Whitepaper published by

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H2energy

Decarbonising heavy-duty trucking and accelerating the European hydrogen economy

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About us

H2 Energy Europe

In 2020, global commodity trading company Trafigura and business innovator in green hydrogen H2 Energy announced a commercial collaboration to develop the production, storage and distribution of green hydrogen for refuelling stations and industrial customers. Under the joint venture **H2 Energy Europe**, the two companies will invest in green hydrogen ecosystems across Europe.

H2 Energy was established in Zurich, Switzerland, in 2014 with the vision to fight climate change. Its core business consists of providing (directly or through its subsidiaries) worldwide hydrogen system solutions and engineering work in the field of fuel cell and hydrogen applications. This includes the development, implementation and operation of ecosystems that are based on green hydrogen. The activities of H2 Energy always have a commercial focus and are executed either independently or through investments in or partnership with other companies which share H2 Energy's vision and ambitions.

www.h2energy.ch

Founded in 1993, Trafigura is one of the largest physical commodities trading groups in the world. Trafigura sources, stores, transports and delivers a range of raw materials (including oil and refined products and metals and minerals) to clients around the world and has recently established a power and renewables business division.

The trading business is supported by industrial and financial assets, including a majority ownership of global zinc and lead producer Nyrstar which has mining, smelting and other operations located in Europe, Americas and Australia; a significant shareholding in global oil products storage and distribution company Puma Energy; global terminals, warehousing and logistics operator Impala Terminals; Trafigura's Mining Group; and Galena Asset Management.

The Company is owned by around 850 of its 8,619 employees who work in 88 offices in 48 countries around the world. Trafigura has achieved substantial growth over recent years, growing revenue from USD12 billion in 2003 to USD147.5 billion in 2020. The Group has been connecting its customers to the global economy for more than two decades, growing prosperity by advancing trade.

www.trafigura.com

Executive summary

Low-carbon hydrogen is a clean, versatile and powerful fuel with the potential to replace fossil fuels in a range of applications, including in hard-to-abate sectors such as heavy-duty transport and industry.

The development of low-carbon hydrogen supply and infrastructure ecosystem for trucking would act as a catalyst to accelerate the growth of the wider hydrogen economy.

Heavy-duty trucking is an optimal sector for the introduction of low-carbon hydrogen, as it offers the lowest marginal cost of abatement.

Governments need to act quickly on a range of low-carbon hydrogen policy measures in order to incentivise private sector investment and accelerate hydrogen uptake.

H2 Energy is a pioneer in deploying green hydrogen trucking ecosystems, their first of which is currently operating in Switzerland.

This whitepaper identifies some of the policy support measures that could effectively kick-start zero-emission hydrogen trucking ecosystems.

Converting 10 percent of the diesel truck fleet in Europe to hydrogen fuel cell trucks could avoid up to 40 million tonnes of carbon dioxide emissions per year.

Both CapEx and OpEx support is required from governments to enable the rapid adoption of hydrogen trucking.

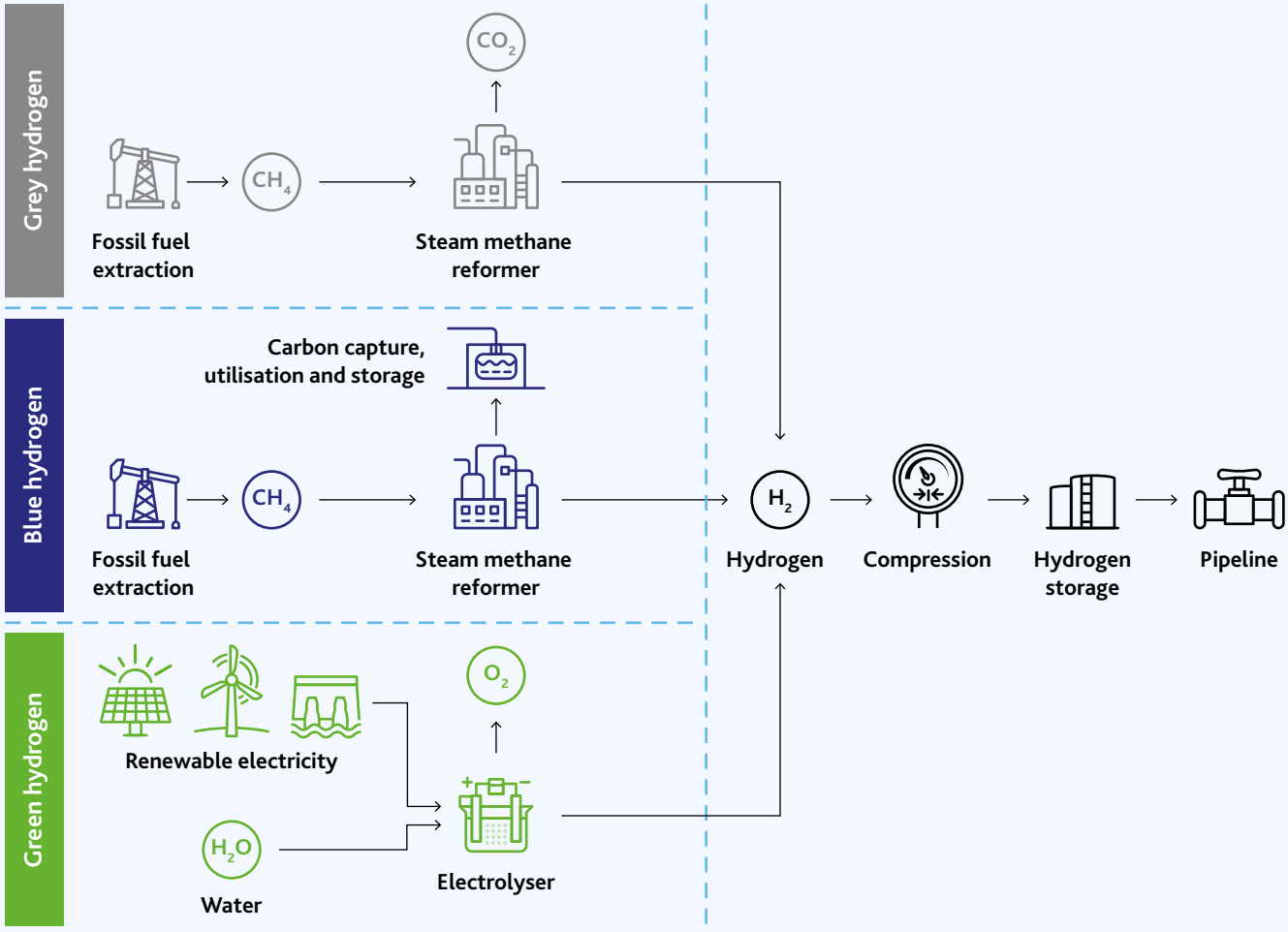
How trucking can lead Europe's hydrogen revolution

The role of hydrogen as a key decarbonisation tool has become the subject of significant international interest. Over 30 countries have published hydrogen roadmaps, industry has announced over 200 hydrogen projects, and governments worldwide have committed more than USD70 billion in public funding.[1]

Hydrogen is a uniquely versatile fuel that can be used in a range of applications as a replacement for fossil fuels. Low-carbon hydrogen has come to be seen as a vital energy carrier for hard-to-abate sectors – where decarbonisation faces technical, operational and economic obstacles, such as the steel and heavy-duty trucking industries. Conventional hydrogen used today is known as grey hydrogen and is produced by steam methane reforming, splitting methane (CH4) into hydrogen (H_2) and carbon dioxide (CO_2) which is released into the atmosphere. There are two main types of low-carbon hydrogen: green hydrogen, produced by electrolysis powered by renewable energy, and blue hydrogen, produced by integrating carbon capture and storage in fossil-based hydrogen production plants.

