CLEAN ENERGY MINISTERIAL
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HYDROGEN INITIATIVE
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Global hydrogen targets

International Energy Agency

IEA

Abstract

This report summarises the main findings of the research and consultation on government hydrogen targets carried out by the IEA. This effort is one of the activities of the Clean Energy Ministerial Hydrogen Initiative working group on Global Aspirational Goals for hydrogen. Close to 70 national governments and the European Union were consulted about the adoption of hydrogen-specific goals. Nineteen countries (and the European Commission) confirmed the adoption of hydrogen goals, across the whole value chain, at national level. This consultation was complemented with additional desk research of IEA analysts.

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Overview

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The CEM Hydrogen Initiative

The Clean Energy Ministerial (CEM) launched its Hydrogen Initiative (H2I) in May 2019. The H2I is a collaborative multi-government initiative that aims to advance policies, programs and projects that accelerate the commercialization and deployment of hydrogen and fuel cell technologies across all aspects of the economy.

The H2I currently comprises the following participating governments: Australia, Austria, Brazil, Canada, Chile, the People's Republic of China (hereafter China), Costa Rica, the European Commission, Finland, Germany, India, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, the Republic of Korea (hereafter Korea), the Russian Federation, Saudi Arabia, South Africa, the United Arab Emirates, the United Kingdom and the United States. The initiative is co-led by Canada, the European Commission, Japan, the Netherlands and the United States, while China and Italy are observers.

The Initiative intends to:

- Build strategic partnerships to develop and facilitate global actions on clean hydrogen and fuel cell related deployment across regional, national, and municipal economies;
- Encourage global deployment, and empirical analysis to advance the understanding of clean hydrogen and fuel cell technology markets, and provide an evidence-base for policy and program development;
- Facilitate and inform the development of policies and programs to enable global supply chains for clean hydrogen, based on real-world actions;
- Inform decision-making in governments through peer-to-peer dialogues on infrastructure deployment, policy, program and project implementation;
- Encourage the sharing and adoption of approaches that enable clean hydrogen to play a role in the global energy and transportation systems;
- Build new analytical resources that support clean hydrogen and fuel cell deployment across countries;
- Engage hydrogen and fuel cell stakeholders and others (e.g., related to infrastructure, renewable fuels, etc.) through consultations and peer-to-peer discussions.

The Global Aspirational Goals working group

The European Commission, with support from the IEA, is leading the work undertaken in the Global Aspirational Goals working group, as part of the work programme agreed by the members of the H2I. The objective of this working group is to track, over time and by sector, all country goals and targets, as well as benchmarking achievements against the goals and targets, and to support the integration of hydrogen in long-term plans. The findings of this working group will be used to inform about these national targets and their progress over time, with the intention to facilitate their achievement. This briefing presents a summary of the working group's findings in 2021.

Government hydrogen targets

Governments have adopted targets across the entire hydrogen supply chain

The data presented in this briefing has been collected by the IEA in 2021 through a survey jointly developed with officials from the European Commission, and completed with additional desk research and information exchanged with government officials.

The findings of this research effort show that governments have adopted hydrogen targets across the whole hydrogen supply chain, spanning the deployment of low-carbon hydrogen production technologies to various end use applications. According to the findings of this research, targets have been divided in four categories:

