HYDROGEN FOR INTERNAL COMBUSTION ENGINES IN HEAVY MATERIAL

An affordable and reliable alternative on the road to zero emissions

HYDROGEN AS NECESSARY ALTERNATIVE

We still have a long way to go to realise the Paris Climate Agreements. Liquid and gaseous energy carriers will continue to be needed as fuels in certain heavy-duty applications. Think, for example, of aviation and shipping, road traffic with heavy, energy-intensive and demanding patterns of deployment. The use of hydrogen, as a fuel, in internal combustion engines can play an important role in the energy transition linked to the climate agreements.

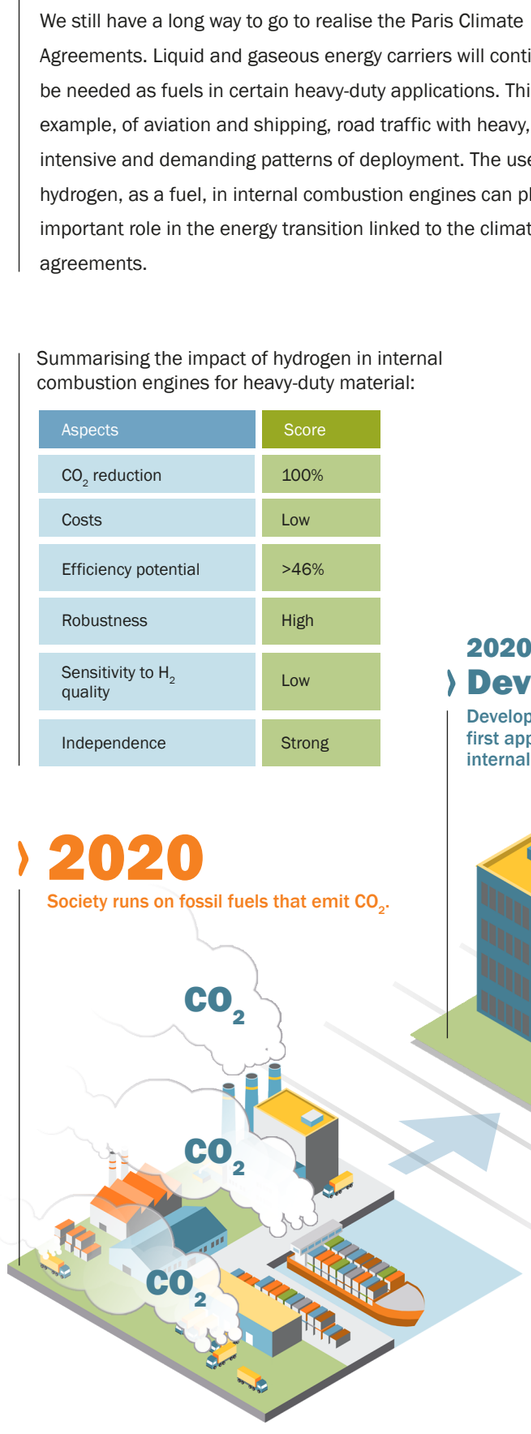
Opportunities exist to introduce hydrogen quickly and to speed up sustainability significantly in the short term, especially in HD (high power & heavy duty) engines in the transport and industry sectors. Since the combustion of hydrogen releases only water, no CO_2, a limited amount of NO_x and requires no emission after-treatment, it is a very sustainable technology. An additional advantage is that hydrogen can be refuelled quickly. And with sufficient pressure, hydrogen has a high energy density and is therefore suitable for long-distance transport.

Summarising the impact of hydrogen in internal combustion engines for heavy-duty material:

Aspects	Score
CO_2 reduction	100%
Costs	Low
Efficiency potential	>46%
Robustness	High
Sensitivity to H_2 quality	Low
Independence	Strong

2020

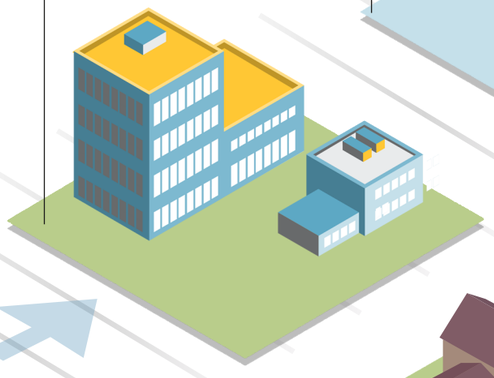
Society runs on fossil fuels that emit CO_2.



2020

Development

Development is needed for the first application of H_2 in larger internal combustion engines.