1 Hydrogen Council (July 2021) *Hydrogen Insights 2021*. Hydrogen Council study, http://www.hydrogencouncil.com/en/hydrogen-insights-2021/

1 Grey hydrogen vs blue hydrogen vs green hydrogen



Source: Pertofac and Trafigura

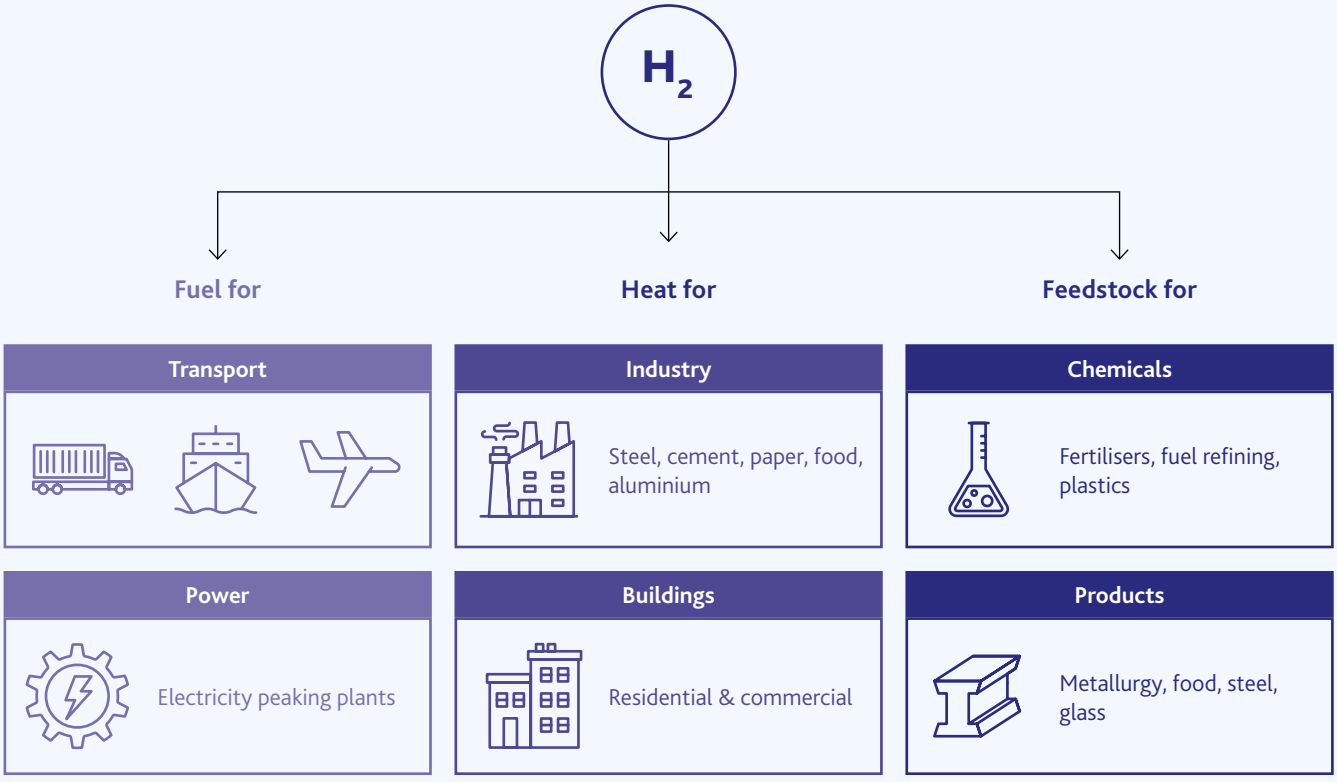
The annual hydrogen market currently comprises approximately 80 million tonnes of pure hydrogen, of which around 99 percent is produced from natural gas and coal (grey hydrogen). Today, hydrogen is used as a feedstock, principally in the refining and chemicals industries and is itself the source of significant carbon emissions, with six percent of global natural gas production and two percent of global coal going into hydrogen production. Trafigura estimates that fossil-based hydrogen accounts for around 800 million metric tonnes of CO_2 emissions per year, roughly two percent of global energy-related emissions in 2019.[2]

Multiple use cases for low-carbon hydrogen have been identified. (See Figure 2). Of these cases, the use of hydrogen fuel cells to decarbonise trucking is seen as a "sweet spot". It enables decarbonisation that would be difficult to achieve by other means such as electrification, at a low-abatement cost compared with other potential applications.[3]

2 International Energy Agency (2021) *Hydrogen*. International Energy Agency webpage, http://www.iea.org/fuels-and-technologies/hydrogen

3 J.P. Morgan Cazenove (February 2021) *EMEA Hydrogen: A revolution in need of realism; separating the opportunity from the optimism*, J.P. Morgan Cazenove report, https://buyhydrogen.com.au/wp-content/uploads/2021/04/J.P.Morgan-CAZENOVE-EMEA-Hydrogen.pdf

2 The many uses of hydrogen



Why trucking should lead Europe's hydrogen revolution

Decarbonising heavy-duty trucking is critical in the global effort to reduce greenhouse emissions to net zero. In Europe, heavy-duty trucks make up 23 percent of total road transport emissions, yet account for less than two percent of vehicles on the road.[4] Emissions from heavy-duty transport in the EU increased by 25 percent between 2000 and 2018[5], growing faster than emissions from passenger cars.

The conditions under which trucks operate (long distances, heavy loads, small profit margins and the need for rapid refuelling) create operational challenges in terms of decarbonising the sector. While battery-powered electric vehicles are making rapid inroads into the market for passenger cars, we do not believe that lithium-ion battery technology is currently viable for heavy-duty, long-haul trucks. This is because the size of battery required would unduly constrain payload size and battery-recharging times would create additional operational constraints.

Fuel-cell trucks already on the market offer operational performance comparable to diesel trucks in terms of daily range, refuelling time and payload capacity. Refuelling time, at between 10 and 15 minutes, is significantly faster than the time required to recharge batteries. Hydrogen fuel cells also benefit from energy efficiencies similar to those achieved by electric vehicles via electric propulsion. In chemical terms, the energy density of hydrogen is equal to 33.6kWh of usable energy per kilogram. This means that one kilogram of hydrogen, when used in a fuel cell to power an electric motor, produces energy approximately equivalent to that from a gallon of diesel.[6]

Emission reduction potential

Given the length of the investment cycle in trucks, approximately 10 percent of the heavy-duty trucking fleet is replaced each year. Replacing retired diesel trucks with fuel cell trucks offers an immediate decarbonisation solution that is deployable today. If hydrogen fuel cell trucks replaced 10 percent of the EU trucking fleet, it would enable the abatement of around 42 million tonnes of CO_2 per year (assuming annual CO_2 footprint of a diesel truck is approximately 68 metric tonnes CO_2e per year, and the size of EU trucking market is approximately 6.2 million trucks).[7]

Achieving market penetration of fuel cell trucks by 2030 will be a vital precursor to the phasing-out of diesel engines by 2050 and aligned with net zero targets. However, significant progress can only be achieved if policy-makers create a conducive economic, financial and regulatory ecosystem that supports all stakeholders in the hydrogen value chain: truck operators and logistics users, truck original equipment manufacturers (OEMs), technology providers and fuel and infrastructure providers.

