Green hydrogen

A catalyst to India's energy independence

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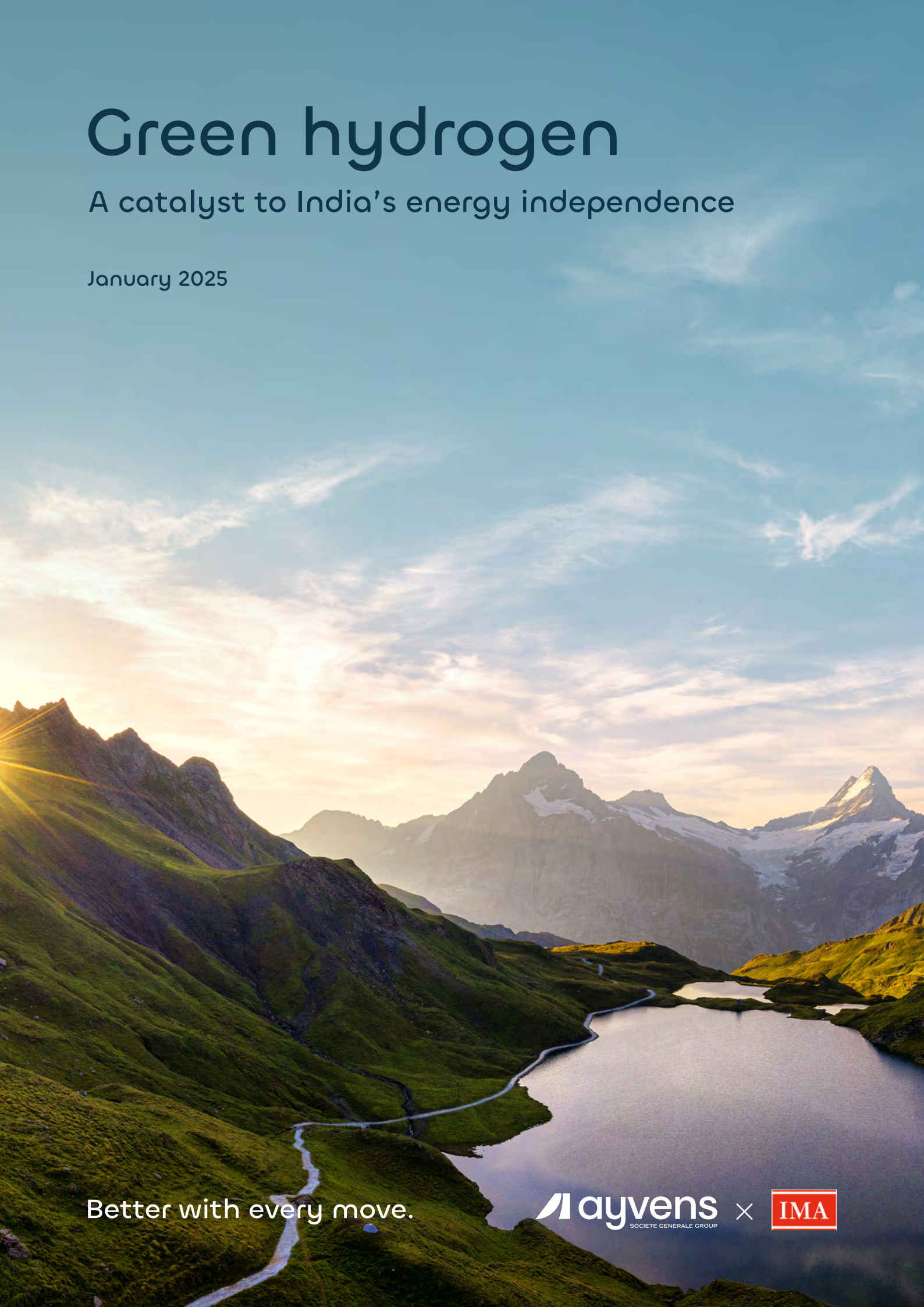

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Introduction

India is on the verge of an energy revolution, with bold ambitions to achieve energy independence by 2047 and reach net-zero emissions by 2070. Hydrogen is a versatile, potentially 'clean' energy source that produces zero emissions when used, can be stored and transported relatively easily, and has the potential to decarbonise hard-to-abate sectors like industry, transport and power generation. In particular, green hydrogen – hydrogen that is produced using renewable sources such as solar and wind – presents a versatile alternative to fossil fuels. It is particularly interesting for industries where electrification is not yet viable, such as cement production, steelmaking and shipping. With abundant renewable resources and ambitious targets, India has a unique opportunity to lead the global green hydrogen market.

