Hydrogen: climate saviour?

Source of hope for decarbonisation of the economy

June 2020

H_2: A molecule with potential

Hydrogen has been touted as a saviour for years but has never quite lived up to its billing. The need to combat the effects of coronavirus has now led to renewed interest in this technology. Has hydrogen's time finally come?

Contents

1 Introduction

When we start talking about hydrogen, we very quickly get into astronomical figures. Investment bank Morgan Stanley estimates that the costs of building sufficient capacity to produce climate-friendly hydrogen could add up to around US$ 20 trillion US dollars by 2050 – that's 20 with twelve zeros. So far, it seems the immense investment requirement has deterred companies and states from seriously and comprehensively pursuing the vision of a hydrogen economy.

Here is a comparison to put this sum into context: The coronavirus pandemic and the resulting forced lockdown of large parts of the economy has been greeted with the announcement of massive rescue and economic stimulus packages in many countries around the world. Although it not yet possible to put a precise figure on the current and future costs of these measures, according to an analysis by Deutsche Bank the cost to the German government alone could be up to €1.9 trillion. This sum, which itself is almost impossible to comprehend, gives some idea of the scale of 'Project Hydrogen'.

Investment programmes provide important momentum for a hydrogen strategy

So what has changed? What does the investment in hydrogen technologies and infrastructure, which is so necessary from a climate perspective, have to do with the coronavirus pandemic? The difference is the change in attitude of many politicians and the willingness to intervene in the current crisis and provide support through fiscal and structural policy measures. The comprehensive government investment packages and support programmes could therefore ignite and accelerate the process of transformation towards a decarbonised economy. In addition to the climate agenda of the EU Commission, the planned green recovery fund in Europe and the German economic stimulus package will play an important role.

In many countries, the planned fiscal stimulus programmes are to be used to encourage investment in the technologies of the future that have so far received little support. Promoting investment that will help to tackle climate change is a central objective. The more widespread use of molecular hydrogen – chemical symbol H_2 – is an important step on this path to a carbon-neutral economy. The image used on the cover of this study paper is a symbol of the new direction of travel: H_2 has been used in various compounds as a fuel to launch rockets for many years. As is so often the case, the space industry is blazing a trail, striking out in different directions to explore new possibilities.

This paper begins by examining why investment in hydrogen production is urgently needed in order to achieve the Paris climate goals, before going on to explain why this investment has not been made already. It then provides important information on different production processes and the various possible applications and concludes by asking whether investors in the capital markets can benefit from an emerging hydrogen economy and, if so, how.

2 Why is everyone talking about hydrogen (again)?

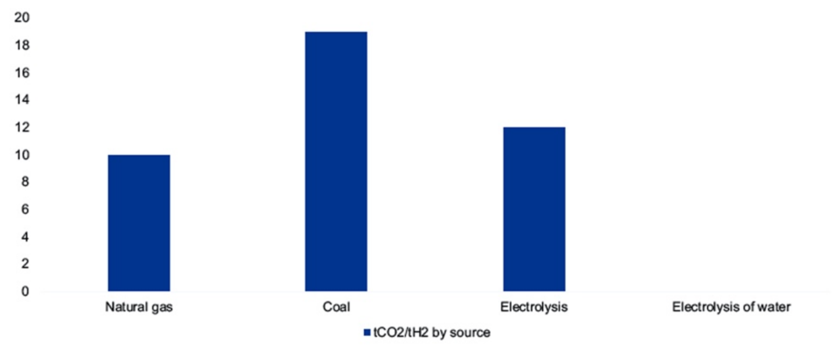
Extensive decarbonisation of the economy is essential if we are to limit climate change and the associated rise in temperature. This realisation forms the basis for the conclusions reached at the Paris climate summit. The target is to establish carbon-neutral economic and production systems by 2050. The increased use of hydrogen (H_2) – especially in industrial production – is a promising alternative.

It has been known for many years that using hydrogen in industrial applications results in much lower emissions of harmful CO_2 than using fossil fuels. Various studies carried out by analysts such as Bloomberg and Morgan Stanley conclude that the increased use of hydrogen could reduce global carbon emissions by between 24 and 30 per cent by 2050. This could be even more climate-friendly if the hydrogen is produced by water electrolysis using renewable energy. Figure 1 illustrates this.