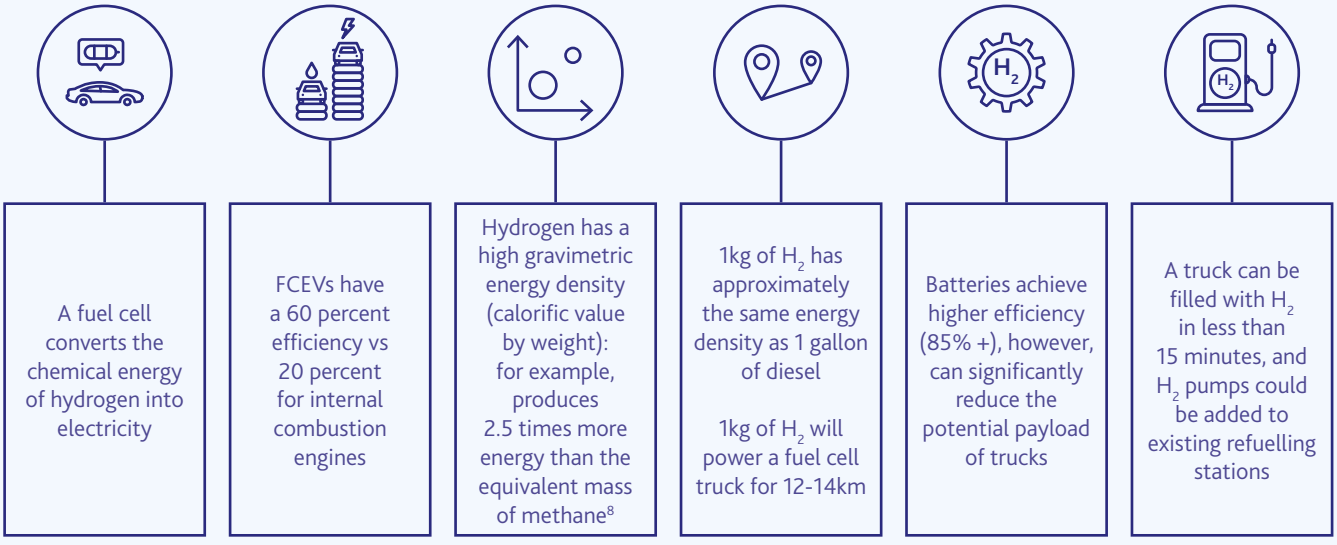
4 Source: Transport & Environment, *Road freight truck challenges*, https://www.transportenvironment.org/challenges/road-freight/trucks/

5 Sources: European Environmental Agency, European Automobile Manufacturers' Association and Transport & Environment.

6 Molloy, P. (October 2019), 'Run on Less with Hydrogen Fuel Cells', *Rocky Mountain Institute*.

7 Trafigura research (2021)

Advantages of hydrogen fuel cell vehicles (FCEVs) in decarbonising trucking

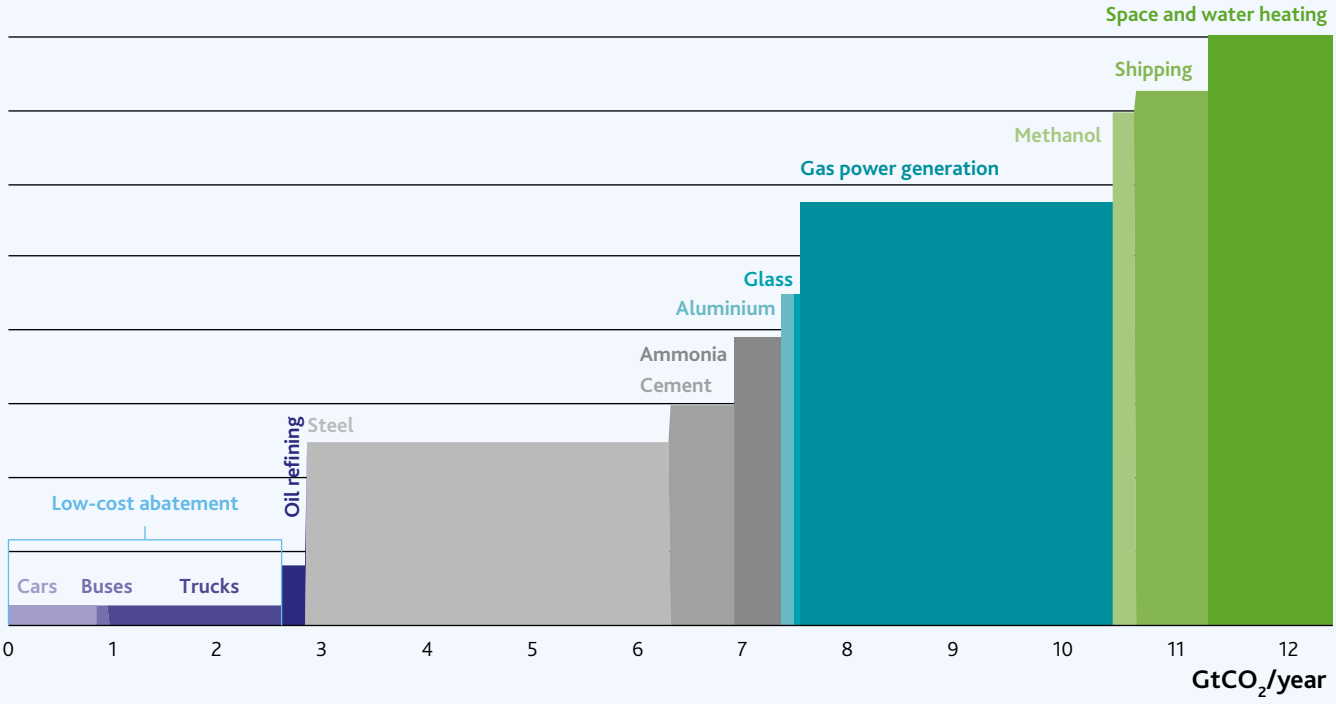


8 By contrast, it has a low-energy density by volume, which creates some challenges in storage and transportation.

Why trucking should be an early focus of the hydrogen rollout

Trucking is only one of many possible use cases for hydrogen. However, it makes economic sense to make trucking an early priority, because most market projections suggest trucking will be one of the first applications to be economic as hydrogen production costs decline. As economies of scale are reached in this sector, it will enable the use of low-carbon hydrogen across all sectors that need it to decarbonise. The 2020 Hydrogen Economy Outlook from Bloomberg shows that transport applications entail significantly lower marginal abatement costs than industrial applications.

3 Relative marginal abatement cost curve from using hydrogen for emission reductions, by sector



Source: Adapted from Bloomberg

Scaling the market for a low-carbon hydrogen trucking sector

The trucking market represents a significant source of potential demand for hydrogen, and an equally significant opportunity to reduce emissions by curbing consumption of fossil fuels. Bloomberg NEF estimates the global trucking market for diesel at 17 million barrels per day.[9] Trafigura calculates that if 10 percent of this diesel demand were replaced by hydrogen, it would translate into an addressable market for hydrogen of 32 million tonnes per year, equivalent to over one third of the existing 80 million tonne global market for hydrogen (See Figure 4).

Generating this level of demand would require the creation of a new industry at scale, with its own infrastructure of production, transmission and storage facilities. This is not simply a matter of scaling up existing production because today's market is dominated by carbon-intensive grey hydrogen.

Securing cleaner hydrogen means either fitting existing hydrogen production facilities with carbon capture and storage equipment to reduce emissions or investing in a substantial increase in renewable energy capacity and electrolysers to produce green hydrogen. Electrolysis requires significant power – typically more than 50kWh to produce one kilogram of hydrogen. However, it is not a nascent technology; industrial electrolysis has been used in other industries such as aluminium production for more than a century. Building out hydrogen ecosystems for trucking will also require the construction of pipelines, which constitute a relatively low-cost transportation option over limited distances, and specialised distribution infrastructure such as refuelling stations. As climate transition measures start to erode natural gas use in the coming years, some gas pipelines could be repurposed for hydrogen transmission.

9 Including vans and light, medium and heavy trucks, but excluding buses.

4 Global hydrogen market potential

Application	Total annual market size	Low-carbon H_2 equivalent demand (million tonnes)	Low-carbon H_2 demand with 10% penetration (million tonnes)
Pure hydrogen	80 million tonnes	80	8
Trucking diesel	6,205 million barrels*	316	31.6

* Value from BNEF (17 million barrels per day).