Green hydrogen is emerging as a transformative energy source, complementing battery electrification and other renewable fuels to help create a carbon-neutral society. Currently, India consumes 6 million metric tonnes per annum (MMTPA) of hydrogen, mostly in the form of grey hydrogen, which is derived from fossil fuels and therefore generates significant carbon emissions. To transition to cleaner alternatives, India has launched the National Green Hydrogen Mission (NGHM), a Rs 197 billion initiative aiming to produce 5 MMTPA of green hydrogen by 2030. While challenges such as infrastructure gaps, high costs and supply chain issues remain, strong policy support, technological advancements and promised investments make the 2030 target achievable.

The Indian government: playing a strategic role

India's ambition to lead in green hydrogen is driven by several key factors, including abundant low-cost renewable energy, robust legislative support, grid stability, an extensive coastline and ports for transport and export and proven expertise in engineering, procurement, and construction (EPC). These elements position India as a strong player in the global green hydrogen market.

States like Tamil Nadu, Karnataka, Gujarat, Maharashtra and Rajasthan offer ideal conditions for wind-powered hydrogen production. A stable national grid ensures a steady supply of renewable energy, which is crucial for green hydrogen production. Policies such as waivers on inter-state transmission charges and faster grid connectivity help make renewable power more accessible and affordable, supporting the green hydrogen ecosystem.

India's vast renewable energy potential supports its green hydrogen goals, but rapid capacity expansion is necessary. To achieve this, the government has introduced various Production-Linked Incentive (PLI) schemes to boost renewable energy across sectors like solar, wind, biomass, hydro and energy storage.

These initiatives ensure a reliable supply of renewable energy for hydrogen production. In January 2023, the NGHM was launched with a goal of producing 5 MMTPA of green hydrogen by 2030, with plans to expand to 10 MMTPA as export markets develop.

In June 2023, the government introduced the Strategic Interventions for Green Hydrogen Transition (SIGHT) programme under the NGHM, with a budget of Rs 175 billion. This programme provides financial incentives for domestic electrolyser manufacturing and green hydrogen production.

Additionally, in May 2024, the Ministry of New and Renewable Energy (MNRE) exempted export-oriented green hydrogen projects from the Approved List of Models and Manufacturers (ALMM), allowing producers to import cheaper solar modules and thus reduce renewable energy costs for powering electrolysers.

The government has also issued guidelines for three pilot projects in shipping and steel manufacturing, backed by Rs 10.7 billion in funding. These projects aim to demonstrate the safe and efficient use of hydrogen-based processes in steel production, with a focus on validating technical feasibility, assessing performance, and evaluating economic viability, all with the goal of achieving low-carbon steel production. A 100% waiver on interstate transmission charges for green hydrogen and ammonia projects commissioned by 31st December 2030 will further reduce costs and support offshore wind energy projects. These policies encourage the expansion of green hydrogen and ammonia projects while promoting the uptake of renewable energy from energy storage systems.

The role of green hydrogen in decarbonising transport

As countries worldwide prioritise sustainable mobility, the shift has largely focused on battery electric vehicles (EVs), though hydrogen-fuelled vehicles are also gaining attention for their potential to mitigate local pollution. In India, the government has shown strong support for hydrogen in mobility, with ministries in sectors such as road transport, power and railways advocating its adoption.

Through the NGHM, the government has allocated Rs 14.6 billion for various pilot projects, including Rs 4.5 billion for steel, Rs 5 billion for transport, Rs 1.1 billion for shipping and Rs 4 billion for other sectors traditionally reliant on fossil fuels. These projects serve as innovation labs, testing new technologies, assessing regulatory frameworks and developing the necessary infrastructure.

Aside from their varying combustive properties and emission levels, hydrogen combustion engines (HCE) are functionally similar to conventional internal combustion engines (ICE). However, a major challenge for hydrogen-fuel adoption is the lack of an established infrastructure for distribution and refuelling, particularly when compared to conventional petrol/diesel networks. In the trucking sector, hydrogen fuel cells can significantly reduce emissions, improving air quality and lessening the transportation sector's climate impact. For long-haul transport, hydrogen fuel cells provide a viable solution, offering a range comparable to diesel trucks and refuelling times similar to conventional vehicles, enhancing efficiency for freight operators.

Hydrogen holds immense potential, too, for the passenger vehicle markets, as demonstrated by some early initiatives. Toyota's Mirai, launched as a pilot project in 2022, marked India's first hydrogen fuel-cell electric vehicle (FCEV).