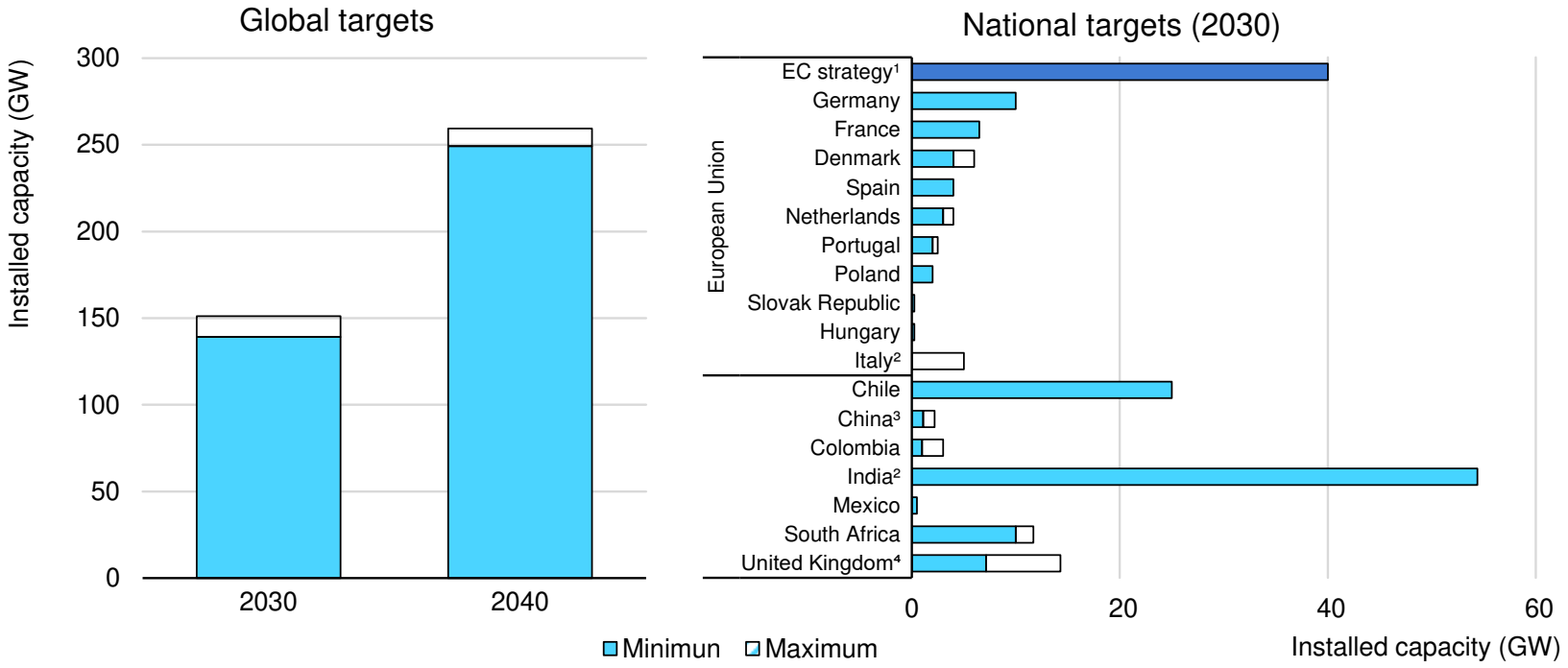
- Targets for hydrogen production: includes targets adopted by governments for the deployment of technologies for the production of low-carbon hydrogen (electrolysis and fossil fuels with carbon capture and use or storage).
- Targets for hydrogen use in industry: includes targets that the government have announced for the use of low-carbon hydrogen in industrial applications.
- Targets for hydrogen use in transport: includes targets for the deployment of fuel cell electric vehicles (FCEVs) as well as targets for the use of hydrogen or hydrogen-derived fuels in across various transport modes (e.g., aviation applications). Targets for the deployment of hydrogen refuelling stations have also been included in this section.
- Other targets: this category groups targets from applications for which targets have not been widely adopted by governments (including for domestic heating, blending into gas networks or for power generation) as well as other targets that do not fit in the previous categories, such final energy consumption met with hydrogen.

Regarding the time horizon for the adoption of targets, most governments have defined targets for the next decade, although some strategies and national plans have considered longer timeframes, even 2050 in certain cases. This document summarises the targets announced until 2040.

Targets for hydrogen production

Governments targets for electrolysis capacity deployment account for 140-150 GW by 2030

