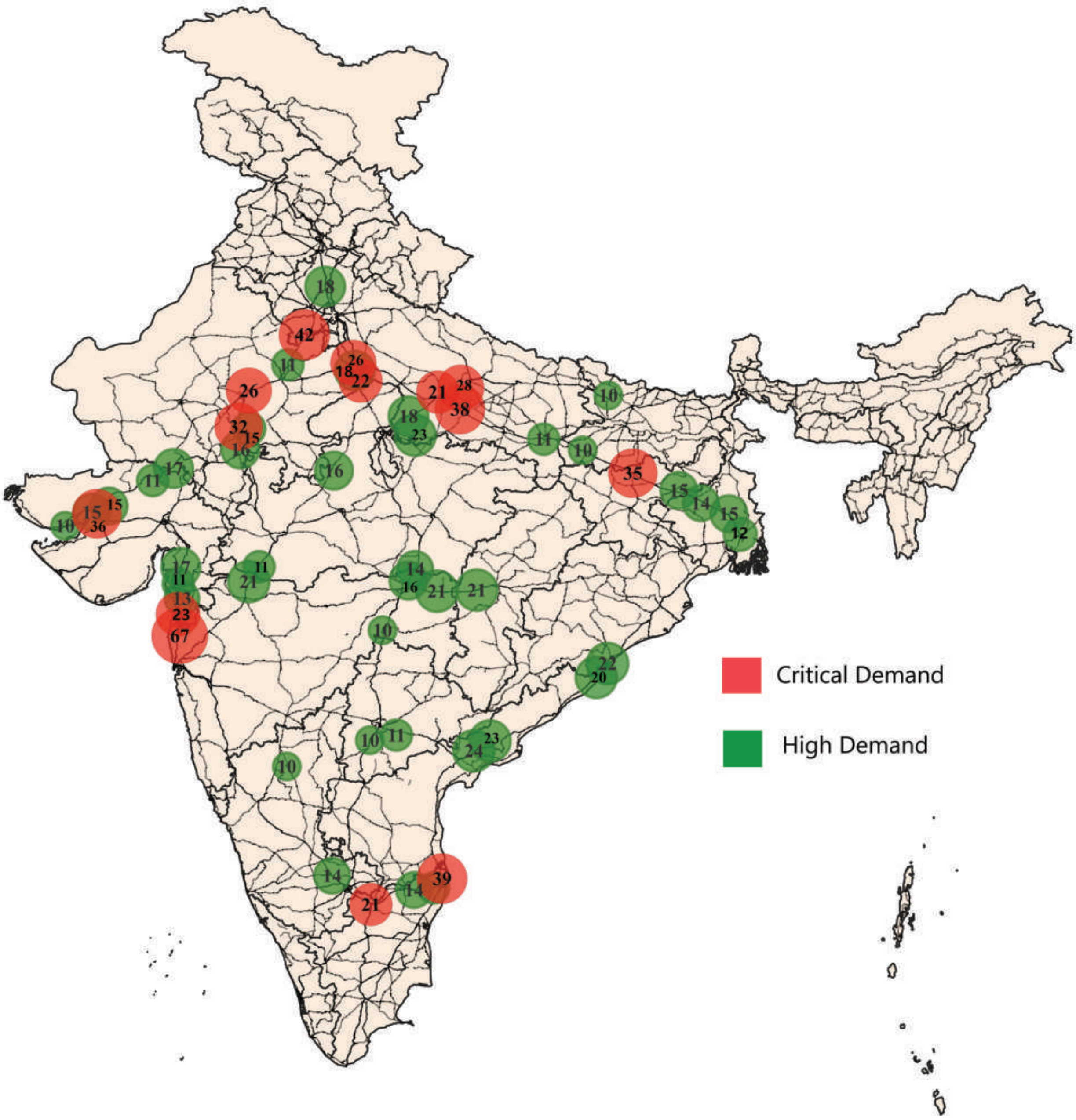
To identify the priority corridors, a classification structure that encompasses both the HRS numbers and their placement along the segment is adopted in this study. Frequency of HRS allocation in each segment is defined as the distance/spacing between successive HRS, assuming that the total number of HRS per segment is distributed at equal spacing. For example, Class A segments satisfy either of the two conditions: number of HRS exceeding 30 or number of HRS in the range 20-30 and at a frequency less than 10 km. Similarly, for Class D segments, the conditions are: the number of HRS is in the range 0-4, or the number of HRS is in the range 5-9 and at a frequency exceeding 15 km.



