Building Energy Security Through Accelerated Energy Transition

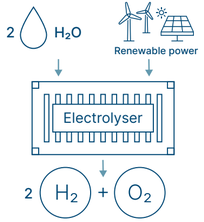
What you need to know about...

How green hydrogen can deliver energy security

Energy Transitions Commission

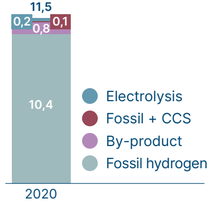
What is green hydrogen and how is it used in Europe?

Green hydrogen is obtained through water electrolysis.



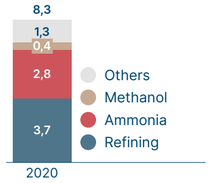
Today's hydrogen production is mainly fossil based.

Hydrogen production – in MtH_2/yr



Hydrogen is currently used in industry.

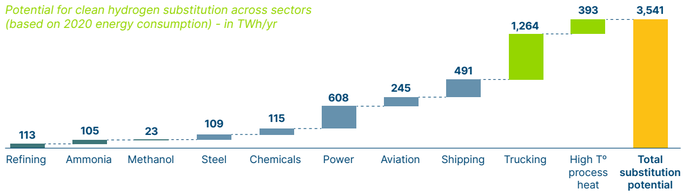
Hydrogen use – in MtH_2/yr



Where can green hydrogen be used?

Green hydrogen can play an important role in improving energy security by diversifying away from fossil fuels - replacing existing demand for fossil-based hydrogen and meeting new demand as a complementary energy vector to electricity.

Potential for clean hydrogen substitution across sectors (based on 2020 energy consumption) - in TWh/yr

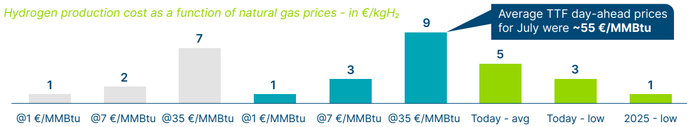


From grey to clean	Long-term need requiring development	Possible uses
• **Replacing natural gas** used as feedstock in **existing hydrogen plants**	• Replacing **natural gas** and **coal** in **steel** and **chemicals** • Replacing **oil** in **aviation** and **shipping** • Replacing **oil** and **natural gas** in **power** production	**If electricity doesn't win:** • Replacing **oil in trucking** • Replacing **natural gas in residential and high temperature heating**

How cost-competitive is green hydrogen?

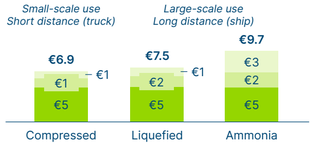
1 Green hydrogen is more expensive than grey or blue hydrogen, although costs are falling and current high natural gas prices are making green hydrogen increasingly competitive today.

Hydrogen production cost as a function of natural gas prices - in €/kgH_2



2 Transport and storage networks will be required to link low-cost green hydrogen production with end-uses.

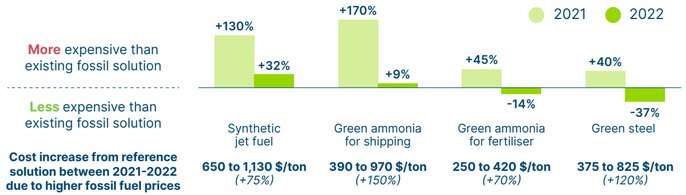
All-in green hydrogen production costs in €/kgH_2



Green hydrogen production facilities must be **connected with transport and storage networks** to **replace existing grey production** and **scale up to new users.**

3 There is a "green premium" for many applications of green hydrogen, although this has been reduced by the recent increase in fossil fuel prices.

Low carbon premium for products produced with clean hydrogen @2 €/kgH_2 vs. existing fossil fuel solution In % change



Cost increase from reference solution between 2021-2022 due to higher fossil fuel prices

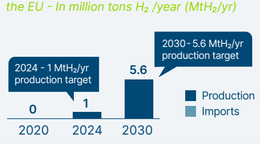
650 to 1,130 $/ton *(+75%)* | **390 to 970 $/ton** *(+150%)* | **250 to 420 $/ton** *(+70%)* | **375 to 825 $/ton** *(+120%)*

What are the EU's ambitions for green hydrogen?

The EU has recently raised its ambition for green hydrogen supply, especially for imports.

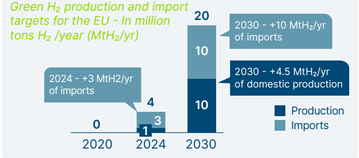
July 2021 Fit for 55

Green H_2 production and import targets for the EU - In million tons H_2 /year (MtH_2/yr)



May 2022 REPowerEU

Green H_2 production and import targets for the EU - In million tons H_2 /year (MtH_2/yr)

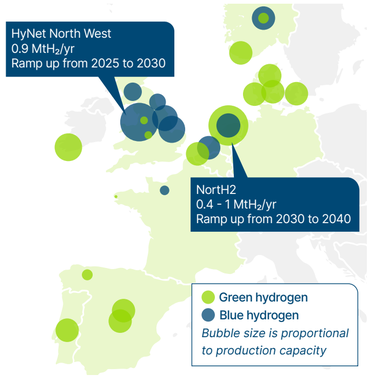


Where can the EU get green hydrogen from?

Domestic

Several **green hydrogen facilities** are scheduled to **come online before 2030**, the largest of these are in **Spain**, the **Netherlands**, **Sweden** and **Germany.**

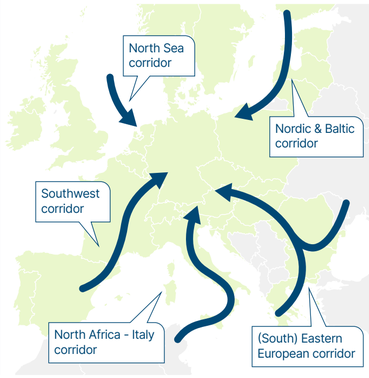
Map of domestic supply



Imports

Hydrogen can be **imported** either as a **compressed gas in pipelines** or in **liquid form (-253°C) by ships**. Hydrogen vectors such as **ammonia** can also be used.

Map of international supply



What is needed for green hydrogen to develop and meet targets?

	Domestic	Imports
Supply	• Provide **direct investment support** and **access to low-cost capital** • Provide **access to lower power prices** (PPAs, grid tariff waivers, power market design) • **Ban greenfield unabated grey hydrogen plants** • **Streamline permitting for renewable generation** for hydrogen production	• **Adapt & expand regulatory & safety frameworks** for H_2 and ammonia • **National infrastructure planning** to design international hydrogen networks • **Government support** (e.g. blended finance) **for import infrastructure build out** • **Improve technological readiness of liquid transport fuel**
Demand	**Beyond supply, green hydrogen demand must also be scaled up.** Mitigating the increased costs would require: • Imposing a **carbon tax of $100/ton by 2030** • **Stimulating early demand** (e.g. mandates, public procurement, voluntary green market) • **Providing investment support to reduce the "green premium"**	