Global and national targets for installed electrolysis capacity, 2030-2040

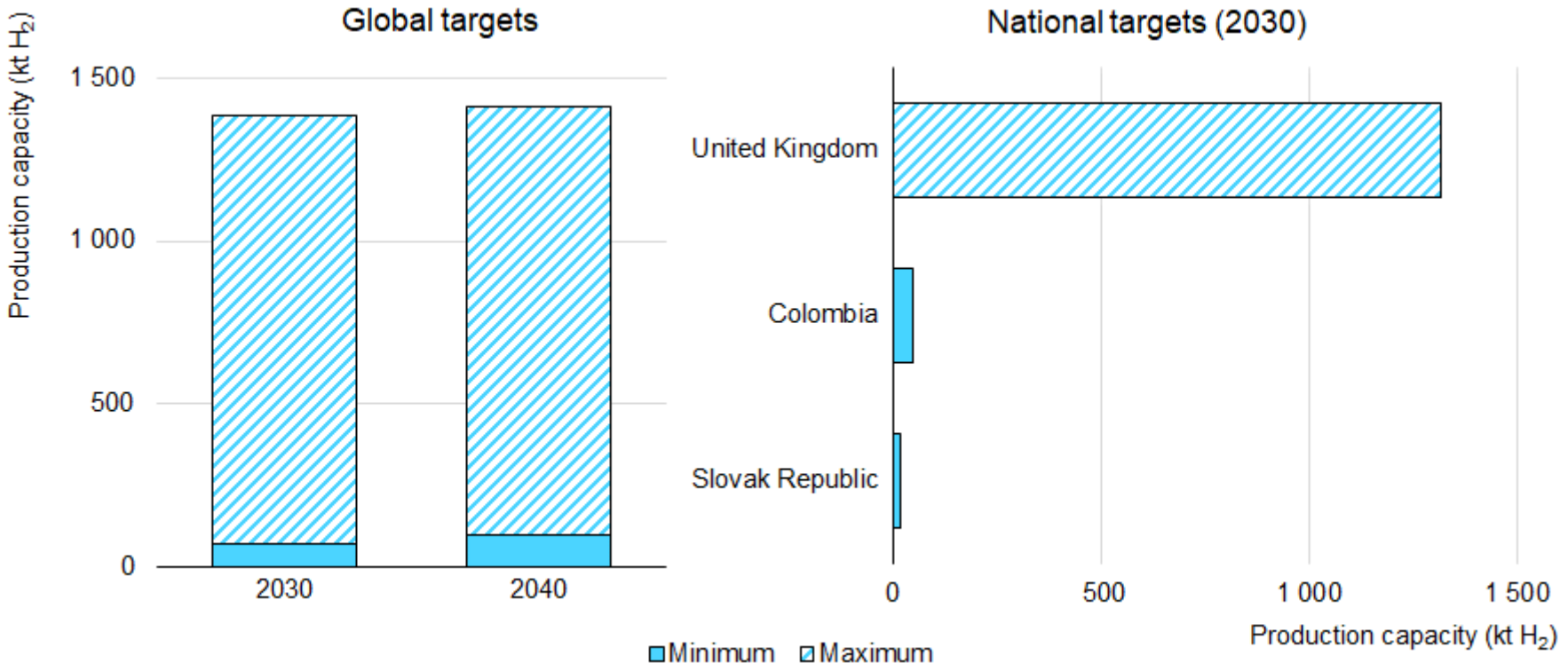


Notes: GW = gigawatts; EC = European Commission. Solid columns represent the lowest targets announced by the countries. Hatched columns represent the highest targets announced by the countries. [1] The EC strategy target is not additional to the EU country-level targets; combined, country-level targets should meet, or even exceed, the EC strategy target. [2] The draft of the Italian Hydrogen Strategy is under consultation and includes a proposal for a target of 5 GW of electrolysis capacity by 2030, but this is still provisional. [3] China and India have targets for renewable hydrogen production (100-200 kt by 2025 and 5 Mt by 2030 respectively), not for electrolysis capacity; the values in the graphs have been estimated assuming a 50% load factor and 70% efficiency. [4] The United Kingdom has a target of low-carbon hydrogen production of 10 GW, with at least 5 GW being electrolysis-based, by 2030; the values in the graph have been estimated assuming 70% efficiency.

Source: IEA analysis based on CEM H2I surveys and consultation with government officials.

Few countries have targets for hydrogen production from fossil fuels with CCUS

Global and national targets for the production of low-carbon hydrogen using fossil fuels with CCUS, 2030-2040



Notes: CCUS = carbon capture, utilisation and storage. Solid columns represent the lowest targets announced by countries. Hatched columns represent the highest targets announced by countries. For the United Kingdom, 5 GW of low-carbon hydrogen production by 2030 has been included in the hatched columns, as the UK target of 10 GW of low-carbon hydrogen production specifies at least 5 GW being electrolysis-based.

Source: IEA analysis based on CEM H2I surveys and consultation with government officials.