Hydrogen production can be very carbon-efficient

The 'missing' bar in the water electrolysis column clearly illustrates the attractiveness of ramping up investment in hydrogen production infrastructure in the future – especially from a climate perspective.

Figure 1: CO_2 emissions generated in the production of hydrogen in tonnes (CO_2 or H_2) by source



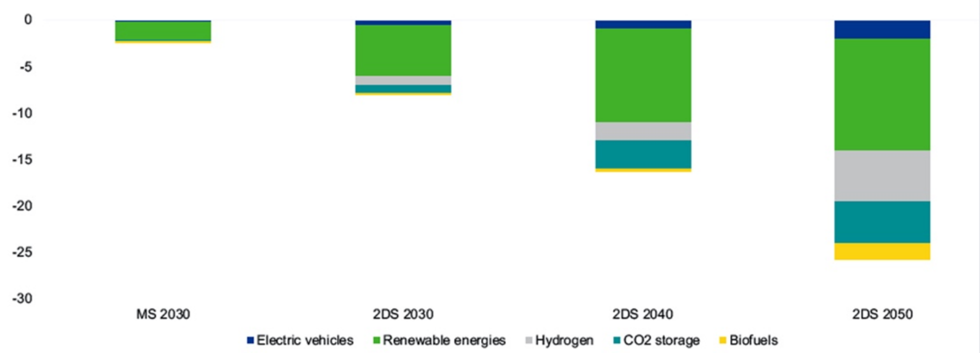
Sources: HSBC (Research Report January 2020), IEA (information correct as at 2018)

The combination of various approaches should reduce CO_2 emissions

In addition to the use of H_2, other initiatives and technologies will also be crucial for achieving the required level of decarbonisation, such as

- the production and use of biofuels, especially for the aviation sector,
- the increased use of electric vehicles,
- the capture and storage of CO_2 using *c*arbon *c*apture utilisation & *s*torage (CCs or CCUs)
- and, above all, the further expansion of renewable energy (also known as 'green electricity'), especially in the areas of wind and solar power.

Figure 2: CO_2 reductions achieved by various initiatives (in gigatonnes of CO_2, compared with 2017)



Sources: IEA, Hydrogen Council, CCS Institute, Morgan Stanley Research

Hydrogen plays an important role

Figure 2 shows that renewables and hydrogen are the most important factors in significantly reducing carbon emissions by 2050 and thereby limiting the rise in temperature to below 2°C. And the target range of *necessary* CO_2 reductions (‘2DS 2030’ bar) cannot be achieved by 2030 with the *current* initiatives (‘MS 2030’ bar) – at least according to this study. So *additional* initiatives are needed – and time is pressing. If now is not the right time to invest in sustainable future technology, when will be?!

3 The will and the financial means are available

In view of the many clear and known benefits of H_2 for key industrial applications, it is surprising that its use is still so limited. There are a number of reasons for this:

- H_2 is still far more expensive as an energy source in production than fossil fuels such as coal and gas, and this is one of the reasons why there has been little interest in investment from the private sector – there simply has not been clear enough evidence of profitability.
- At the same time, there has been insufficient financial support for hydrogen technology from the public purse.
- As a result, the current capacity and the necessary infrastructure are inadequate.
- Added to this, there is a lack of consensus as to the ‘right’ production technology for hydrogen (see chapter 4).

Broad alliance forming to promote the use of H_2

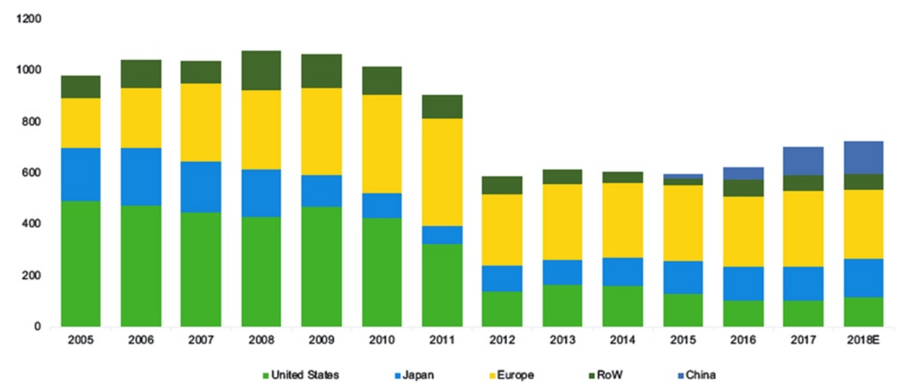
It is clear that interest in hydrogen and investment in this sector by companies has increased significantly (see selected examples in chapter 6). This is undoubtedly due in part to the realisation in some industries that a reduction of carbon emissions is urgently needed in many areas of the economy;