Government action is vital

Green and blue hydrogen have become the focus of unprecedented government plans and investments, with several European countries at the frontline of this development.

In July 2020, the European Commission published a strategic roadmap for the development of a green hydrogen economy. The strategy includes investment support, enabling regulatory frameworks, plans for large-scale infrastructure networks, and cooperation with third country partners[10] (See Figure 5). The EU is targeting 40GW of electrolyser capacity capable of producing up to 10 million metric tonnes of hydrogen within the bloc by 2030. Individual EU member states are responsible for devising and rolling out policies to enact the EU hydrogen strategy. Member states are at different levels of progress, but most have adopted some form of low-carbon hydrogen plans as part of their climate efforts.

Further measures were contained in the EU's "Fit for 55" package of policy proposals. The package contains plans to accelerate the build-out of alternative fuels infrastructure, including a target to deploy hydrogen refuelling stations for heavy- and light-duty vehicles at maximum intervals of 150km along European highways. The EU projections forecast that the share of hydrogen in Europe's energy mix to grow from its current level of less than two percent to between 13 and 14 percent by 2050. This could entail cumulative green hydrogen investments in Europe of anywhere between EUR180 and EUR470 billion by 2050, and in the range of EUR320 billion for blue hydrogen.[11] The EU expects each EUR1 billion invested in green hydrogen to create 10,570 new jobs, so building this industry at scale could create millions of jobs.

The main challenge demanding government intervention is reducing the cost of low-carbon hydrogen as the industry scales. Combining production costs with storage and distribution gives a total price for green hydrogen at the pump today of up to EUR10 per kilogram in Europe, which cannot compete with the price of diesel. However, the system cost of low-carbon hydrogen is coming down quickly. So has the cost of purchasing and constructing electrolysers, which has decreased by up to 50 percent in the last ten years and represents around 20 percent of the cost of producing green hydrogen.

10 European Commission (July 2020), *A hydrogen strategy for a climate-neutral Europe*, European Commission Communication, https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf

11 European Commission (July 2020), *A hydrogen strategy for a climate-neutral Europe*, European Commission Communication, https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf

5 The European Commission's 3-Phase Hydrogen Strategy

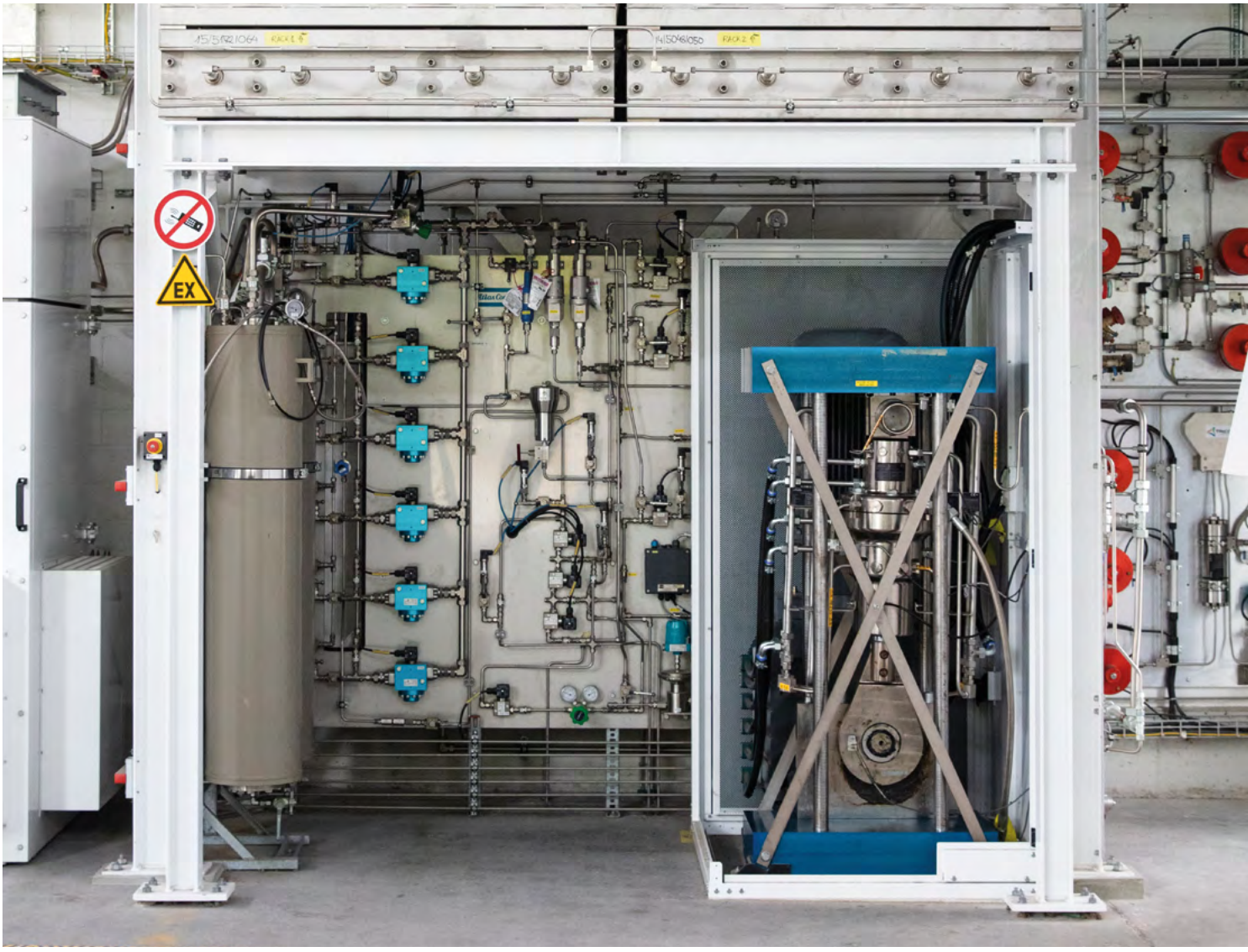
Today – 2024	2025 – 2030	2030 –
From now to 2024, we will support the **installation of at least 6GW of renewable hydrogen electrolysers in the EU**, and the production of **up to 1 million tonnes** of renewable hydrogen.	From 2025 to 2030, hydrogen needs to **become an intrinsic part of our integrated energy system**, with at least 40GW of renewable hydrogen electrolysers and the production of **up to 10 million tonnes** of renewable hydrogen in the EU.	From 2030 onwards, **renewable hydrogen will be deployed at a large scale** across all hard-to-decarbonise sectors.

Source: European Commission 2020

Currently the largest operational electrolyser is 10MW but projects of 50MW and above are expected to be commissioned in the next few years. Installed electrolyser capacity is set to double to 319MW by the end of 2022, according to Hydrogen Europe. Such economies of scale are likely to cause unit costs to halve by 2030, by which time green hydrogen in regions with cheap renewable energy, including many parts of Europe, should be able to compete with fossil fuel alternatives. The key is scaling demand as well as supply. Heavy-duty trucks could contribute significantly, provided costs of fuel cell trucks are also brought down rapidly. The European Commission strategy document identifies heavy-duty trucks as a "lead market" for hydrogen, as vehicle emission standards tighten and fuel cell technology matures.

As we aim to show later in this whitepaper, it is crucial that policy-makers consider all parts of the ecosystem from hydrogen fuel cell technology, the provision of renewable power, hydrogen storage, transportation and final distribution. The aim should be to find the most economically efficient solution for all parts.

What should not be in doubt, despite all the challenges, is that creating a functioning hydrogen trucking ecosystem is possible. Indeed, Europe already has one. In Switzerland, H2 Energy has created an ecosystem to produce green hydrogen and supply it to the Swiss trucking industry at a competitive cost. There are lessons to be learned from this effort and there is the potential to replicate it in other countries, which we will detail in the following chapters.