Deployment of technologies for the production of low-carbon hydrogen has featured strongly in government strategies and long-term plans for hydrogen

A wide range of low-carbon hydrogen production technologies are mentioned across various policy documents, with electrolysis being the dominant technology featured in targets. Seventeen national governments and the European Union adopted targets for deploying electrolysis capacity by 2030. These targets account for 140-150 GW[1] of capacity by 2030, mainly coming from the announcements by India (54 GW of estimated capacity), the European Union (40 GW[2]) and Chile (25 GW). In addition, Japan announced a target to use 420 kt of renewable hydrogen by 2030. However, Japan's target could be met through either domestic production or imports, so the targets has not been included in the analysis on electrolyser capacity. While practically all of announced targets have a 2030 horizon, Chile and the Slovak Republic have targets for 2040 and Portugal has objectives up to 2050.

In the European Union, many countries have adopted national targets, accounting for 70-75%[3] of the EU Hydrogen Strategy target. Moreover, as part of its REPowerEU package, presented in March 2022 as a a plan to make Europe independent from Russian fossil fuels before 2030, the European Commission announced the aim of domestically producing an additional 5 Mt of renewable hydrogen.

The deployment of hydrogen production capacities using fossil fuels with CCUS has received less attention. Only two countries have explicit targets. Colombia targets of 50 kt of hydrogen from fossil fuels with CCUS by 2030, and the Slovak Republic has an ambition to produce 20 kt by 2030 and 50 kt by 2040.

Canada and the United Kingdom have followed a different approach without chosing technology specific targets. The UK target is to deploy 10 GW of low-carbon hydrogen production capacity (with at least 5 GW based on electrolysis) by 2030, supporting both the production of hydrogen from electrolysis and fossil fuels with CCUS. In the case of Canada, the strategy envisions an increase of total hydrogen production (to 4 Mt by 2030) combined with a simultaneous decrease in the carbon intensity of the hydrogen produced (less than 36.4 g CO_{2e}/MJ by 2025), without disinguishing between different production routes.

[1] The lower value includes the minimum targets of China, Colombia and South Africa and only 7.1 GW for the United Kingdom (5 GW of production capacity assuming 70% efficiency). The upper value includes the maximum targets of China, Colombia and South Africa and that the UK target of 10 GW of low-carbon hydrogen production is met only with electrolysis (assuming 70% efficiency).

[2] The EU H_2 Alliance, a public-private partnership that has identified a pipeline of projects in the European Union, announced that more than 50 GW of electrolysis could be deployed by 2030, with 85% being renewable based. The 40 GW do not reflect the new REPowerEU targets.

[3] Including the provisional target of 5 GW of electrolysis capacity by 2030 of the Italian Hydrogen Strategy would increase this value to 83-86%.

Finally, several governments mentioned in their strategies and policy papers cost targets for low-carbon hydrogen by 2030, ranging from USD 1/kg (United States) to USD 3/kg (Japan). Noteably, the United States launched the Hydrogen Earthshot in June 2021, seeking to reduce the cost of low-carbon hydrogen to USD 1/kg by 2030.

Targets for hydrogen use in industry

Few countries have targets for the use of low-carbon hydrogen in industry

Today, industry is the main consumer of hydrogen (over 50 Mt in 2020). This is recognised in all strategies and national plans, which put the focus on decarbonising current hydrogen demand in industry, as well as the emerging role of low-carbon hydrogen in reducing CO_2 emissions from heavy industry.

However, this focus has not been widely backed by the adoption of specific targets for the use of low-carbon hydrogen in industrial processes. Only five governments have defined such targets. Three countries (Colombia, France and Spain) have defined targets for low-carbon hydrogen to meet between 20 and 40% of their industrial hydrogen demand by the end of this decade. Alternatively, Hungary has defined specific amounts of low-carbon and zero-carbon hydrogen to be used in industrial processes. Portugal defined targets for the share of renewable hydrogen for ammonia production, aiming to reach 100% renewable hydrogen between 2030 and 2040. In addition, Portugal also defined targets related to the share of hydrogen in final energy consumption in transformation and extraction industries.

In addition to these targets already adopted, in July 2021 the European Commission released a proposed revision of the Renewable Energy Directive (RED) which includes a binding target on industry to have 50% of all hydrogen from renewable origin by 2030 in EU Member States. If this revision is approved, the EU countries that have already approved targets below that threshold may need to revise their targets. Finally, Norway also has the goal of developing one or two industrial projects with associated low-carbon hydrogen production units.