Frequency of HRS is defined here as the distance between successive HRS in km (when the HRS are distributed at equal intervals). It is determined by dividing the segment/link length by the total HRS in a segment.

In this study, 1158 segments are analysed, out of which the Class A segments are 14 (comprising 1.2% of the total segments analysed). However, their cumulative hydrogen demand is estimated at 13.8% of national demand. Similarly, the 40 Class B segments (comprising just 3.45% of the total segments) have a cumulative hydrogen demand that is 17.4% of the national demand. Hence, these 54 segments together form the top priority decarbonisation corridors of the country, catering to around one-third of the nation's HCV hydrogen demand. Based on the segregation protocol discussed, segments of critical demand and high demand are represented in the map with their respective HRS number requirements.

HRS Requirements in the Segments of "Critical" and "High" Demand in the Country



The number of hydrogen refuelling stations required in the proposed Class A (critical demand) and Class B (high demand) segments is indicated in the map, with the bubble size being a relative indicator of the number of HRS alone

Class A Segments (Critical Demand)

Class A segments segregated from the results are summarised along with their daily hydrogen demand, HRS estimates and HRS distribution frequency, corresponding to a 100% transition scenario (corresponding to baseline year 2025). The results for class B segments are summarised in the Technical Annex.

Class A Segments (Critical Demand)

Segment Nodal Plaza	Major Towns/Sections of NH*	NH*	Daily Hydrogen Demand (tonnes)	Total HRS	Frequency of HRS (km)
Charoti	Surat - Dahisar	8	330.3	67	5.8
Shahjahanpur	Gurgaon-Kotputli -Jaipur Bypass	8	206.5	42	6.1
Nallur	Chennai-Tada	16	192.4	39	7.2
Badauri	Chakeri - Usrania	2	189.6	38	12.1
Surajbari	Garamore - Samakhiali	27	178.3	36	3.5
Rasoiya Dhamna	Barachetti - Gorhar	2	171	32	8.9
Lambiya Kalan	Gulabpura-Chittorgarh	48	157.3	32	8.0
Nawabganj	Kanpur-Ayodhya	27	138.3	28	9.2
Mahuvan	Delhi-Agra	2	127.9	26	8.5
Kishangarh	Jaipur - Kishangarh	8	125.9	26	4.1
Bhagwada	Surat - Dahisar	48	114.4	23	5.2
Baretha or Jajau	Agra-Gwalior	44	106	22	8.9
Krishnagiri	Hosur-Krishnagiri	44	100.1	21	7.8
Bara Jode	Etawah - Chakeri	19	100	21	6.0

Frequency of HRS is defined here as the distance between successive HRS in km (when the HRS are distributed at equal intervals). It is determined by dividing the segment/link length by the total HRS in a segment.

*Reference for NH numbers and section: (Indian Highways Management Company Ltd., 2025)[8]

