

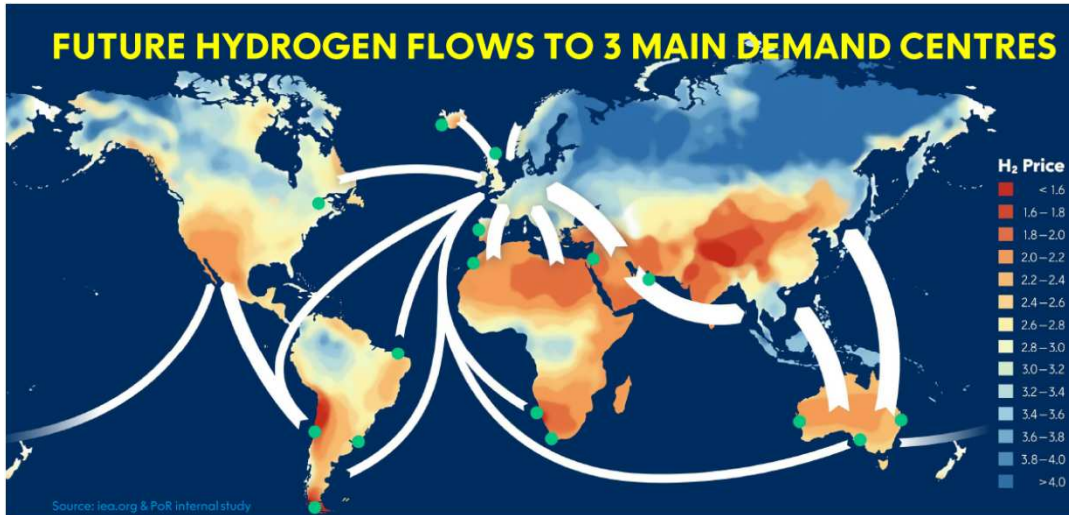


- **H2 Production**
- **H2 Export**
- **H2 Use for the production of synthetic fuels**

The Potential of Biofuels for Hydrogen Production

- The “Bio to Hydrogen” technologies open new perspectives for the ethanol sector for H2 production, H2 export and H2 use for the production of synthetic fuels.
- Hydrogen does not compete with biofuels, instead it can be a by-product and create new business opportunities, accelerate market expansion and promote technology innovation.
- Synthetic fuels such as E-Methanol, E-Gasoline, HVO and E-Kerosene will play an important role in the decarbonization pathway using internal combustion engines for all transportation modes and biogenic CO₂, available in all ethanol plants, is the most desirable raw material in this process.
- New investments are being directed towards renewable energy and biofuels, and renewable/green hydrogen will become more valuable than fossil fuels, due to the world demand focused on achieving the Paris Agreement goals.

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Increased H₂ Global demand to achieve decarbonization targets

- By 2050, demand for clean energy carriers is expected to increase to 20 Mtonnes, of which around 18 Mtonnes will be imported.
- Importing countries such as Europe consumes far more energy than can be sustainably generated regionally.
- Countries with great potential in renewable energy generation will be part of the new global energy trade.
- **4.6 Mton H₂ will be distributed via Port of Rotterdam in 2030, of which 4 Mton will be imported.**

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Source: <https://www.portofrotterdam.com/en/news-and-press-releases/several-rotterdam-terminals-to-be-ready-for-hydrogen-imports-by-2025>



Most analyzed H2 Carriers

Port of Rotterdam now working on terminals to receive Hydrogen from other countries

1. short term:

- LOHC (DBT or MCH)
- Ammonia (NH₃)

2. Long term:

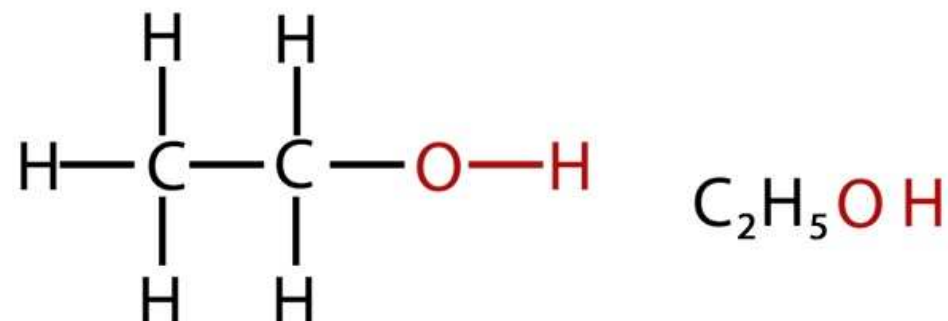
- LH2 (Liquid H₂) -253°C
- Working on building international relations with producing countries and ports
- Aim: starting projects in Europe, Middle East, Africa and the Americas, Australia...

Several Rotterdam terminals to be ready for hydrogen imports by 2025

- The Port of Rotterdam has experience in the transshipment of energy carriers such as LNG and chemicals such as methanol and is developing terminals to receive all hydrogen carriers such as: **liquid hydrogen, ammonia and LOHCs.**

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Why not ethanol as H2 Carrier?

- Ethanol is already produced in large scale in Brazil, US and India and can be reformed to obtain H2 in the port terminal of the importing country.
- Ethanol as a H2 carrier could accelerate hydrogen import and distribution.
- What is needed to start is just to install an ethanol reformer in a port terminal.
- Ethanol reformer is already commercially available technology in Brazil.

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Source:
<https://www.koyotky.co.jp/fleet/cargo/ethanol.html>



Biomass, Biofuels, Biogas Big Potential for H2 Production for the Ethanol Sector

- **ELECTROLYSIS:** The ethanol sector generates a large amount of waste, which can be used to generate electricity and produce renewable/green hydrogen from electrolysis.
- **GASIFICATION:** Biomass gasification is a mature technology pathway that uses a controlled process involving heat, steam, and oxygen to convert biomass to hydrogen and other products, without combustion.
- **BIOGAS REFORMING:** Biogas is obtained via the anaerobic digestion of biomass waste, and because growing biomass removes carbon dioxide from the atmosphere, the net carbon emissions of this method can be low, especially if coupled with carbon capture, storage and re-utilization, for example for the production of synthetic fuels. This scenario could be very competitive in the global H2 market.
- **SYNTHETIC FUELS:** Will play an important role in the decarbonization pathway using internal combustion engines for all transportation modes. The demand will be huge.
- **ETHANOL REFORMING:** Steam reforming of biofuels such as bioethanol offers a clean and sustainable route to improve hydrogen production capacity for the hydrogen economy.

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Image: Raízen



Image: Quatro Rodas



Image: Hytron/NEA Group



Image: SAE Brasil

Potential for the Ethanol Sector in the H2 Mobility

- On board ethanol reformer?
- Ethanol directly in a SOFC fuel cell?
- Ethanol reformer at a refuelling Station?

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