however, may also be linked to hopes of being able to open up promising areas of business for the future through new technologies and possible applications. The Hydrogen Council, founded in 2017, plays an important role in promoting cooperation and the sharing of ideas. This association of companies and public institutions began with just 17 members, and now has 81 from a variety of different sectors such as energy and utilities, chemicals, plant engineering, and automotive. It also has members from the financial sector, who are keen to play their part. Their shared goals are to make a material contribution in the fight against climate change while also benefiting from the opportunities that the hydrogen sector will offer in the future. According to various studies – including some carried out by the Hydrogen Council itself – global revenue of up to US$ 2.5 trillion per year could be possible by 2050.

Politicians are also planning massive investment in H_2

What is striking is the willingness and speed with which governments are launching investment programmes in the current pandemic. This is very different to responses seen in previous crises. In the case of hydrogen and fuel cells in particular, the tendency has been for state funding to fall sharply in the wake of crises such as the European debt crisis in 2011. See Figure 3.

Figure 3: Public research and development spending in the field of hydrogen and fuel cell technology (US$ million, in real terms, 2018)



In the years after 2012, the focus was on consolidating public budgets and, in some cases, this came at the cost of important research spending. By 2018, public spending on hydrogen still hadn't recovered – except in China. This is now set to change. Numerous political initiatives and fiscal stimulus programmes have been launched with the aim of achieving the Paris climate targets for CO_2 reduction. Selected examples include:

- the European Green Deal unveiled by the European Commission in December 2019,
- the German climate package announced in January 2020,
- the European green recovery plan announced at the end of May 2020,
- and the results of the coalition committee of the Federal Government on 3 June 2020 (in particular the 'package for the future') in conjunction with the national hydrogen strategy presented one week later.

Unprecedented fiscal stimulus packages

Although the various plans each have different priorities, they all aim to significantly reduce carbon emissions over the coming years. One beneficiary of all these programmes will be hydrogen, and any associated sectors of the economy. The current version of the European green recovery deal, for example, contains a number of elements that are specifically aimed at comprehensively promoting the hydrogen economy. These include:

- A doubling of spending on 'clean' hydrogen initiatives and partnerships, to €1.3 billion
- The launch of an innovation fund to support the production of one million tonnes of 'clean' hydrogen per year in future; the fund will be able to provide between €5 billion and €30 billion in subsidies for this purpose.
- Initial cost disadvantages in the production of green hydrogen compared to grey hydrogen are to be offset through subsidies (see next chapter for an explanation of the differences in production).
- Additional funding in the field of renewables and necessary hydrogen infrastructure could be up to €20 billion.
- The Commission will present an even more detailed, dedicated Europe-wide hydrogen strategy in June.

The structure of the green recovery deal and the associated subsidies show that the political will to support and establish a hydrogen economy unquestionably exist (this time), and the financial support is on a scale that has never been seen before.

The US, however, is something of an outlier in this regard. There, spending on research into hydrogen fell significantly after 2011 and has not recovered again since. Even an infrastructure package introduced in June 2020 – the INVEST in America Act – provides only around US$1.4 billion to build charging stations for electric vehicles and hydrogen fuelling infrastructure, and that sum is spread over a period of four years. One explanation for this is that, despite everything, the US still relies heavily on supplying its economy and industry with energy from domestically produced fossil fuels.