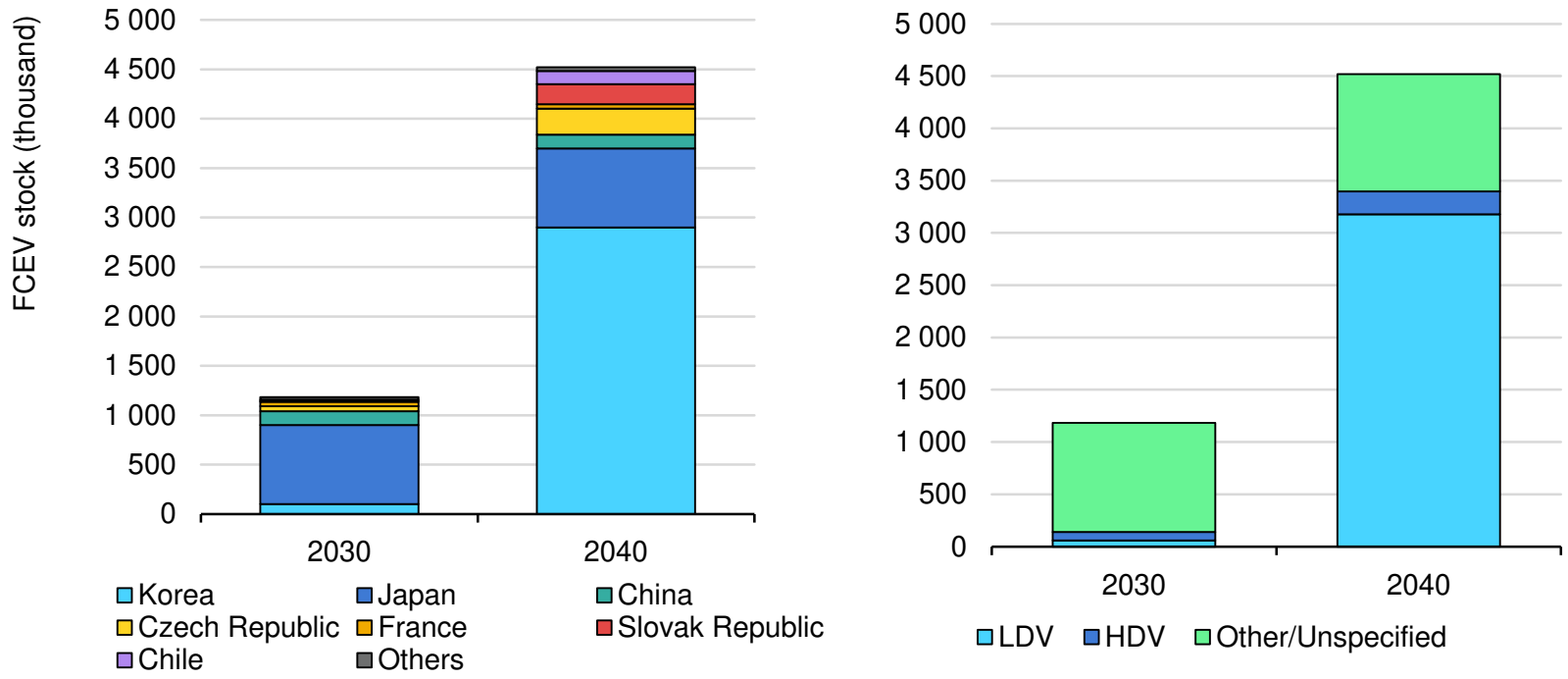
Targets for the use of low-carbon hydrogen in industry

Government	Target
Colombia	40% of industrial demand being low-carbon hydrogen by 2030
France	20-40% of industrial demand being low-carbon hydrogen by 2028
Hungary	20 kt of low-carbon hydrogen and 4 kt of carbon-free hydrogen used in industry by 2030
Portugal	75-100% of demand for ammonia production being met by renewable hydrogen by 2030. 100% by 2040 1-5% of final energy consumption in transformation and extraction industry met with renewable hydrogen by 2030. 10-15% by 2040
Spain	25% of industrial demand being renewable hydrogen by 2030
European Commission	50% of all hydrogen demand in industry from renewable origin by 2030