2022 - 2025

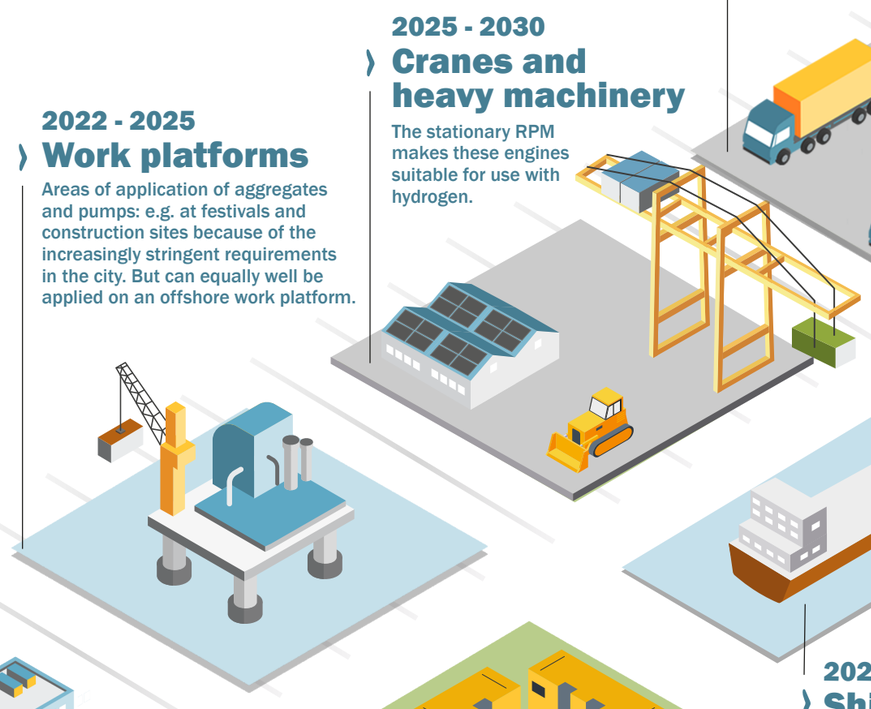
Work platforms

Areas of application of aggregates and pumps: e.g. at festivals and construction sites because of the increasingly stringent requirements in the city. But can equally well be applied on an offshore work platform.

2025 - 2030

Cranes and heavy machinery

The stationary RPM makes these engines suitable for use with hydrogen.

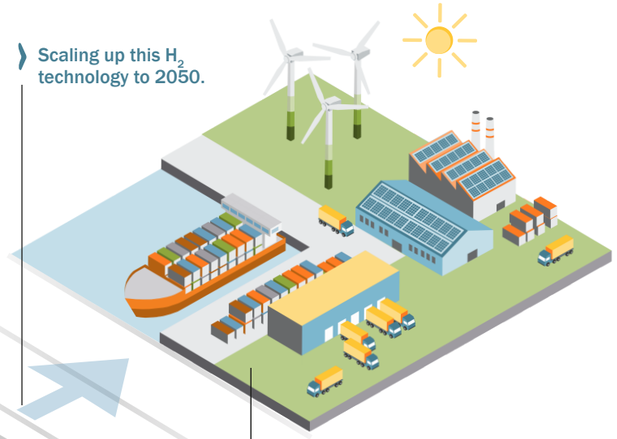


2025 - 2030

Trucks

The transient application of H_2 combustion in trucks comes later on in the roadmap but is a robust form of clean mobility.

Scaling up this H_2 technology to 2050.



2050

80% - 95% reduction of greenhouse gases. Complete elimination of polluting emissions, such as NO_x.

2025 - 2030

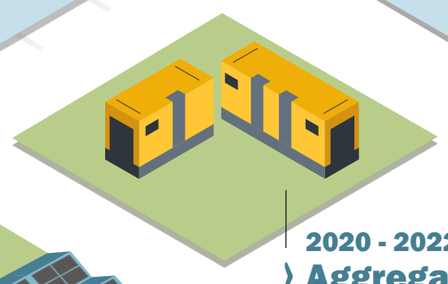
Ship engines

Application in ship engines is important because of the high reliability of the internal combustion engine.

2020 - 2022

Aggregates and pumps

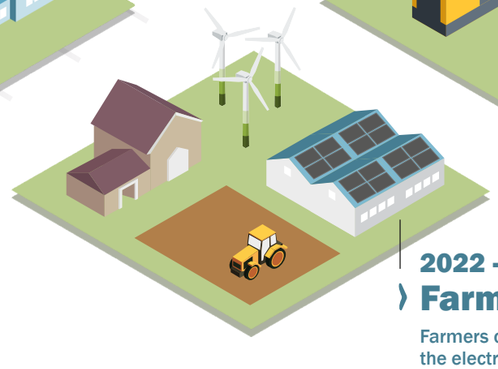
Aggregates may be the first to use hydrogen combustion due to their stationary application.



2022 - 2030

Farms machines

Farmers can keep the chain ultra-short by storing the electricity from windmills in the form of hydrogen on the property and use it to directly refuel a tractor.



HYDROGEN COMBUSTION OFFERS MANY ADVANTAGES

The use of hydrogen in HD engines offers many advantages. To a large extent, this is already developed and proven technology. As a result, the applications are very reliable and affordable from a user and maintenance perspective. Add to this that currently a significant part of our industry is already equipped and prepared for the use of hydrogen (design, production, service & maintenance, recycling). Also, combustion engines running on hydrogen have a high tolerance for the quality of the hydrogen used. Moreover, hydrogen in internal combustion engines makes the Netherlands and Europe more independent from the outside world because no precious or rare metals are needed. This is an opportunity for the Netherlands to create concrete solutions for numerous "niche" applications in the short term, and to boost the eco-system of the HD automotive and energy sector. The associated innovation foundation in Helmond (including the Innovation Centre for Sustainable Powertrains) as an important part of the Brainport Region is ready.

TNO innovation for life