Entirely eco-friendly, the Mirai generates electricity solely from hydrogen, emitting only water and offering a range of up to 600 kilometres on a single refuelling, which takes just five minutes. This innovation, actively promoted by the Union government, emphasises hydrogen's role in fostering a sustainable future. Complementing this progress, Omega Seiki Mobility (OSM) is revolutionising the commercial vehicle segment with hydrogen-powered three-wheelers. Developed under the 'Hydrogen Intelligence' joint venture with Systemics, these vehicles are designed for India's unique needs, boasting an impressive range of 700 kilometres on just 2 kg of hydrogen.

Priced at Rs 650,000, they promise long-term economic benefits through lower maintenance costs and extended operational lifespan. Together, these advancements position India as a global leader in adopting accessible, hydrogen-powered transportation solutions. Government support has spurred commitments from major corporations to advance hydrogen technology.

For instance, Adani and TotalEnergies SE are collaborating to develop green hydrogen production and commercialisation in India, aiming to provide the lowest-cost green hydrogen to consumers and accelerate the global energy transition. NTPC is deploying 10 Fuel Cell Electric Vehicles (FCEVs) for intra- and intercity applications, with five based in Leh and five in Delhi, while exploring the use of green hydrogen from a dedicated fuelling facility to support these vehicles.In 2023, Reliance Industries (RIL) partnered with Ashok Leyland to unveil India's first hydrogen internal combustion engine technology for heavy-duty trucks. RIL also collaborated with Olectra Greentech to launch a hydrogen bus, with plans for commercial availability within a year. Additionally, RIL has joined forces with Bharat Benz to develop India's first hydrogen fuel cell-powered intercity luxury coach. US engineering firm Cummins and Indian conglomerate Tata have pledged Rs 35.4 billion to build a large-scale hydrogen internal combustion engine manufacturing facility in India, with a production capacity of up to 4,000 engines annually.

To further incentivise hydrogen mobility, the Indian government has selected five companies – Ashok Leyland, Eicher Motors, Pinnacle Mobility, Tata Motors and Booma Innovative—to manufacture hydrogen fuel cell electric vehicles under the Rs 259 billion PLI scheme for the automotive industry. This scheme is designed to promote both battery electric and hydrogen fuel cell vehicles across various segments. According to MHI data, the scheme has attracted Rs 748 billion in proposed investment, surpassing the Rs 425 billion target. Of this, Rs 450 billion is from the Champion OEM Incentive Scheme, with the remaining Rs 298 billion from Component Champion applicants.

Although hydrogen-powered mobility is still in its early stages, it is expected to grow into a significant market in the coming years. According to the Centre for Energy Finance, India's green hydrogen market could reach USD 340 billion by 2050, with approximately 22% of the country's hydrogen demand projected to come from the transport sector. The cumulative market size for fuel cells in hydrogen vehicles could reach USD 40-55 billion in the next 2-3 decades. However, realising this vision requires reducing the current cost of green hydrogen from USD 6/kg to USD 2/kg or lower, aligning it with India's EV targets. As hydrogen-powered trucks currently consume three times more electricity than their EV counterparts, strategic deployment in sectors like long-distance road transport, railways, aviation and shipping is crucial to scaling hydrogen technology and advancing sustainable mobility goals. The government is working to make green hydrogen viable through initiatives such as public-private partnerships, boosting domestic electrolyser manufacturing, and harnessing India's vast renewable energy potential.

Barriers to green hydrogen implementation

India faces significant challenges in scaling up green hydrogen adoption, primarily related to cost, infrastructural and environmental concerns. The most efficient alkaline electrolysers currently require approximately 50 kWh of electricity and 10 litres of fresh water to produce 1 kg of hydrogen. To meet India's target of 5 million tonnes of green hydrogen by 2030, around 50 billion litres of fresh water and 250 billion kWh of renewable electricity – mainly from wind and solar – will be required.

The high cost of electrolysers, currently over USD 800 per kilowatt, is a major barrier to scaling up production. India's electrolyser manufacturing capacity is estimated at just 2-4 GW annually, while over 30 GW of electrolyser capacity and more than 100 GW of renewable energy will be needed by 2030 to meet its green hydrogen production target.

To make green hydrogen viable for steel production, its price must drop to USD 1-2/kg, down from the current price of approximately USD 3.6/kg. Additionally, penalties should be introduced for carbon emissions from Indian steelmakers to incentivise the switch to green hydrogen-based alternatives.

Another concern is the water-intensive nature of hydrogen production through electrolysis, a significant issue for a country facing severe water scarcity.Scaling up green hydrogen production could exacerbate water stress unless addressed through solutions such as desalination plants co-located with electrolyser facilities. IIT Madras has developed a prototype electrolyser that uses seawater, offering a potential solution for R&D. Stringent wastewater treatment regulations must also be enforced to minimise environmental impact.