4 When is hydrogen truly sustainable?

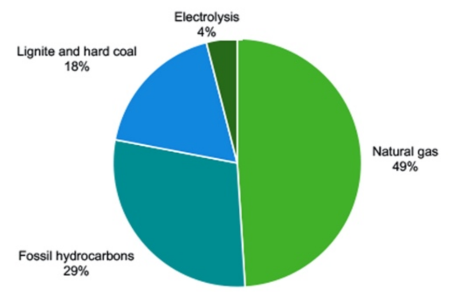
Requirements for sustainable H_2 production

There are at least three essential conditions that have to be met in order for hydrogen to contribute to a noticeable reduction in CO_2 emissions and thus limit the rise in global temperature:

- Support for the greater use of renewable energy sources and the electricity generated by them (especially from wind farms and solar power plants) in order to make the entire H_2 production process as climate-friendly as possible (as explained in the description of green hydrogen below). Various analyses have been carried out with regard to the necessary capacity expansion: Morgan Stanley, for example, estimates that renewable energy capacities will have to increase by a factor of 11 by 2050 in order to generate sufficient quantities of – affordable – electricity from these sources and enable the Paris climate targets to be met.
- A significant expansion of the hydrogen infrastructure, especially in the areas of transport and storage, but also in electrolysis capacity. It will be necessary to promote and increase electrolysis efficiency – especially in the production of green hydrogen.
- Special support must be given to those H_2 production technologies that actually make a significant contribution to carbon reduction throughout the entire production and application chain.

In order to understand the crucial differences in the production of H_2, we must look at the input factors and the ways in which hydrogen is currently produced.

Figure 4: Which sources are currently being used to produce hydrogen?



Sources: IEA, Hydrogen Council, CCS Institute, Morgan Stanley Research

Figure 4 shows that at present, the vast majority of hydrogen is produced using fossil gas and coal. Only around 4 per cent of the hydrogen produced in 2018 was produced using (clean) electrolysis in conjunction with renewable energy. Looked at from another angle: 96 per cent of the hydrogen was produced using input materials that are still prime causes of climate change.

Differences in H_2 production

An understanding of the main differences between the various types of H_2 – and the associated advantages and disadvantages – is therefore necessary when deciding on future financial assistance:

- *Grey hydrogen:* Is mostly extracted from natural gas or other fossil fuels. Hydrogen is produced by means of a chemical reaction using superheated steam. The downside is that this technology has a very negative carbon footprint. For every tonne of H_2 produced, almost 10 tonnes of CO_2 are released. However, around 76 per cent of global H_2 production facilities use this method. In the US, 95 per cent of hydrogen is produced in this way. The upside is that established production methods and readily available input materials can be used to produce inexpensive hydrogen. However, if we are to achieve the target of carbon neutrality by 2050, we will have to make changes to this method of producing H_2 or abandon it altogether. It is not worth supporting from a climate perspective.

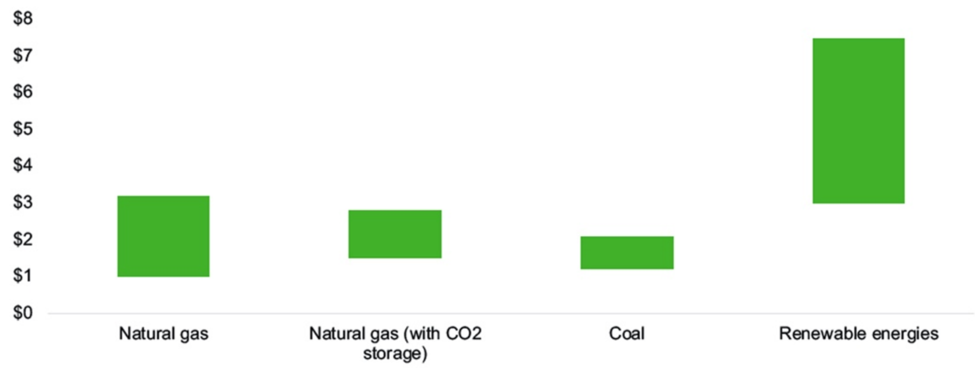
Blue hydrogen as a pragmatic interim solution