H2 Energy: Europe's first hydrogen trucking ecosystem

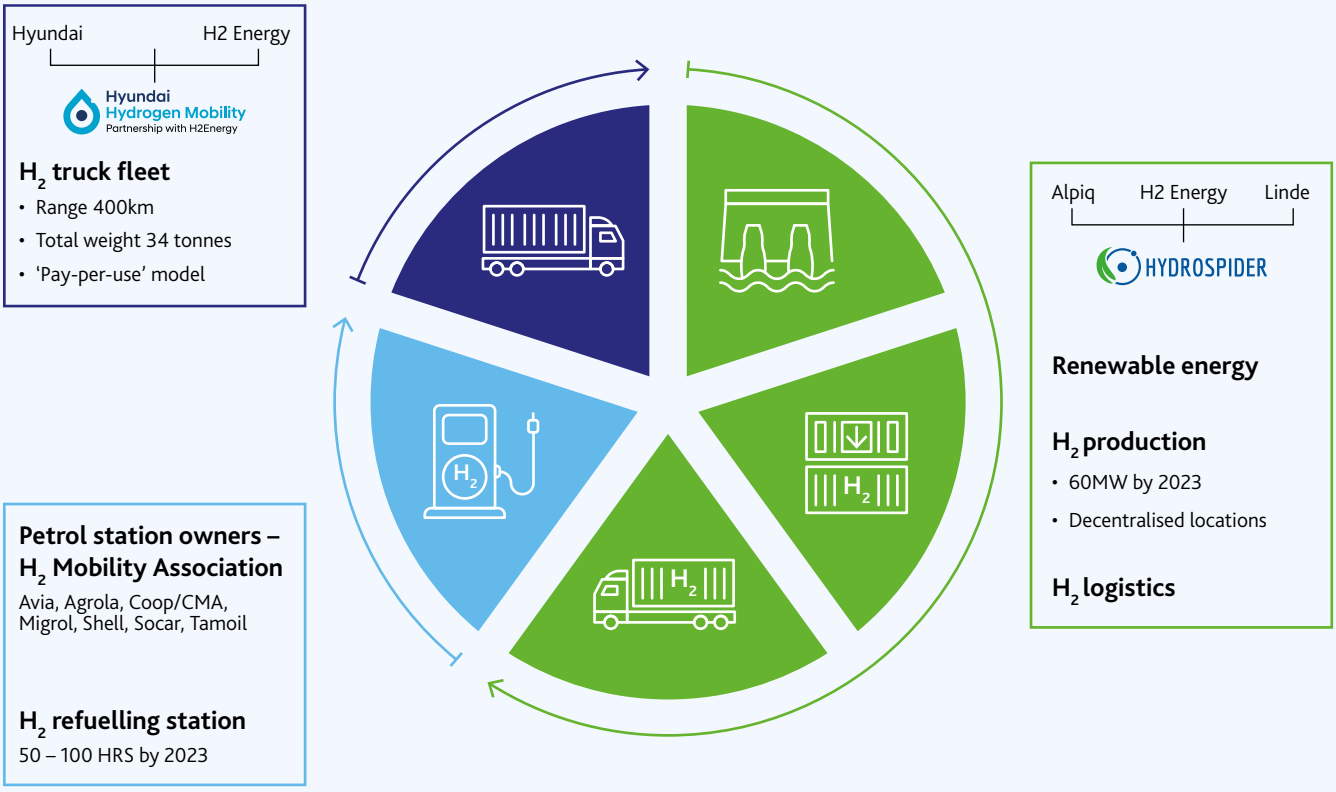
H2 Energy is a pioneer in making hydrogen-fuelled trucks a commercial reality. Founded in 2014 and based in Zurich, the company has worked with a range of partners to establish the first functioning green hydrogen ecosystem for heavy-duty vehicles in Europe.

Operating a unique pay-per-use business model, H2 Energy now has 46 hydrogen fuel cell trucks on the road with a wider roll-out across Switzerland planned by the end of this year. H2 Energy Europe, a joint venture with Trafigura, is working on plans to establish similar hydrogen ecosystems in other European countries.

The successful establishment of the initial Swiss operation provides useful lessons for those attempting to establish hydrogen-fuelled trucking elsewhere. In particular, it underlines the need for cooperation between many different players and the role of fiscal incentives in redressing early cost disparities between hydrogen and fossil fuels. In Switzerland, an exemption for zero-carbon trucks from the country's heavy-vehicle levy, known as LSVA, offsets this cost disparity. This is a tax originally introduced in 1998 aimed at reducing emissions from heavy-duty trucks traversing the Alps.

The fuel-cell truck fleet is supplied by Hyundai Hydrogen Mobility, a joint venture between H2 Energy and truck manufacturer Hyundai, the world's first serial producer of heavy-duty trucks powered by hydrogen. Hydrospider, another joint venture involving H2 Energy and Swiss energy company Alpiq and industrial gas company Linde, operates electrolysers to produce green hydrogen powered by renewable electricity (hydropower) and provides specialised containers to transport and store gaseous hydrogen. A coalition of seven Swiss service-station owners and 14 logistics companies have agreed to establish hydrogen refuelling stations at up to 100 existing petrol station sites across the country, covering three-quarters of the Swiss market, by 2023.

6 Ecosystem sets the stage for commercial roll-out of heavy-duty trucks

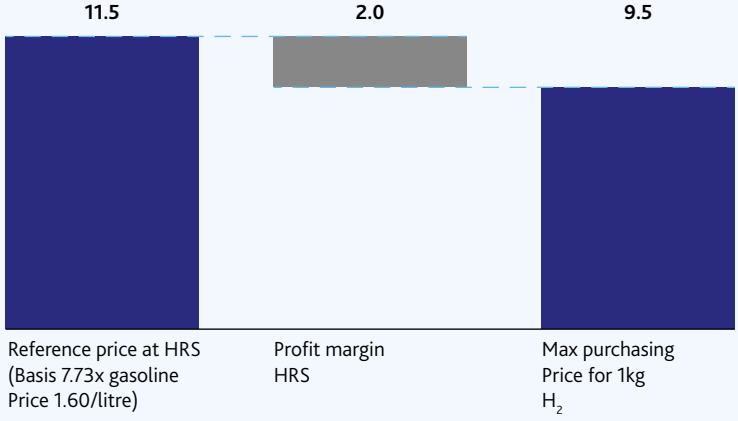


Source: H2 Energy

This close cooperation has helped to ensure the establishment of consistent technical and safety standards and to create a commercially viable and scalable system. A critical component of this ecosystem is the contractual arrangements between these various parties that establish prices and profit margins. The selling price for hydrogen at the pump to the truck operators is indexed to the gasoline price at a fixed ratio of 7.73. This enables the operation of the fuel cell trucks at cost parity to diesel trucks while providing fixed profit margins for all stakeholders in the ecosystem, giving them the confidence to invest. Figures 7 and 8 below illustrate how these economic incentives work for producers and filling station operators.