03

What this Means for India: Strategic Implications and Roadmap

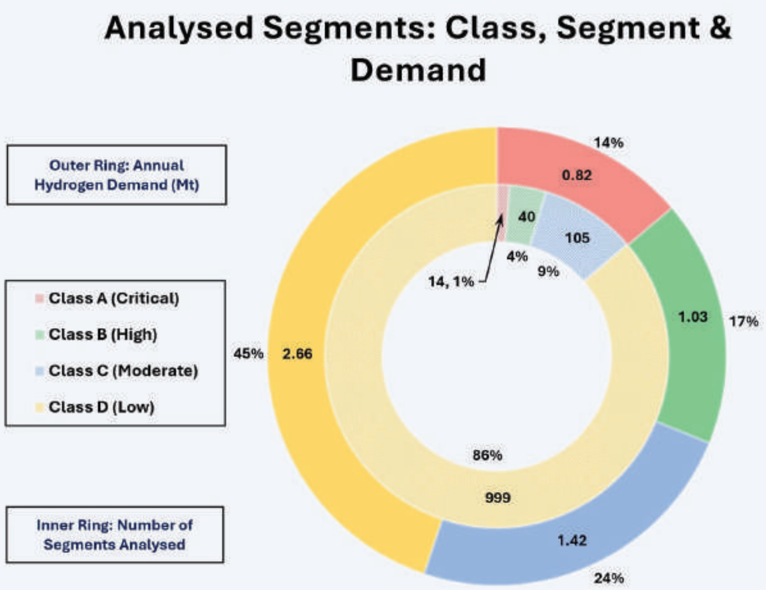
Concentration of Freight Activity and Priority Segments

The hydrogen demand estimation study highlights a fundamental characteristic of India's freight system: the demand is expected to be concentrated along a limited number of high-intensity transport corridors. A relatively small subset of highway segments accounts for a disproportionately large share of total freight movement, fuel consumption, and emissions.

Class A (Critical Demand): 14 segments with a net annual demand of 0.82 Mt (~*14%* of the total national demand).
Class B (High Demand): 40 segments accounting for ~*17%* of total national demand (approximately 1.03 Mt).
Class C (Moderate Demand): 105 segments with a net annual demand of 1.42 Mt (~*24%* of the total national demand).
Class D (Low Demand): 999 segments with a net annual demand of 2.66 Mt (~*45%* of the total national demand).

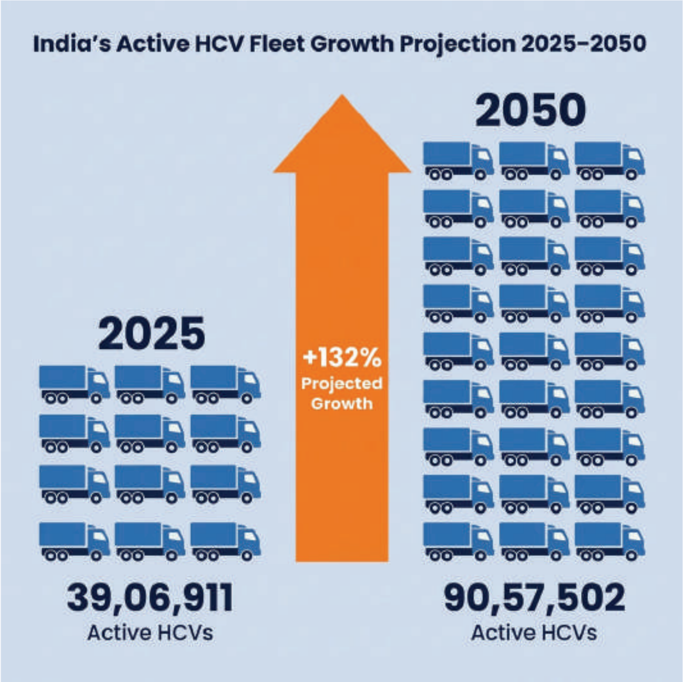
This concentration creates a strategic opportunity to prioritise infrastructure deployment in areas where utilisation and economic viability will be highest. Corridors linking major industrial zones, logistics hubs, and port regions emerge as the prominent segments of the national freight system. These corridors exhibit consistently high traffic volumes, making them well-suited for early hydrogen adoption. A targeted deployment strategy along these routes can deliver rapid emissions reduction while establishing the foundation for broader network expansion. As evident from the study, approximately one-third of the demand is expected in 54 analysed segments of the country.

This spatial concentration has important implications for decarbonisation strategies. The findings are particularly relevant to India's National Green Hydrogen Mission, which aims to scale up green hydrogen production. India targets 5 MMT of Green Hydrogen production annually by 2030[3]. The HCV sector could emerge as a major demand-side driver for the mission, providing a strong economic case for investment in hydrogen technologies. A transition to hydrogen-powered trucks would require substantial expansion of hydrogen production, storage, and distribution infrastructure. This underscores the need for coordinated planning between the transport and energy sectors.