Targets for hydrogen use in transport

Targets for FCEVs deployment account for 1.5 million FCEVs by 2030 and nearly 5 million by 2040

Global targets for the deployment of FCEVs by country and segment, 2030-2040



Notes: LDV = light-duty vehicles; HDV = heavy-duty vehicles. HDV includes medium- and heavy-duty trucks as well as buses. Korea and France have announced targets for 2025 and 2028, respectively, which have been included in 2030. Korea has a target for producing 6.2 million FCEVs by 2040, 2.9 million for the domestic market and 3.3 million for export. Only the targets for the domestic market have been included for 2040. China does not have national targets, so the numbers shown in the graph correspond to the summary of local and provincial targets.

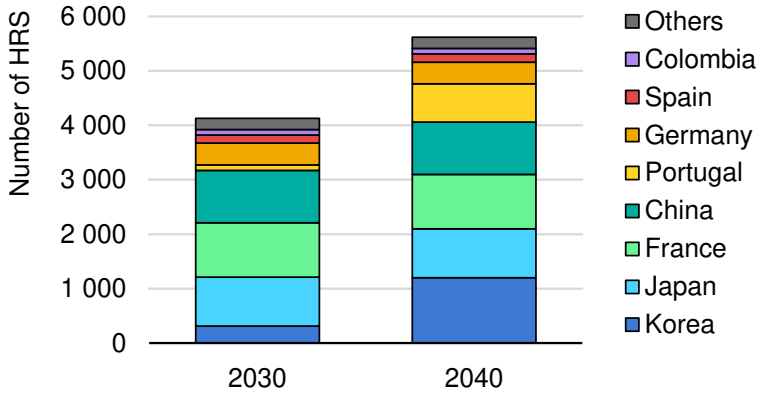
Source: IEA analysis based on CEM H2I surveys and consultation with government officials.

Targets for FCEV deployment are common among many national strategies, but global numbers are dominated by Japan and Korea

Targets for road transport

Fourteen countries have adopted targets for the deployment of FCEVs, accounting for a total of 1.5 million FCEVs by 2030 and 4.8 million FCEVs by 2040[4]. Japan and Korea have adopted the most aggressive targets, accounting for around 60% and 75% of the global commitments by 2030 and 2040 respectively.

Global targets for the deployment of HRS by country, 2030-2040



Notes: Korea and France have targets for 2022 and 2028, which have been included in 2030. Targets for China correspond to local and provincial targets.
Source: IEA analysis based on CEM H2I surveys and consultation with government officials.

With regards to different segments, many governments have defined targets for specific segments. Most countries have focused particularly on buses and medium- and heavy-duty trucks. However, the largest targets (from China, Japan and Korea) have either not specified the type of vehicles or have put the focus on light-duty vehicles. Hungary, in addition to the target to deploy 4 800 heavy-duty fuel cell vehicles, has also announced a target to use 10 kt of carbon-free hydrogen in road transport by 2030.

As the deployment the FCEVs should be accompanied by the infrastructure to supply hydrogen for refuelling, several countries have announced targets for the deployment of hydrogen refuelling stations (HRS). Globally, targets for HRS account for more than 4 100 by 2030 and more than 5 600 by 2040. China, France, Japan and Korea have the largets targets, accounting for around three-quarters of the global target, both in 2030 and 2040. In addition, in July 2021, the European Commission presented a Alternative Fuels Infrastructure Regulation proposal (not yet approved), which includes a requirement to have one HRS at least every 150 km along the core transport network and each urban node by 2030.

[4] Korea has a target for manufacturing 6.2 million FCEV, exporting 3.3 million of FCEVs. Meeting it would require larger global deployment that current adopted targets acros the world.

Targets in other transport sub-sectors

The potential role of hydrogen in non-road transport sub-sectors has also received significant attention in national hydrogen strategies and plans, although a very small number of countries have adopted specific targets for these sectors. This is likely due the fact that hydrogen technologies are less mature in these sectors.

Four countries have adopted targets for the use of hydrogen in rail, which together could account for few tens of hydrogen trains by 2030.

In the case of shipping, only Portugal and Slovak Republic have adopted targets for the use of hydrogen. In addition, Norway has a target to create five maritime clusters for hydrogen by 2030.