7 Economic incentive for HRS operators

Financial planning from an HRS view
in CHF per kg, no VAT



Operating costs
in CHF per kg, no VAT

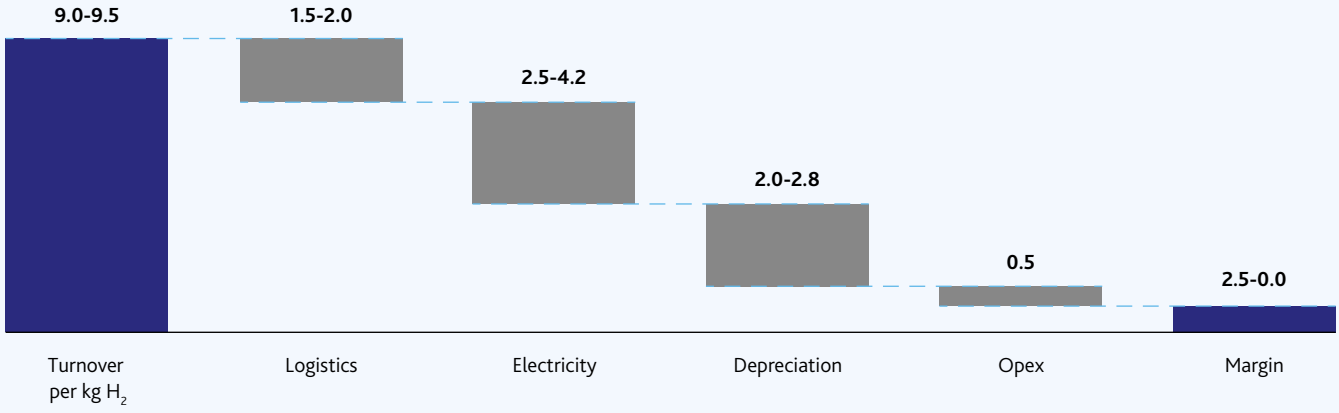
Depreciation	130,000
Service/admin	20,000
Electricity	15,000
Space	25,000
Total	**190,000**

CHF190,000 / 2.0 = 95 tonnes
Equates to break-even @
~ 15 H_2 heavy-duty trucks
~ 750 H_2 passenger cars

Source: H2 Energy

8 Commercial incentives for H_2 producers

Financial planning H_2 provider
in CHF per kg hydrogen (USD/CHF: 0.93)



Source: H2 Energy

The pay-per-use model established by H2 Energy enables these pricing relationships to be maintained in a holistic fashion and the hydrogen ecosystem to be constantly optimised. It operates similarly to leasing. Various factors including the size of a company's truck fleet, the average annual range per truck and service levels required are used to calculate the estimated support cost for a client, which is then translated to a flat fee rate per kilometre, covering truck use, maintenance, financing, insurance and fuel: in other words, all aspects apart from the truck driver.

This model, with its guaranteed relationship between the cost of hydrogen and the cost of diesel, helps overcome the problem that would otherwise deter fleet operators from investing in hydrogen trucks, which in terms of capital outlay currently cost four to five times the price of equivalent diesel vehicles.

H2 Energy's operation to date underlines the role trucking can play in the establishment of a wider hydrogen economy. Since a truck uses on average 30 to 50 times more hydrogen than a passenger car per day, using hydrogen in heavy-duty trucking creates demand for hydrogen that can rapidly expand. This helps to optimise use of the necessary infrastructure and to resolve the chicken-and-egg problem that tends to arise when it comes to stimulating investment in hydrogen infrastructure.

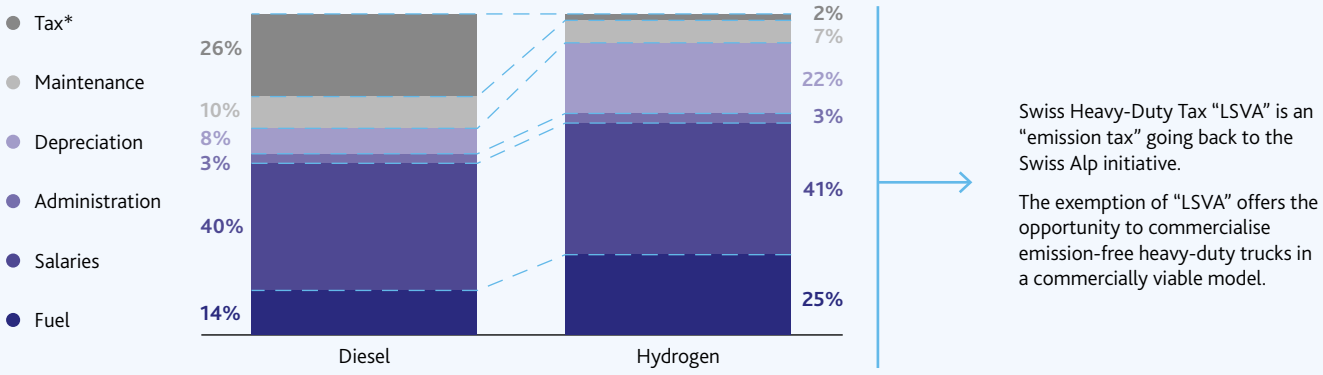
The final success factor for H2 Energy is the exemption of its trucks from the Swiss heavy vehicle levy. This is important because without it, hydrogen fuel-cell vehicles could not be cost-competitive with diesel-powered trucks. In effect, the tax differential created by the levy exemption levels the playing field between hydrogen and diesel. Figure 9 below illustrates how this works.

The levy exemption, plentiful hydropower and modest territorial size are among the unique factors that have made Switzerland an ideal country to establish a hydrogen-trucking ecosystem. In addition, it has enabled the trucks to be trialled on rigorous Swiss roads, which are steep and experience large temperature fluctuations. Countries contemplating hydrogen-trucking will need to consider how to make the most of their resources such as existing renewable power capacity, and what measures – whether tax incentives, subsidies or performance standards – they could take to establish cost competitiveness with diesel.

As H2 Energy demonstrates, once such a system has been established, it can be scaled relatively quickly. This creates significant environmental benefits and contributes to the global goal of reducing greenhouse gas emissions. The advent of hydrogen-fuelled trucks in Switzerland has generated considerable enthusiasm among fleet operators and consumers and has encouraged an increasing number of Swiss companies to make accelerated commitments to zero-carbon trucking operations.

9 LSVA exemption enables cost parity to diesel

100% approx. CHF250,000



* Includes insurance and financing costs, Swiss Heavy-Duty Tax "LSVA" for Euro 6 trucks (2.28 Rp./tkm; i.e., CHF0.91 per km for a 40-tonne vehicle)

Source: H2 Energy

Next stop: Denmark

With its ambitious target of a 70 percent reduction in emissions by 2030 and plentiful renewable power, Denmark is the next target market for H2 Energy Europe. The country has already decarbonised its power sector, with offshore wind generation already exceeding the needs of the national electricity grid. Using this surplus power to produce green hydrogen will enable Denmark to decarbonise hard-to-abate sectors such as industry and heavy-duty transport.

The domestic construction of electrolysers also enables more efficient use of wind power by ramping production up and down with the availability of wind. Denmark has recognised these benefits by investing in a series of power-to-X projects involving the development of renewable energy storage and conversion technologies.

In August 2021, H2 Energy purchased an 11-hectare site near the port of Esbjerg, where it plans to build Europe's largest power-to-X project, a 1GW electrolyser capable of producing up to 90,000 tonnes of green hydrogen per year, sufficient to fuel up to 15,000 trucks.

H2 Energy Europe's plan comes in two parts, firstly an immediate focus on small-scale green hydrogen production by the end of 2022 so that the first hydrogen-fuelled trucks can be in operation on the Danish roads. Secondly, construction of the 1GW plant, which could be commissioned by as early as 2024, with timings dependent on receiving government support along with permits and approvals.

Policy insights from Germany, the Netherlands and the United Kingdom

This chapter provides a summary of policies in three European countries that have made low-carbon hydrogen a priority: Germany, the Netherlands and the United Kingdom. Policies and projects in these countries can offer insights to policy makers and other stakeholders on how to accelerate the growth of this market.

Developing a successful market for hydrogen powered heavy-duty transport will require strong policy support that enables infrastructure build out. Heavy-duty transport is both an inter- and an intra-country operation and therefore integrated policy frameworks for cross-border development are crucial.

Germany

In June 2020, Germany's Ministry for Economic Affairs and Energy published its National Hydrogen Strategy.[12] The strategy announced EUR7 billion of funding, plans for tax and fee reductions to support hydrogen production, and a 5GW electrolyser capacity target for 2030, instilling confidence in the sector.

The government of Germany recently legislated to exempt electricity for hydrogen production from the Renewable Energy Sources Act surcharge.[13] This exemption reduces the electricity prices applied to green hydrogen production, thereby reducing the levelised cost of hydrogen.