Priority Deployment Segments (Classes A & B)

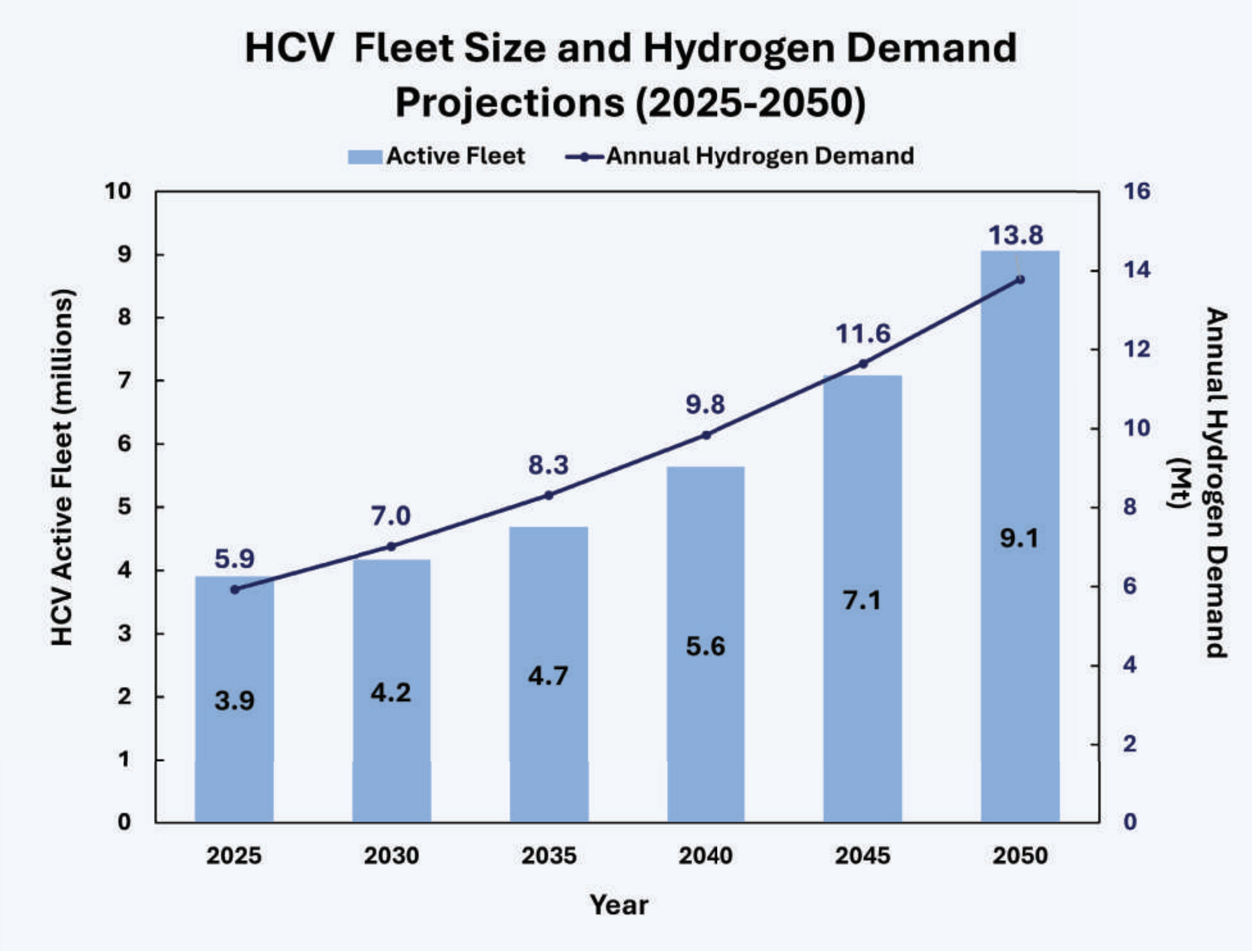
Infrastructure deployment must begin where demand is most certain. Rather than requiring a uniform nationwide rollout of hydrogen infrastructure, the transition can be initiated by targeting the 54 priority segments- Classes A & B. Such an approach enables more efficient allocation of resources by focusing investments where they yield the greatest impact. Focusing on these segments alone allows the government and industry to capture 31% of the total decarbonization potential with minimal geographic complexity. This approach minimises upfront investment while enabling gradual scaling of infrastructure. It also reduces the risk associated with early-stage hydrogen deployment. The Classes A & B require dense networks of refuelling stations, while lower-demand regions can be addressed in later phases.