The land requirements for large-scale green hydrogen facilities also pose challenges, as these installations need vast areas, often located outside densely populated regions. This necessitates the development of expensive transport and supply chain infrastructure. State-level renewable energy policies show inconsistencies regarding land use conversion and land banks, creating information gaps. While many states offer stamp duty exemptions, only a few – such as Jharkhand and Karnataka – provide land banks, and most do not have provisions for using wasteland.

Enhancing green hydrogen adoption: steps for success

To accelerate green hydrogen adoption, the government can implement several supply-side interventions to reduce production costs:

De-risking projects through credible offtake guarantees:
An offtake guarantee programme can lower the cost of capital and attract private investment. Adopting frameworks like Germany's H2Global, which focuses on domestic demand creation and viability gap funding, would further support the sector.

Implementing a contract for differences (CfD) model:
A tailored CfD model can ensure a stable, round-the-clock renewable energy supply for electrolysers by addressing mismatches between renewable generation and consumption. This model allows the buying and selling of power in the market, providing electrolysers with stable energy costs and enhancing solar power utilisation.

Reducing taxes on equipment:
The government could mitigate the impact of indirect taxes on hydrogen production equipment. Lowering or refunding these taxes could reduce the final cost of hydrogen by 6-10%, encouraging further investment in hydrogen technologies.

Investing in a national pipeline network:
Establishing localised green hydrogen production clusters and investing in a national pipeline network would significantly reduce transportation and storage costs, facilitating efficient hydrogen production and use.

The adoption of green hydrogen is gaining momentum due to a combination of economic, technological and policy-driven factors. India's drive towards net-zero emissions by 2070 has spurred substantial investments in renewable energy and green hydrogen. The declining costs of solar energy and advancements in electrolyser technology have made green hydrogen more viable. Recognising its potential to decarbonise hard-to-abate sectors such as heavy transport, steel and fertiliser industries, the Indian government launched the NGHM with the aim of making India a global hub for green hydrogen production and export. Geopolitical factors and the need to reduce dependence on imported fossil fuels have further accelerated its adoption. With initiatives like hydrogen corridors and public-private partnerships, India is positioning itself to leverage green hydrogen for energy security and sustainable industrial growth.

Case Study:

Advancing green hydrogen solutions for a sustainable future

Thyssenkrupp, a leading global industrial and technology company, is driving innovation in green hydrogen and ammonia technologies, positioning itself as a key player in the clean energy transition. Focused on decarbonisation and carbon emissions reduction, it has refined its product offerings to meet the growing global demand for sustainable energy solutions.

Recently, the company has made significant progress in green hydrogen production using its expertise in alkaline electrolysis. By leveraging decades of experience, it has developed modular 20-megawatt electrolysis units designed for scalable hydrogen production, providing industries with a viable decarbonisation solution. Additionally, Thyssenkrupp is advancing green ammonia technologies, offering cryogenic storage solutions and ammonia cracking capabilities, which enable the conversion of green ammonia back into hydrogen when needed. These innovations place it at the forefront of the hydrogen value chain, serving a wide range of industries, including steel, mobility and power.

The company's efforts also extend to other decarbonisation technologies. It supplies critical components for renewable energy projects, such as gears for wind turbines and parts for solar power plants, essential for the renewable infrastructure needed for hydrogen production. In the cement industry, its innovative CO2 capture technologies are helping to reduce emissions and contribute to broader sustainability goals.

While the global market for green hydrogen continues to grow, Thyssenkrupp's focus remains on reducing production costs, enhancing scalability and supporting the development of green hydrogen infrastructure. With its portfolio of cutting-edge technologies, the company is well-positioned to lead the green hydrogen revolution and support global efforts towards a sustainable, carbon-neutral future.

About Ayvens

Ayvens is a leading global sustainable mobility player born from the acquisition of LeasePlan (founded in Amsterdam in 1963) by ALD Automotive (founded in Paris in 1968), part of the Societe Generale group. We've been improving mobility for decades, providing full-service leasing, flexible subscription services, fleet management and multi-mobility solutions to large international corporates, SMEs, professionals, and private individuals. With 14,500 employees across 42 countries, 3.3 million of vehicles and the world's largest multibrand EV fleet, we're leveraging our unique position to lead the way to net zero and spearhead the digital transformation of the mobility sector.

(The company is listed on Compartment A of Euronext Paris (ISIN: FR0013258662; Ticker: ALD). Societe Generale Group is Ayvens majority shareholder.)

+91 22 6193 3200 www.ayvens.com/en-in/

Jolly Board, Tower 1, D-Wing, 4th Floor, I-Think Techno Campus,
Kanjurmarg East Mumbai - 400 042

Ayvens in India

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About IMA

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+91 124 459 1200 www.ima-india.com

Sushant Lok - I, B107, Time Square, Block B, Gurgaon, Haryana, 122002

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