To establish a refuelling network for heavy-duty vehicles, Germany has committed EUR3.4 billion under the energy and climate fund (available until 2023) for charging and refuelling stations for all alternative propulsion technologies, which includes hydrogen refuelling stations. Germany has also successfully transposed the Renewable Energy Directive Recast (RED II) into German law. RED II is an EU-level policy that mandates member states to have 14 percent of total energy used in the transportation sector coming from renewable sources. German policy has exceeded minimum requirements set by RED II, and has mandated that fuel suppliers must reach 25 percent greenhouse gas reduction in the fuels they place on the market by 2030.

To support the purchase and operation of fuel cell trucks, the Ministry of Economic Affairs and Energy has announced funding for up to 80 percent of the cost difference between low emissions and diesel commercial vehicles, with up to EUR1.6 billion available until 2024 across new energy vehicles.[14] This helps to lessen the financial impact of switching to hydrogen trucks, making them a more attractive option to fleet operators.

At present, there are around 90 hydrogen refuelling stations in Germany. Although this is a significant number, most can only serve light duty vehicles, with just six offering 350 bar refuelling for buses and trucks. However, there are plans to develop existing hydrogen refuelling stations to support heavy-duty vehicle compatibility through the H_2Mobility SENECA project.[15] The project includes the development of a 700 bar and 350 bar hydrogen refueling station network along the main transport routes, which will ensure the refueling of trucks and buses with a range of 500km.

CapEx support across the value chain combined with a large market size makes Germany a leading example of the development of a hydrogen economy for the transport sector.

12 Federal Ministry for Economic Affairs and Energy (June 2020) *The National Hydrogen Strategy*. Federal Ministry for Economic Affairs and Energy strategy document, *https://www.bmwi.de/Redaktion/EN/Publikationen/Energie/the-national-hydrogen-strategy.html*

13 Federal Ministry for Economic Affairs and Energy (May 2021) *Kabinett beschliesst grobes Verordnungspaket zur Umsetzung des EEG 2021 – Starkes Signal für Markthochlauf von Wasserstoff*. Federal Ministry for Economic Affairs and Energy press release, *https://www.bmwi.de/Redaktion/DE/Pressemitteilungen/2021/05/20210519-Kabinett-beschliesst-grosses-Verordnungspaket-zur-Umsetzung-des-EEG-2021.html*

14 Federal Ministry of Transport and Digital Infrastructure (October 2021) *Förderung von Fahrzeugen verkehrsträgerübergreifend* Federal Ministry of Transport and Digital Infrastructure news article, *https://www.bmvi.de/SharedDocs/DE/Artikel/G/Alternative-Kraftstoffe/foerderung-von-fahrzeugen.html*

15 H_2 Mobility (May 2021) *H_2 Mobility strategy for H_2 commercial vehicle selected by BMVI*. H_2 Mobility press release, *https://h2.live/en/press/h2-mobility-strategy-for-h2-commercial-vehicle-selected-by-bmvi/*

The Netherlands

The government of the Netherlands set targets for hydrogen in its National Climate Agreement published in June 2019.[16] The Agreement includes specific targets in the mobility sector for 15,000 fuel cell cars, 3,000 fuel cell heavy-goods vehicles and 50 hydrogen refuelling stations by 2025. The government then published its National Hydrogen Strategy[17] in April 2020, highlighting the importance of hydrogen for Dutch decarbonisation. The document sets out a number of targets including 500MW installed electrolysis capacity by 2025, increasing to 4GW by 2030. The government has also adopted RED II, which is scheduled for implementation in January 2022.

To promote hydrogen use in the transportation sector, the Dutch Emissions Authority plans to extend its existing HBE (renewable energy units) obligation to include low-carbon hydrogen as a renewable fuel under the scheme. One HBE represents one gigajoule of renewable energy that is delivered to the Dutch transport market. Companies within the Dutch Energy for Transport compliance system are subject to a minimal annual HBE obligation. Once implemented, hydrogen delivered to the transport sector in the Netherlands will earn an HBE 'credit', in effect serving as a Euro per kilogram subsidy on hydrogen.[18]

The government has also extended its Renewable Energy Transition Incentive Scheme to cover the replacement of grey hydrogen production with low-carbon hydrogen. The scheme provides a "carbon contract for difference", whereby recipients are paid per tonne of carbon mitigated with the agreed price per tonne variable according to technology costs. Companies can receive up to EUR300 per tonne CO_2 avoided, for a maximum of 2,000 electrolyser load hours per year, equating to around EUR2.60 per kilogram of hydrogen.

To support the purchase and operation of fuel cell trucks, the Dutch Government has pledged to establish heavy-transport subsidy schemes, which will be developed under the framework of the National Climate Agreement.

Some of Europe's most ambitious hydrogen production projects are underway in the Netherlands (a total of 4.8GW capacity is planned), with off-takers for mobility being targeted. The government and the industrial sector are directly collaborating with the aim of mapping out and delivering key hydrogen projects. This is being done through the H_2Platform and the Northern Netherlands Hydrogen Investment Plan[19], which lays out an ambitious plan to bring in a total of EUR9 billion of investment to help build out the full hydrogen value chain through to 2030.

CapEx support along with a subsidy for delivered hydrogen will accelerate the uptake of hydrogen in the Dutch transportation sector.

16 Government of the Netherlands *Climate Agreement*. Government of the Netherlands strategy document, https://www.government.nl/documents/reports/2019/06/28/climate-agreement

17 Government of the Netherlands *Government Strategy of Hydrogen*. Government of the Netherlands strategy document, https://www.government.nl/documents/publications/2020/04/06/government-strategy-on-hydrogen

18 Dutch Emissions Authority *Feedstocks and double-counting*. Dutch Emissions Authority web page, https://www.emissionsauthority.nl/topics/claiming-deliveries---energy-for-transport/feedstocks-and-double-counting

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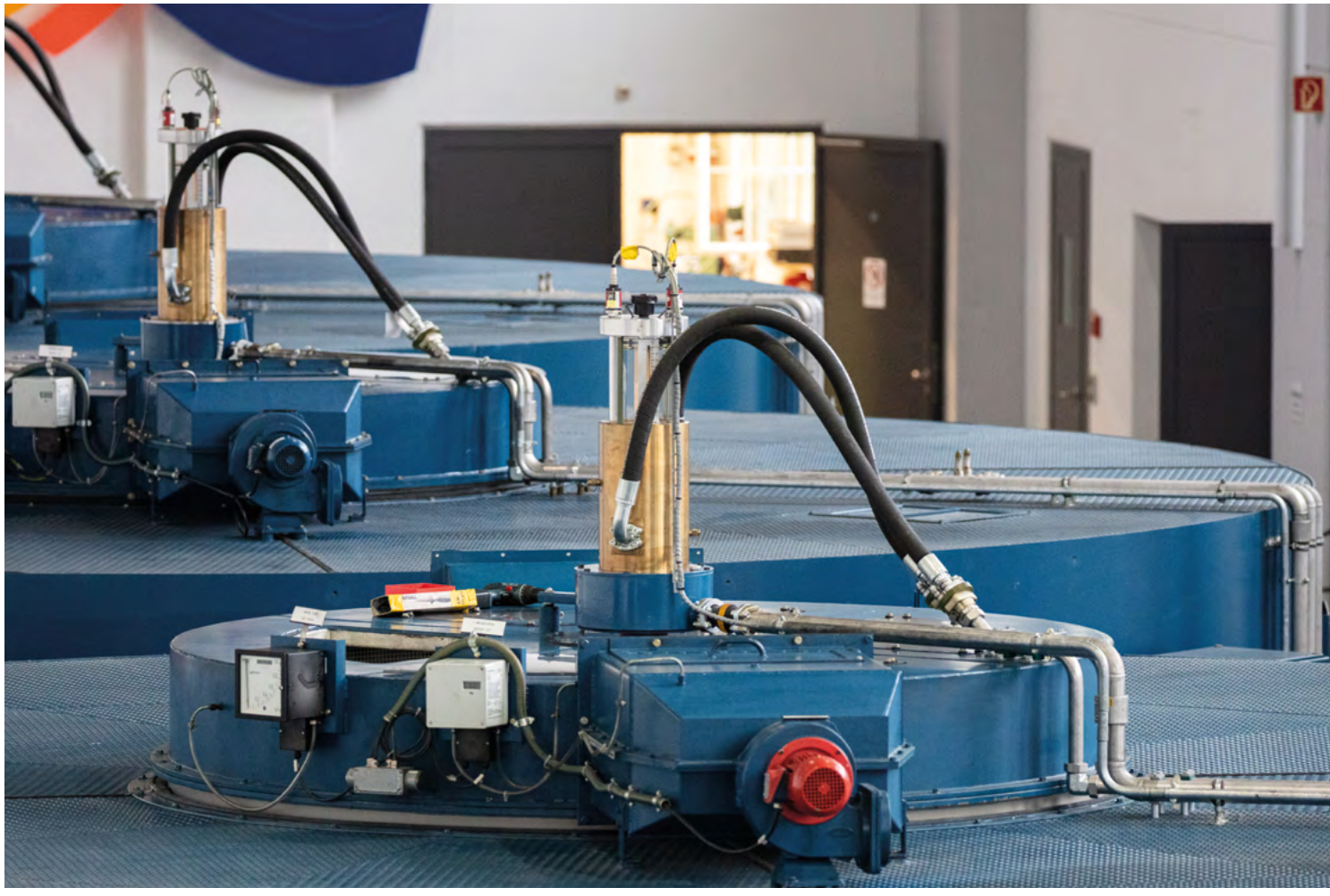
United Kingdom

