**Hydrogen risks being the great missed opportunity of the energy transition**

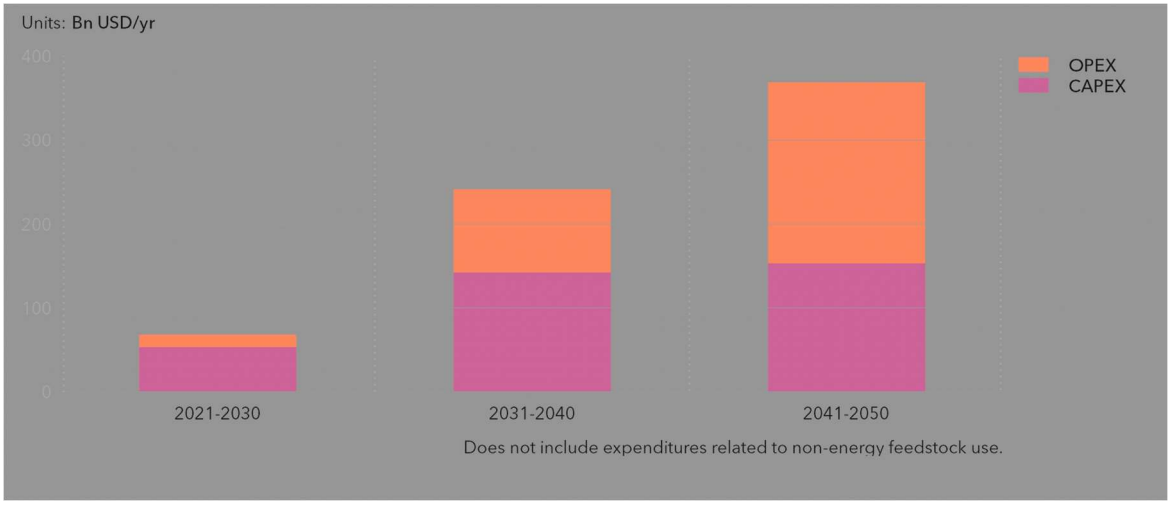
**Sverre Alvik (Director Energy Transition Outlook at DNV)**

World leaders seem to have grasped the **importance of hydrogen to the energy transition**. German Chancellor Olaf Sholtz travelled to Canada recently to sign a green hydrogen deal as Europe's largest economy seeks to decarbonize its energy system whilst increasing energy security. President Joe Biden signed the Inflation Reduction Act of 2022 into law, which contains hydrogen tax incentives. The European Commission's Temporary Crisis Framework, which is a response to the region's new energy reality, includes specific measures to boost hydrogen production.

Hydrogen is essential to decarbonizing industries that cannot be easily electrified, like deep sea shipping, aviation, and high heat industrial processes. Yet, our recent forecast *Hydrogen Future to 2050* finds that **hydrogen uptake will be far too slow**. To meet Paris Agreement goals, by 2050, hydrogen should meet approximately 15% of energy demand, but our findings show it will reach just 0.5% by 2030 and 5% by midcentury.

*Hydrogen Future to 2050* examines the hydrogen industry in detail, but here, I will highlight some of the key findings.

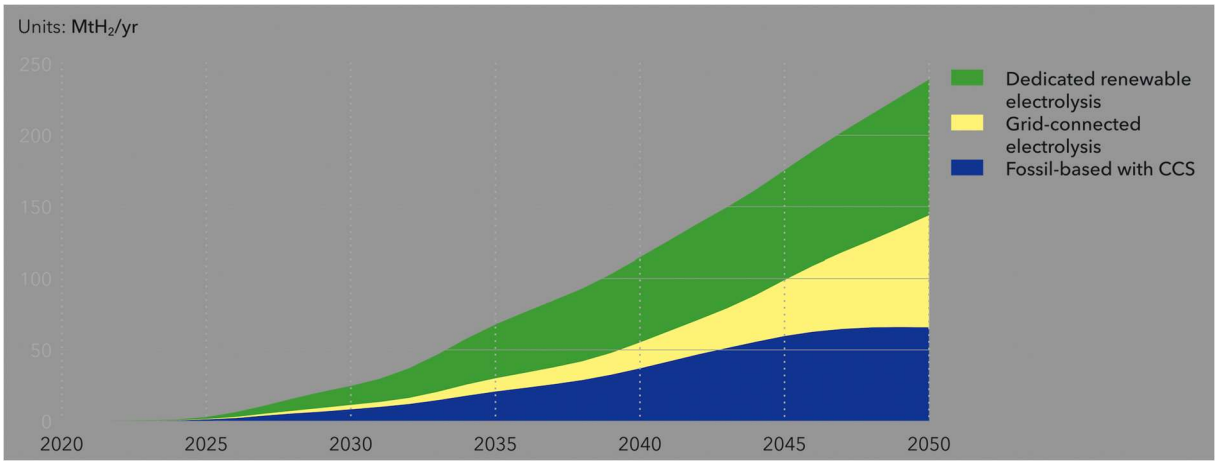
**Global annual average expenditure for production of hydrogen and its derivatives for energy purposes - Trillions of dollars in investment**




*Source: DNV*

Even if hydrogen production is forecast to fall short of what it needs to be, **huge investment opportunities** exist. Global spend on producing hydrogen for energy purposes from now until 2050 will be USD 6.8trn, with an additional USD 180bn spent on hydrogen pipelines and USD 530bn on building and operating ammonia terminals.