Projections for 2050

Cumulative registrations of HCVs crossed 5.4 million units between 2000 and 2026[1]. However, to estimate the active fleet size of HCV for the future years, historical and projected vehicle sales are combined with an age-dependent Weibull survival function to reconstruct the in-use fleet over time[10,11,1]. In 2025, the active HCV fleet is estimated to be approximately 39,06,911. Under a business-as-usual (BAU) scenario, if current trends, policies, and practices continue without major interventions or disruption, the HCV active fleet grows at an average of 3.43% yearly, reaching 90,57,502 by 2050. The VKT is estimated to grow from 65.65 billion km to 152.54 billion km by 2050. Under the BAU scenario, the HCV diesel consumption on the highways will reach 61.02 billion litres by 2050, contributing to annual CO2 emissions of 160.47 Mt by 2050. The annual hydrogen demand is expected to increase from 5.93 Mt to 13.8 Mt by 2050.

Importantly, the business-as-usual projections indicate that delaying decarbonisation will significantly increase the scale of the challenge. Without intervention, freight demand, fuel consumption and emissions are expected to grow rapidly, making future transitions more complex and capital-intensive. Early action, therefore, is not only environmentally necessary but also economically prudent.



With current trends, policies, and practices continuing without major interventions, the HCV fleet is projected to reach 90,57,502 units by 2050. Correspondingly, annual hydrogen demand for a complete transition to a hydrogen-based fleet is expected to rise to 13.8 Mt by 2050

A Roadmap for Scaling Hydrogen-Based HCV Fleet

The transition to hydrogen-based freight transport in India requires a coordinated and strategic policy framework that aligns infrastructure development with demand evolution. While hydrogen-fuelled HCVs offer advantages for long-haul freight, alternative technologies such as battery electric trucks are also being explored. The choice between these technologies depends on factors such as range requirements, payload constraints, and infrastructure availability. Hydrogen is particularly well-suited for long-distance and high-load applications, where battery limitations may pose challenges. However, for LCVs, which dominate the freight sector in terms of number, battery EVs are deemed more suitable for decarbonization than hydrogen-based ones. Specifically concerning the adoption of hydrogen HCVs in the country, the following recommendations may be proposed for policymakers:

Prioritise critical-high demand HCV segments.

Focus initial hydrogen infrastructure deployment along the critical and high-demand segments to maximise impact for initial hydrogen infrastructure rollout. Designate these segments as “green freight corridors”. Concentrating investments in these areas will maximise station utilisation, improve project viability, and accelerate market adoption.

Financial support mechanism for hydrogen vehicle adoption and associated infrastructure.

Early-stage infrastructure deployment should anticipate the need for large-capacity stations along the priority segments. The government should provide a fixed VGF (viability gap funding) for HRS in the priority segments.

Integrate transport and energy planning.

Hydrogen infrastructure planning must be integrated with broader energy and industrial policy frameworks. The location of HRS should be aligned with renewable energy availability, hydrogen production hubs, and industrial demand centres.

Heavy-duty trucking should be recognized as a priority sector within India’s decarbonisation strategy.

Targeted incentives for hydrogen-based HCV adoption, such as purchase subsidies, fuel cost support, and regulatory mandates, can deliver high-impact emissions reduction

Green hydrogen purchase obligations.

Implement mandatory "Green Hydrogen Purchase Obligations" for large fleet operators and e-commerce companies, requiring a fixed percentage of their active fleet to be replaced by hydrogen-powered trucks by the next 5 to 10 years.