- *Blue hydrogen:* This production method also uses gas and/or coal as the most important input materials. For this reason alone, it is problematic from a climate perspective. However, once the hydrogen has been produced using conventional means, the CO_2 released is captured using an additional technology and stored for possible later use. This process is known as carbon capture utilisation and storage, or CCUS. Blue hydrogen has the same advantages as grey hydrogen: established production processes and facilities and readily accessible input materials. Unlike with grey hydrogen, no additional CO_2 is released – as least not during the production of the H_2 itself. The problem, however, is that storing CO_2 in the ground is a very complex and expensive process, as can be the process of gaining approval for CCUS plants, which in some countries are not permitted at all. The amount of storage capacity required is also immense: Morgan Stanley estimates that up to 1,700 new CCUS plants would have to be built worldwide. Currently there are only 18 plants in operation. Nevertheless, blue hydrogen could be an interim step on the way to a largely decarbonised economy because there is already a relatively large production capacity and the costs – depending on the plant and the method – are only slightly higher than for the production of grey H_2. To support blue hydrogen and increase its availability, however, the CCUS approval process needs to be quicker and massive financial support is required. One possible option could involve rewarding private investors who help to prevent or capture carbon emissions by financing CCUS.

Green hydrogen has many advantages but the production costs are still too high

- *Green hydrogen:* This is the most expensive type of hydrogen and the most complex to produce. The basic process is not new: water (H_2O) is split into the two molecules O_2 (oxygen) and H_2 by the chemical process of electrolysis – without producing any harmful CO_2 emissions at all. If the electricity required for the electrolysis is also generated from renewable energy sources, the entire value chain is carbon neutral. This is why many experts consider green hydrogen to be the only variant that can help to secure a sustainable future. But the technological and financial hurdles are high. Compared to blue hydrogen, the production costs per kilogram of hydrogen produced are higher by a factor of 2 to 3, as Figure 5 shows.

Figure 5: Green hydrogen is currently still relatively expensive
(production costs in 2018 in US$ per kilogram of hydrogen)



Source: Bernstein Research (February 2020)

Green H_2 economy needs broad support

The challenge of establishing a green and thus truly clean hydrogen economy is that huge investments have to be made in different technology areas and these all have to be coordinated with one another. Achieving this long-term goal requires the expansion of and support for green electricity, additional infrastructure, and efficient electrolysis capacities. Currently, up to 36 per cent of the energy used in the production of green H_2 is lost. According to various studies, broad-based investment programmes spanning several years are necessary to ensure efficient technology and a comprehensive infrastructure. But this – and the economies of scale that would flow from this – could make it possible to significantly reduce the cost of production, as Figure 6 shows.

Figure 6: The cost of 'green' H_2 production is falling too
(US$ per kilogram of H_2)

Source: HSBC (Research Report January 2020)

Costs expected to fall in the coming years

The first fruits of the cost-cutting measures are already visible. According to a study by Bloomberg, the cost of certain electrolysis processes fell by around 40 per cent in Europe and the US between 2014 and 2019. In China, electrolysis is significantly less expensive than in Europe and the US – due in part to lower labour costs and the economies of scale already achieved.

From a climate perspective, it is clear that green hydrogen is the best production method. However, massive investment is required to set up cost-effective green hydrogen production facilities with sufficient capacity. This cannot be done by the private sector alone. Extensive public funding is required, as envisaged in the European green recovery plan. The financial support provided now should pay for itself in the medium to long term. The more companies and countries participate in the building of a hydrogen economy, the faster this will be achieved. The whole area of 'green hydrogen' could become a sustainable growth engine for all participating countries and companies, as demand for H_2 increases and innovative production technologies are developed.

Subsidies could drive change

The example of the promotion of renewable energy in the US clearly demonstrates how public subsidy programmes can help new, climate-friendly products become established in the market. There, the share of renewable energy in the overall energy mix rose from 9 to 17 per cent in the period from 2000 to 2017, thanks to the provision of start-up financing over a period of several years. The increased use of biofuels in the transport sector has been one of the factors contributing to this development. In the meantime, the subsidy payments are already being reduced as sales of the subsidised products increase and the associated economies of scale are achieved.

However, due to the existing production capacities and even lower costs, the production and expansion of blue hydrogen also appears to be an option for achieving decarbonisation, at least for a certain transition period.

This requires sufficient CCUS capacity, of course. But expansion of blue hydrogen should not be allowed to adversely affect the parallel development of green hydrogen.