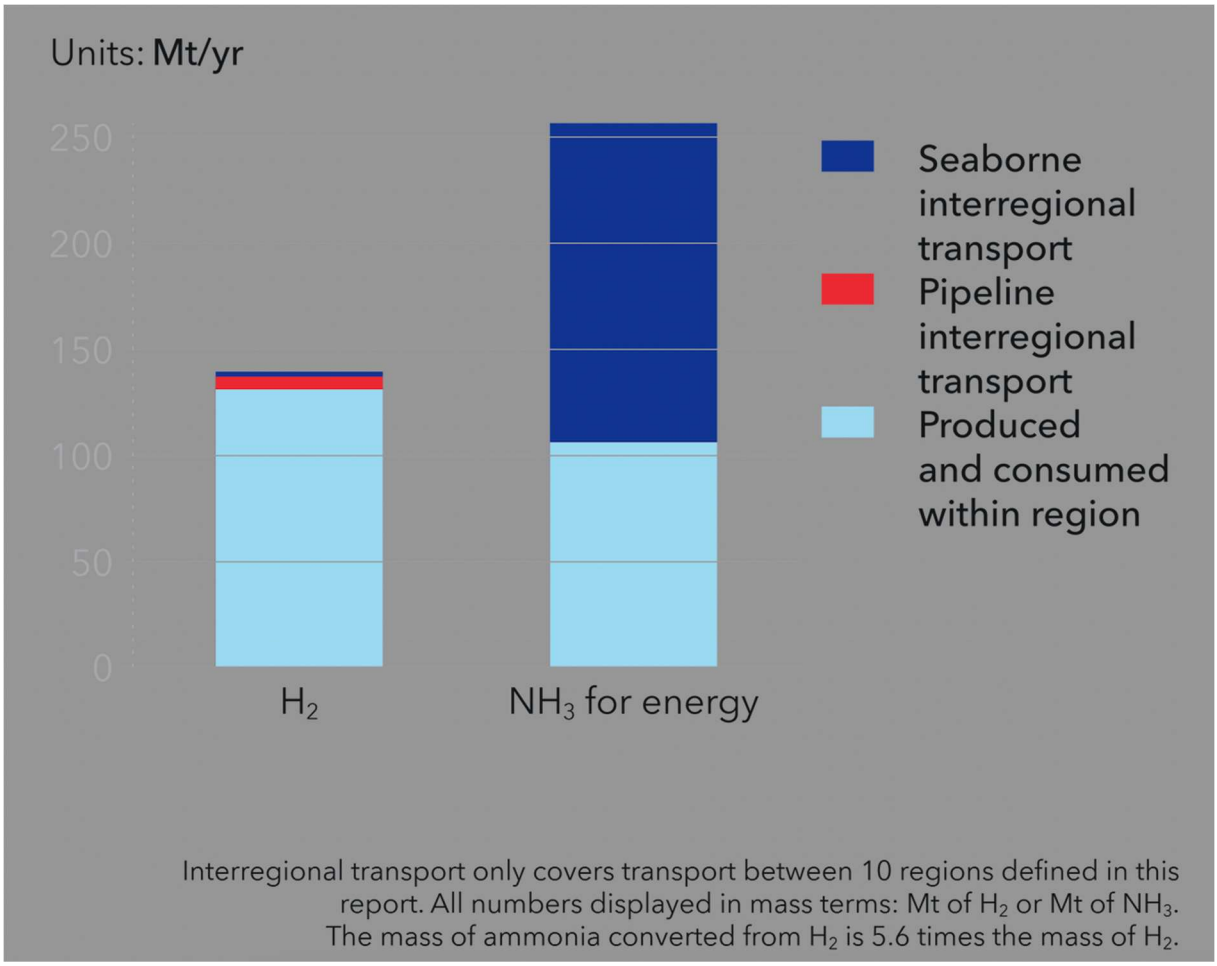
**Global production of hydrogen and its derivatives for energy purposes by production route**




*Source: DNV*

Electricity-based **green hydrogen** – produced by splitting hydrogen from water using electrolyzers – will be the dominant form of production by the middle of the century, accounting for 72% of output. **Blue hydrogen** and blue hydrogen products like ammonia – produced from natural gas with emissions captured – has also a important role to play, but its competitiveness will gradually reduce as renewable energy capacity increases and prices drop.