Support pilot hydrogen corridors.

Develop and promote demonstration projects to validate hydrogen truck performance and infrastructure requirements.

Develop standards and regulations.

Establish safety, refuelling, and operational standards for hydrogen transport systems.

A clear long-term roadmap is required to guide industry stakeholders.

Include defined milestones for infrastructure deployment, vehicle adoption targets, and regulatory frameworks.

04

Towards Deeper Understanding: Emerging Questions

Summary and Future Outlook

The key takeaway from this study is that decarbonising India's HCV sector through hydrogen is a strategic necessity that requires careful planning and execution of HRS infrastructure. By integrating toll plaza traffic data for a bottom-up HCV activity estimation, the analysis demonstrates that highway-based HCV operations alone account for substantial fuel consumption, while also revealing that both hydrogen demand and infrastructure requirements are highly concentrated across a limited number of freight routes.

A full transition to hydrogen would require significant infrastructure investment, including a nationwide network of refuelling stations, hydrogen storage and transport equipment, electrolysers & associated equipment and renewable power plants. This challenge should be managed through a phased approach, initially targeting the critical and high-demand corridors. Early investment in hydrogen infrastructure, focused on these corridors, can therefore deliver both immediate and long-term benefits.

The approach followed in this study is based on tolled national highway segments and may not fully capture HCV activity on non-tolled or secondary road networks. The estimation of VKT may be particularly considered close to the actual scenario, as it uses real traffic count data recorded at toll plazas. The analysis relies on assumptions related to fuel economy and hydrogen efficiency, which may vary across regions & operating conditions. The lower-bound and upper-bound estimates have been done for all cases, with the best-value estimates likely to represent the practical values. Additionally, for determining the HRS numbers, the study assumes a complete nationwide transition to hydrogen-fuelled trucks, whereas real-world adoption is likely to be gradual and technology diverse.

While the present work provides a robust analytical baseline, it also opens several critical avenues for future investigations, which are essential to translate this framework into implementation-ready strategies:

The current analysis evaluates hydrogen demand under defined adoption scenarios but does not explicitly model vehicle adoption rates or behavioural responses of logistics operators. Future work could integrate total cost of ownership (TCO) comparisons between diesel, battery EV alternatives and hydrogen-powered trucks, as well as policy-driven adoption pathways.

While this study allocates HRS based on segment-level demand, further refinement and optimisation are possible only by incorporating real-world metrics such as land availability and cost, renewable energy access, water availability for electrolysis and proximity to industrial hydrogen demand centres. This would enable precise distribution of hydrogen refuelling stations, improving both economic viability and operational efficiency.

The current analysis focuses on demand and refuelling infrastructure but does not explicitly model the upstream hydrogen supply chain. Future extensions should link electrolyser deployment strategies, renewable energy integration (solar, wind) and hydrogen storage and transport (pipelines, trucking). Such an integrated approach would support end-to-end system optimisation, ensuring that production, distribution, and consumption are co-developed efficiently.

To support real-world implementation, future work should evaluate capital and operating costs of HRS across capacity ranges, levelized cost of hydrogen (LCOH) under different scenarios, investment requirements and financing structures. This would enable the development of bankable business models and inform policymakers on the scale and structure of required financial support

The transition to hydrogen freight will be strongly influenced by policy interventions. Future studies should assess the impact of carbon pricing and fuel taxation incentives for hydrogen vehicle adoption, infrastructure subsidies and mandates.

This work demonstrates that shifting India's heavy-duty trucking sector to hydrogen is not an overly complex challenge. The problem is well-defined, with clear patterns in where demand is highest and how infrastructure can be built efficiently. The next step is to move from analysis to action. This means connecting demand estimates with real-world planning: developing hydrogen production, building refuelling stations in the right locations, and supporting adoption through policy and investment.

With coordinated efforts across sectors, India has a strong opportunity to build an effective hydrogen-based freight system that supports both economic growth and long-term decarbonisation goals.