In August 2021, the government of the United Kingdom published its National Hydrogen Strategy[20], reiterating its headline ambition to achieve 5GW of low-carbon hydrogen production capacity by 2030.

In 2020, the government announced its Ten Point Plan, which committed new funding and policies to meet broad decarbonisation goals. Support for hydrogen included GBP240 million for government co-investment in hydrogen production capacity through the Net Zero Hydrogen Fund, a hydrogen business model to bring through private sector investment, and plans for a revenue mechanism to provide funding for the business model. The Ten Point Plan designated hydrogen as a key priority area in the Net Zero Innovation Portfolio, a GBP1 billion fund to accelerate commercialisation of low-carbon technologies and systems for net zero.

The Renewable Transport Fuel Obligation (RTFO) is the government's key measure for incentivising the use of renewable fuels in transport. RTFO has been in operation since 2008, and has been adapted over time to boost carbon savings, reinforce sustainability standards and align the scheme with wider international standards. In recent years, this has included improved support for hydrogen and other renewable fuels of non-biological origin. Under RTFO, suppliers of transport fuel in the UK must be able to show that a percentage of the fuel they supply comes from renewable and sustainable sources. Green hydrogen is classified as a "development fuel" under the scheme, and when supplied to the domestic transport sector earns a development renewable transport fuel credit.

The support provided by RTFO for hydrogen delivered to the transport sector provides a strong incentive for fuel suppliers and transport operators to supply and use hydrogen.



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Creating a hydrogen trucking ecosystem

In this concluding chapter, we set out policy considerations for governments looking to build out a low-carbon hydrogen ecosystem, with a focus on green hydrogen.

According to the IEA, governments need to move fast and act decisively on a wide range of low-carbon hydrogen policy measures to facilitate uptake and enable decarbonisation.

The relatively low break-even point for heavy-duty transport applications means that use in trucking offers a route to rapidly scaling low-carbon hydrogen demand at a reasonable cost. Several European countries have recognised that direct intervention is required to form a hydrogen trucking ecosystem that can compete with, and ultimately supersede, diesel. Below, we outline the types of intervention that can help. The list is not exhaustive and the precise mix of policies will vary from country to country, depending on existing fiscal arrangements.

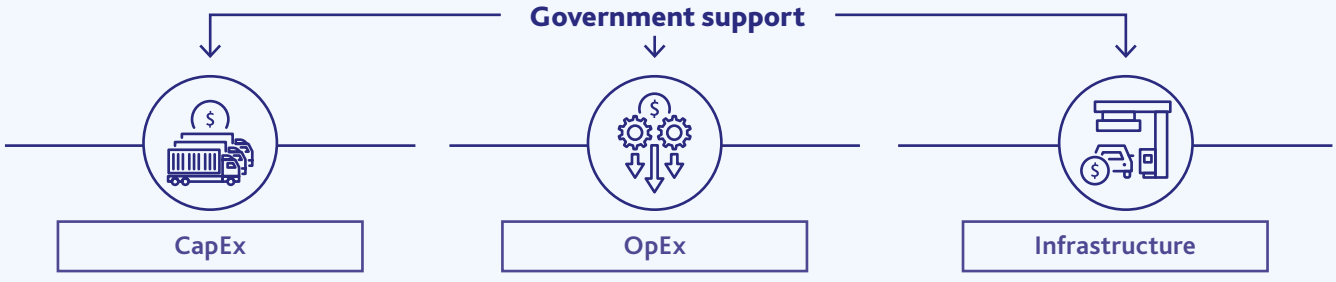
CapEx support for fuel cell trucks and electrolysers is required to lower the initial financial barrier to entry, but is not sufficient to bridge the gap between delivered green hydrogen and diesel. This is because CapEx depreciation only accounts for 20 to 40 percent of the cost of hydrogen, with the remaining 60 to 80 percent resulting from operational costs due to high power consumption. As a result, an ongoing Euro per kilogram of delivered hydrogen subsidy is needed.

The reduction of renewable power costs via grid connection fee exemptions, and grid tariffs that reward the flexibility electrolysers can provide to the grid, are ways to bring down power costs, which is the major cost component of producing green hydrogen. In addition, CapEx support for hydrogen distribution infrastructure is necessary for developing hydrogen ecosystems at scale that are able to benefit from lower logistics-related costs, such as pipeline transport. While pipelines and hydrogen refuelling stations present a significant upfront cost, once established, they will reduce operational and levelised long-term costs dramatically.

Standardised cross-border certification of green, blue and low-carbon hydrogen would allow for the optimisation of trade flows. If hydrogen production meets the criteria to be certified as "green" or "low-carbon" hydrogen, this certification could be traded separately to the physical hydrogen product. Similar to how guarantee of origins function for renewable power, low-carbon hydrogen certificates could allow for wider distribution, bypassing potential logistical bottlenecks. On a national level, clarification on additionality and the use of guarantees of origin to certify renewable power and therefore green hydrogen are required. Finally, safe-handling guidelines, such as standards for transporting hydrogen in tunnels and across bridges, are needed to prevent distribution roadblocks and remove any ambiguity from a hydrogen safety perspective.

Support for participants across the value chain can and should be incrementally reduced as economies of scale are reached, leaving in its place an economic, self-sufficient, very low-emission heavy-duty trucking sector. We expect this will act as a catalyst for the use of hydrogen across all other hard-to-abate sectors and accelerate global decarbonisation efforts, which is the priority above all.

Key support policies that we have identified:



1. Fuel cell truck purchase subsidies

1a. Diesel truck scrapping subsidies

2. Support for the purchase and construction of electrolysers

3. Subsidies on a Euro per kilogram basis for delivered hydrogen

4. Access to renewable power exempt from grid connection fees

5. Support for the creation of infrastructure including pipelines and hydrogen refuelling stations

6. Cross-border low-carbon hydrogen certification

7. Clarity on additionality requirements in relation to green hydrogen production

8. Appropriate standards for the safe handling and use of hydrogen

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TK/0384.2e
Last updated: March 2022

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