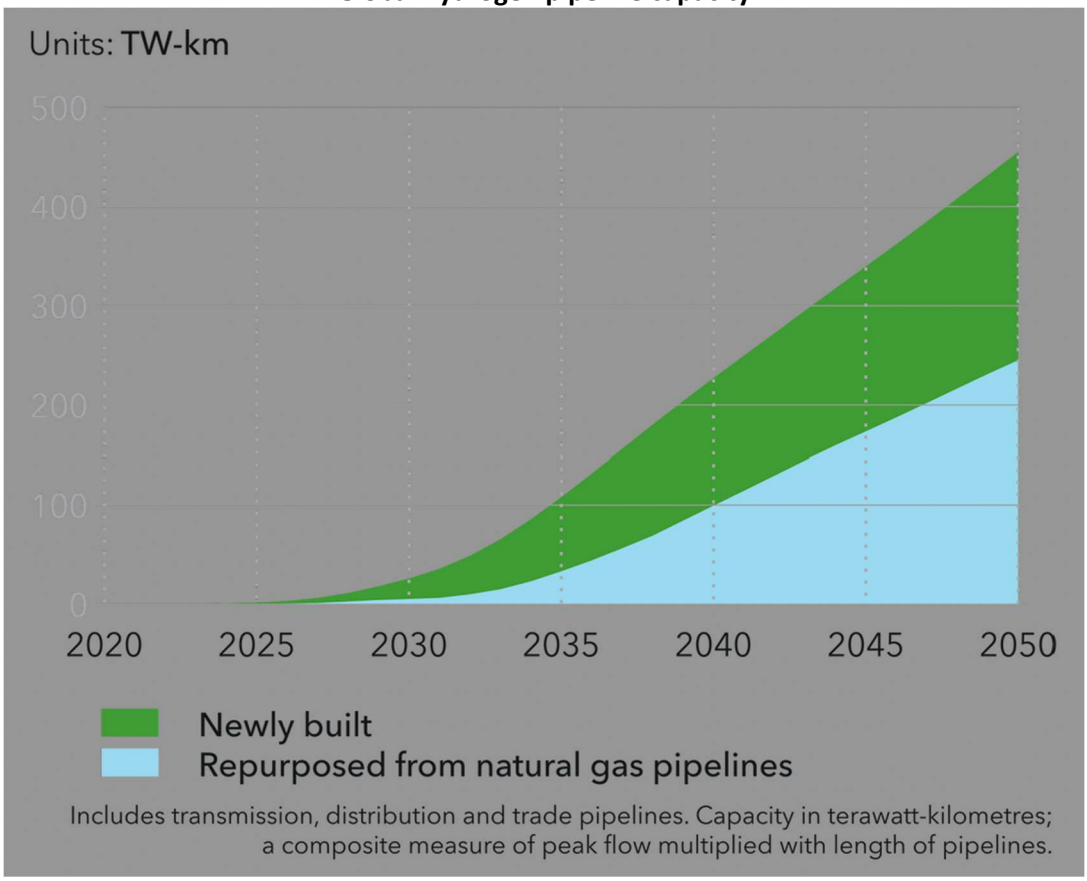
**Transport of hydrogen and ammonia in 2050**




*Source: DNV*

Hydrogen will be **transported by pipelines up to medium distances** within and between countries, but almost never between continents. Ammonia – a derivative of hydrogen - is safer and more convenient to transport and is more suitable for long distance seaborne trade. Therefore, we forecast that 59% of energy-related ammonia will be traded between regions by 2050.