Germany is the only country that has announced targets for the use of hydrogen-based fuels in aviation, whereas Japan is the only country that has adopted a target for using hydrogen in industrial vehicles, concretely in forklifts.

In July 2021, the European Commission presented two proposals, which have yet to be approved:

- A revision of the Renewable Energy Directive which includes a binding target on transport to have 2.6% of all fuels from renewable hydrogen by 2030 in EU Member States.
- ReFuelEU Aviation, with a target of 0.7% share of synthetic fuels in aviation by 2030 and a long term objective of increasing share to 28% by 2050.

Targets for the use of low-carbon hydrogen in non-road transport sub-sectors

Government	Targets
	Rail
France	12 trains by 2025
Portugal	1-5% of final energy consumption in rail met with hydrogen by 2030 and 5-10% by 2040
Slovak Republic	12 trains by 2030
Spain	2 commercial train lines operated with hydrogen trains by 2030
	Shipping
Portugal	3-5% of final energy consumption in domestic shipping met with hydrogen by 2030 and 10-15% by 2040
Slovak Republic	2 ships by 2030
	Aviation
Germany	2% for hydrogen-based fuels in aviation fuel demand by 2030 200 000 tonnes of hydrogen-based sustainable aviation fuel in 2030
European Commission	0.7% share of synthetic fuels in aviation by 2030, increasing up to 28% by 2050
	Industrial vehicles
Japan	1 000 forklifts by 2030

Other targets

Governments around the world have adopted targets for hydrogen infrastructure, blending, power generation, domestic cogeneration or final energy consumption

Hydrogen infrastructure

The creation of a market for hydrogen needs the developemnt of adequate infrastructure for delivering hydrogen to end users and facilitate cross border trade. Currently, there are no targets adopted by governments aiming to develop such infrastructure. However European transmission system operators (TSOs) have a plan to develop a hydrogen network of 39 700 km by 2040, including repurposing existing natural gas pipelines. Although TSOs in Europe are not estate entities, they are regulated and have a mandate from government authorities to plan and develop gas infrastructure through the Ten-Year Network Development Plans.

Hydrogen imports

Same as in the case of hydrogen infrastructure, the European Commission has taken the lead in the adoption of targets for hydrogen imports. As part of its REPowerEU package, presented in March 2022 as a a plan to make Europe independent from Russian fossil fuels before 2030, the European Commission announced a Hydrogen Accelerator. Through this programme the Commission aims to import 10 Mt of renewable hydrogen by 2030, as well as develop the required infrastructure, including in ports.

Japan, as part of its target of using 420 kt of renewable hydrogen by 2030, has the objective of developing international hydrogen supply chains which can deliver a fraction of this renewable hydrogen target, but there is no specific target on hydrogen imports.

Hydrogen blending

Several countries have seen hydrogen blending in the gas network as a way to create dependable demand for hydrogen at its early deployment phase and trigger cost reductions for low-carbon hydrogen production technologies. For this reason, five countries have adopted targets specific for blending hydrogen gas networks.

Targets for hydrogen blending in the gas gris, 2030-2040

Country	2030	2040
Hungary	2 vol%	-
Czech Republic	600 GWh/y	3 100 GWh/y
Chile	8 vol%	20 vol%
Slovak Republic	10 vol%	10 vol%
Portugal	10-15 vol%	40-50 vol%

Use of hydrogen in power generation

Two governments have announced targets for the use of hydrogen in power generation. Korea seeks to have 1.5 GW of installed capacity of fuel cells for power generation by 2022 and to expand it to 8 GW by 2040 (with additional 7 GW exported). Portugal has adopted a target to use 5-15% of hydrogen in gas-powered electricity plants by 2030 and 40-50% by 2040.

Use of hydrogen in domestic applications

Japan and Korea have targets for the deployment of hydrogen technologies in domestic applications. Japan has a target to reach 5.3 million of cumulative sales of micro-cogeneration fuel cell units by 2030; whereas Korea has a target for achieving 2.1 GW of installed capacity of micro-cogeneration fuel cell units by 2040.

Final energy consumption met with hydrogen

Canada and Portugal have announced targets for the use of hydogen in final energy consumption. Portugal seeks to meet 1.5-2% of its final energy consumption with hydrogen by 2030 and 5-10% by 2040. In the case of Canda, the targets are 6.2% by 2030.