5 A wide range of potential applications

Hydrogen offers a number of advantages…

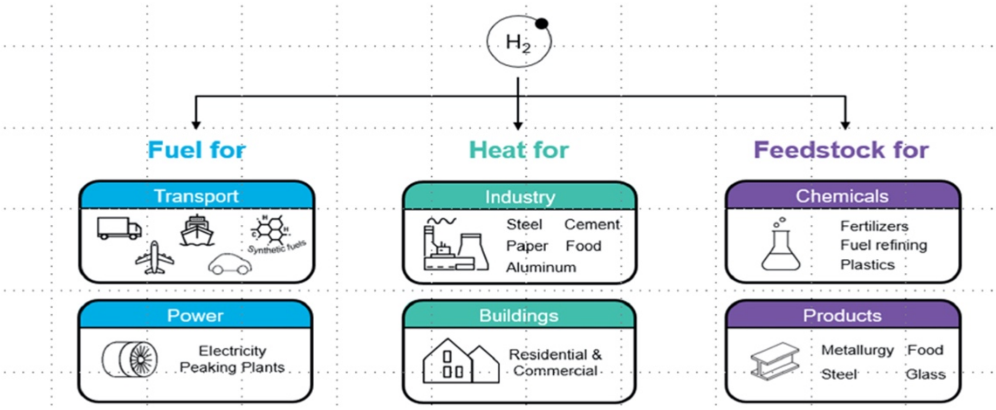
The potential to help mitigate climate change, particularly through the increased use of green hydrogen, is one of the key reasons why public investment in hydrogen has become a talking point and would appear to be a smart move. But hydrogen also has other important properties that make it suitable for broader use:

- It can be stored, despite having a lower density than other gases. This is an advantage over electricity, which is harder to store.
- It can be transported (for example in existing gas networks, but in principle also by ship and truck)
- It can be used as an intermediate product (for example in the chemical industry).
- It can be used to produce energy, fuels and very high temperatures.
- It can be used in a wide range of industrial sectors that have so far relied almost exclusively on fossil fuels in their production processes.

…and is very versatile

Figure 7 clearly shows the variety of potential industrial applications.

Figure 7: Potential applications of hydrogen



Source: Bloomberg (BNEF)

As a fuel for the transport and utilities sectors, hydrogen could be used in the following areas, for example:

- For biofuels in the aviation industry. In the long term, hydrogen could support the increased use of sustainable aviation fuel (SAF).
- For fuel cells that could be used in the medium term, especially in heavy trucks, trains and ships. The use of fuel cells in the automotive sector, on the other hand, seems less likely, since battery-based drive technology has weight and cost advantages that fuel cells are unlikely to match in the medium term. The efficiency losses in the H_2 upstream chain up to the point at which it is used in a passenger car fuel cell are currently still too high.
- For utility companies that will, in the long term, add hydrogen into the existing gas supply and thereby help to reduce consumption of natural gas, which is more harmful in terms of carbon emissions. A complete switch from traditional power plants to hydrogen-powered plants is still a long way off.

In industry, hydrogen could be used more widely in production processes that require heat and/or very high temperatures. In these areas in particular, there are currently no alternatives that could decarbonise production processes or heat large building complexes in a climate-friendly way. Use of hydrogen would therefore achieve a significant reduction in CO_2 emissions, particularly if used in industries that have a particularly damaging effect on the climate. In the medium term, hydrogen could be a low-carbon production alternative for

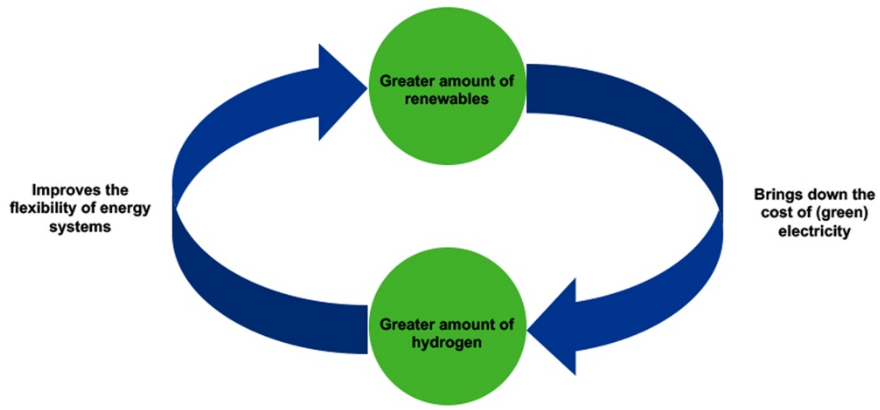
- the cement industry,
- the steel industry,
- the aluminium industry
- and the large sector of residential and commercial property.