While the capital costs remain high, the improving efficiency of fuel cell systems and the rapidly declining costs of renewable power and electrolysers point toward a future where green hydrogen is an economical fuel for heavy transport.

References

1. NITI Aayog. (2026). Road Transport. Transport Sector in India. India Climate and Energy Dashboard. Retrieved March 21, 2026, from https://iced.niti.gov.in/energy/end-use/transport/road-transport

2. NITI Aayog. (2021, June). Freight Report National Level. Government of India. Available at RMI:https://rmi.org/insight/fast-tracking-freight-in-india-a-roadmap-for-clean-and-cost-effective-goods-transport

3. Ministry of New & Renewable Energy. (2023, January). National Hydrogen Mission: Decarbonising India, achieving Net-Zero vision (Explainer document). Government of India, Press Information Bureau. https://static.pib.gov.in/WriteReadData/specificdocs/documents/2023/jan/doc2023110150801.pdf

4. Petroleum Planning & Analysis Cell. (2025). Indian Petroleum & Natural Gas Statistics Report 2024-25. Ministry of Petroleum & Natural Gas, Government of India. Retrieved March 26, 2026, from https://mopng.gov.in/files/TableManagements/2026-02-25-141451-b06fw-IPNG_Statistics-Report_2024-25.pdf

5. Rudman, L. M. (1979). Vehicle kilometers traveled: Evaluation of existing data sources. Transportation Research Record, 701, 19-28.

6. Lima de Azevedo, C., & Cardoso, J. L. (2009, June). Estimation of annual traffic volumes: A model for Portugal. ECTRI-FEHRL-FERSI Young Researchers Seminar, Lisbon, Portugal. National Laboratory of Civil Engineering (LNEC).

7. Indian Highways Management Company Limited. (2026). ETC transaction reports. IHMCL. https://ihmcl.co.in/etc-transaction-reports

8. Indian Highways Management Company Ltd. (2025). NH Fee Plazas [PDF file]. Retrieved February 3, 2026, from https://ihmcl.co.in/wp-content/uploads/2025/08/NH-Fee-Plazas-1.pdf

9. NITI Aayog. (2026). Scenarios Towards Viksit Bharat and Net Zero-Sectoral Insights: Transport (Vol. 3)

10. Guttikunda, S. K. (2024). Vehicle stock numbers and survival functions for on-road exhaust emissions analysis in India: 1993-2018. Sustainability, 16(15), 6298. https://doi.org/10.3390/su16156298

11. Hao, H., Wang, H. W., Ouyang, M. G., & Cheng, F. (2011). Vehicle survival patterns in China. Science China Technological Sciences, 54(3), 625-629. https://doi.org/10.1007/s11431-010-4256-1

HTWO INNOVATION

Contributors

Rohan P Unni (Lead Author)
Manager (Market Research), H2IC

Aravind Kumar Chandiran
Head, H2IC
Associate Professor, Department of Chemical Engineering, IIT Madras.

Shubham Raut
Principal Project Officer, H2IC

Bharathy Krishna
Liaison Manager, H2IC

Raghuram Chetty
Head, Academic and International Relations, H2IC

HTWO INNOVATION

Acknowledgements

We would like to thank the following organisations for offering their support for this work:

HYUNDAI

GOVERNMENT OF TAMILNADU
TRUTH ALONE TRIUMPHS

Guidance TamilNadu
INVEST INNOVATE CREATE

Suggested Citation:

H2IC (2026). Green Hydrogen Demand and Refuelling Network for Heavy-Duty Trucking in India. Article No. 1. Hyundai HTWO Innovation Centre at IIT Madras.

Access the publication online: www.h2ic.in/whitepapers

Access the Technical Annex:

https://github.com/h2ic-iitm/whitepapers.git

For further information or to provide feedback, please contact:

marketresearch@h2ic.in

Disclaimer on AI-Generated Infographics

Certain infographics and visual elements in this report were generated or refined using artificial intelligence (AI) tools. These tools were employed strictly for design and visualisation purposes to enhance clarity. Readers should note that AI-assisted graphics are illustrative aids and do not substitute for the technical analysis presented in the main text.