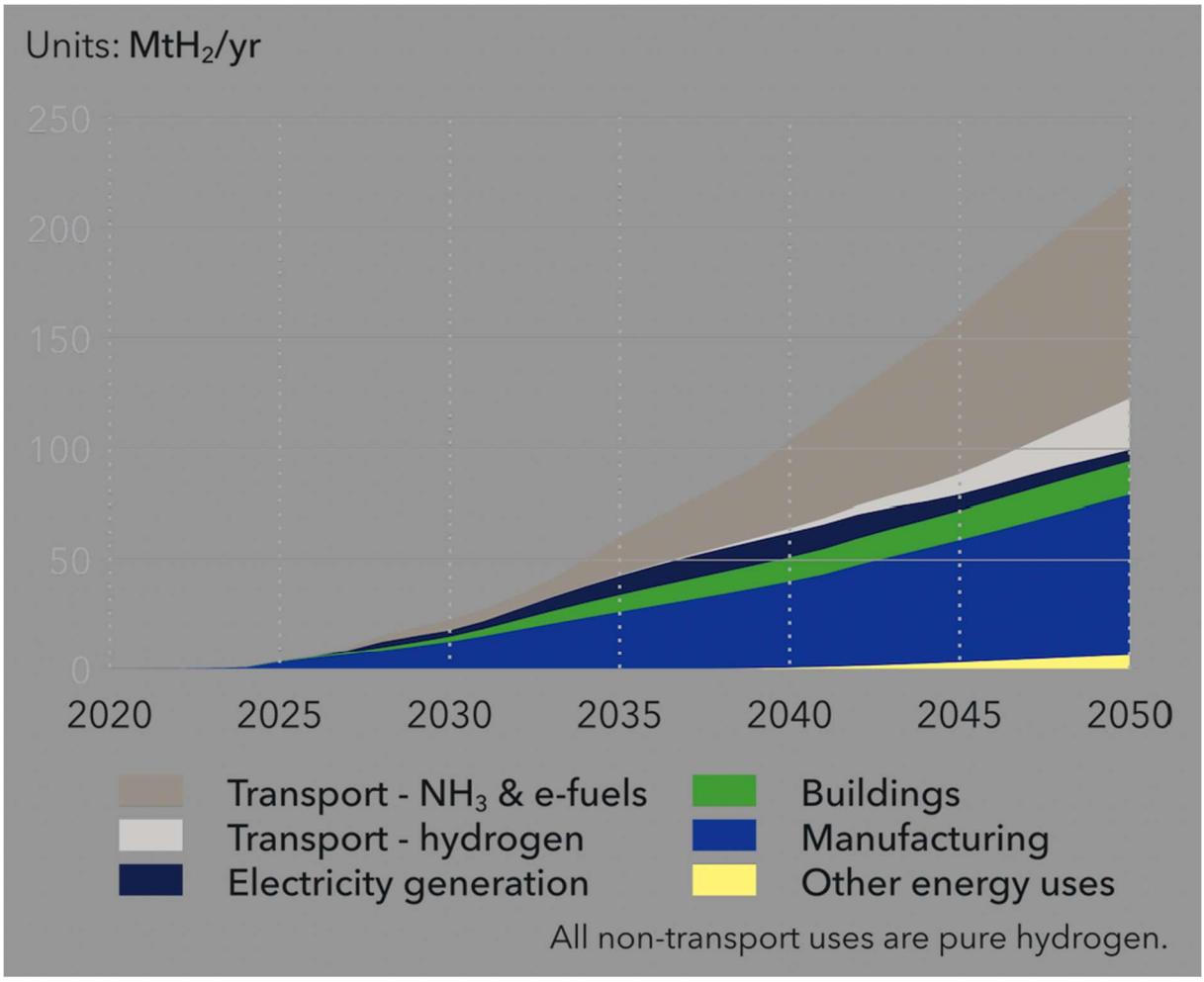
**Global hydrogen pipeline capacity**




*Source: DNV*

Cost considerations will lead to more than 50% of **hydrogen pipelines globally being repurposed from natural gas pipelines**, rising to as high as 80% in some regions, as the cost to repurpose pipelines is expected to be just 10-35% of new construction costs.

**Global demand for hydrogen and its derivatives as energy carrier by sector**




*Source: DNV*

**Hydrogen derivatives** like ammonia, methanol and e-kerosene will play a key role in decarbonizing the **heavy transport sectors** (aviation, maritime, and parts of trucking), but uptake only scales in the late 2030s. We do not foresee hydrogen uptake in passenger vehicles, and only limited uptake in power generation. Hydrogen for **heating of buildings**, typically blended with natural gas, has an early uptake in some regions, but will not scale globally.

One aspect of the hydrogen story that is less easy to capture in graphs or data is **safety**. Even if hydrogen is not new to society, its use has largely been limited to industrial processes. The forecast significant growth in the market for hydrogen as an energy carrier will introduce many new hydrogen facilities that are very different from those we have had in the past. Moreover, some of the facilities will be in much closer proximity to the public and will be built and operated by new entrants who may not have relevant experience in hydrogen safety. Our previous experience of hydrogen safety is thus an imperfect guide, at best, as to what might happen in the future.

Risk perception will be an important factor in **acceptance of hydrogen use**. Accidents involving hydrogen are likely to receive more media attention than comparable events with conventional fuels (at least initially) and this could increase public resistance and prompt a more restrictive regulatory environment.

Research is very active understanding the risks associated with Hydrogen and DNV is engaged in large-scale experimental research at our Research & Testing site at Spadeadam, Cumbria, UK. Although safety provides a challenge, it is not a showstopper. The industry has tried-and-tested methods for

managing the safety of flammable gases that have been used for decades and these come with some very important, hard won, lessons

As hydrogen is so important to the energy transition, we cannot let safety become its Achilles Heel. The hydrogen industry must avoid a Fukushima moment that could delay the uptake by years.