The gases and by-products of hydrogen production are already used as feedstock in many chemical applications and products. They are particularly important in the production of fertilisers, but are also used in the manufacture of glass products and in the food industry. Decarbonisation could also be achieved in these segments in the long term through the use of green hydrogen.

Positive interdependence between H_2 and renewable energies

In addition to the promising industrial applications mentioned above, H_2 offers another advantage: the positive interdependence with the electricity generated from renewable energy sources. The production of hydrogen could serve as a ‘buffer technology’. Figure 8 illustrates this simple, but important relationship.

Figure 8: Interdependence of H_2 and renewables



Source: Created by author.

Currently, particularly in the field of renewable energies (for example wind and solar), there are frequent production peaks where the electricity generated is not always immediately needed. This can be very challenging in terms of the grid capacity. There is currently insufficient capacity to store this (green) electricity. If this ‘surplus’ electricity were to be used to produce green hydrogen, this would have two key advantages. Firstly, it could accelerate the expansion of capacity to produce green electricity, as the problem of overproduction would become more manageable. Secondly, it could further push down the price of electricity from wind and solar plants, as economies of scale have a positive effect on costs and prices. This is very important, because electricity costs are currently one of the most important factors determining the price of green hydrogen. The cheaper the electricity used to produce the hydrogen, the lower the price of hydrogen and the sooner it will be able to compete with other energy sources.

H_2 does however have some drawbacks for industrial use

The medium to long-term opportunities arising from a more widespread use of hydrogen are considerable, especially from a climate perspective. However, it is important to note that in addition to the immense costs, complexity and long-term nature of the projects, hydrogen itself also has some disadvantages:

- Hydrogen has to be made, which means that it always has a (cost) disadvantage compared with fossil energy sources, which only have to be mined or extracted.
- Hydrogen's low density (compared with other gases) makes it more difficult to store. H_2 storage systems require more space and consequently tend to be more expensive.
- Hydrogen can be transported relatively easily in pipelines. However, the conversion of hydrogen that is often required during transport, for example by ship or truck, pushes up costs for industrial end users and leads to energy loss. So it is crucial – but, at the same time, cost-intensive and time consuming – to first ensure that the infrastructure is in place to ensure that hydrogen can be transported as reliably and cost-effectively as possible. Geographical proximity between the electricity producer, the H_2 production and storage sites and the industrial end customer helps to avoid efficiency losses and keep transport costs low.

In spite of all this, the promising application possibilities and the huge potential benefit for the climate through increased use of H_2 should outweigh the known disadvantages. Many policymakers seem to share this view. In the current situation, they are prepared to support a sustainable transformation to a hydrogen economy with significantly higher subsidies and investment incentives than have been available in the past.

6 The capital market is sensing a (new) opportunity

Varied investment opportunities in the capital market

As an investment topic, hydrogen has been offering opportunities in the capital market for some time. But the recently announced plans for fresh public funding for hydrogen and its associated industries are boosting the topic's appeal for financial investors. The investment opportunities in this area are just as varied and promising as the aforementioned areas of application for the gas. The main fields that will benefit from increased funding and investment, and could therefore hold particular interest for investors, can (roughly) be grouped into the following segments:

- Fuel cell technology,
- Plant engineering,
- Utilities
- Producers of gases

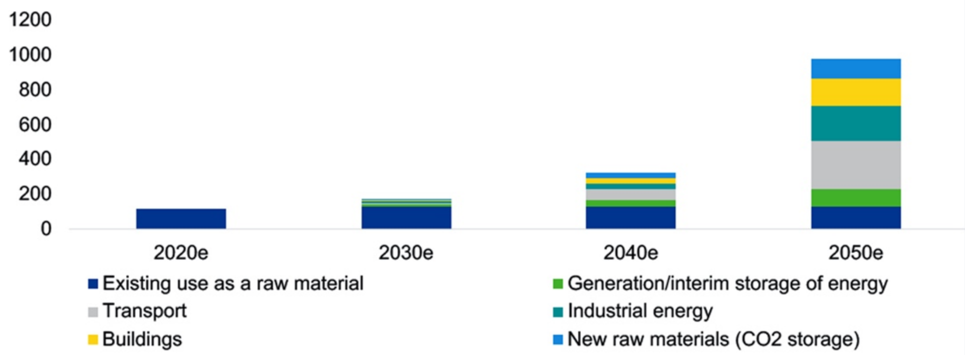
Growth can be expected in many sectors

Figure 9 further illustrates that in addition to its use as a raw material, hydrogen seems to have promising potential for application in areas such as

- transport & logistics (use of fuel cells),
- industrial production processes (plant engineering),
- new network infrastructure (traditional utility companies)
- and renewable energies.

These areas are likely to see a significant increase in revenue between now and 2050.

Figure 9: Global revenue potential of hydrogen
(US$ billion, by field of application)



Sources: Hydrogen Council, IEA, HSBC calculations

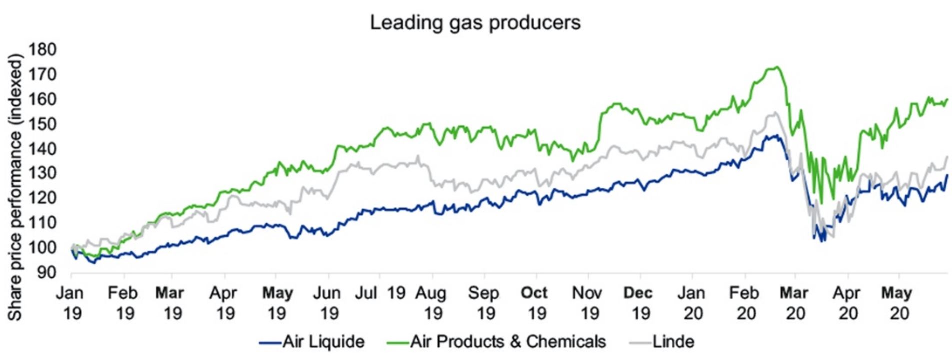
From an investor's point of view, selecting areas that are likely to benefit from growth in hydrogen-related technologies and establishing positions in these at an early stage is a sensible approach. Figure 10 shows that leading producers of gases, for example, have been performing very well since the start of 2019, despite the coronavirus-related turmoil in 2020. In this generally cyclical market sector, investors appreciate the relatively steady returns that these investments generate. And in addition to the growth in their traditional business segments, the rise of hydrogen also bodes well for the future of these companies. This is having a positive impact on sentiment and share price performance. The following chart depicting the share price of selected gas producers illustrates this very well.

Identifying and tapping into sustainable transformation processes that may affect individual companies or even entire industries is also the aim of Union Investment's conviction approach to ESG investment. The aim of this targeted selection process is to identify companies whose future growth trajectory will be influenced strongly by sustainable products and services. Two examples from the hydrogen industry:

Benefiting from a sustainable transformation

- *Air Liquide* (AL) is a founding member of the previously mentioned Hydrogen Council. The company understands that hydrogen is going to play an important role in many areas of industry and the economy in the future. On this basis, AL began to invest in hydrogen infrastructure and fuel cell technology at an early stage. In addition, the company has been steadily expanding its H_2 charging infrastructure around the world. Between 2014 and 2019, Air Liquide invested around €480 million in the field of mobility. The company is also working on

Figure 10: The capital market is recognising the potential of hydrogen



Sources: Bloomberg, Union Investment's own calculations

  technical solutions that will allow the use of hydrogen as a storage medium for surplus energy and promoting the use of biogas from non-fossil sources. In order to help industrial companies to reduce their CO_2 footprint, AL cooperates with steel manufacturers such as ArcelorMittal and thyssenkrupp, offering hydrogen-based alternative production solutions. As a complementary sideline, the company is also developing CCUS applications for cases in which these may be useful and necessary. Air Liquide already generates around 10 per cent of its revenue from hydrogen products. This makes the company a pioneer of the transformation in the gas and energy sector.

- *Orsted* has been undergoing a fundamental transformation of its business model in recent years. Just a few years ago, the company – still operating under the name Dong Energy at the time – was a traditional utility company based in Denmark. But then, its management decided to reorganise the company completely – a step partially driven by climate-related considerations. The company sold its coal and oil operations and has since directed its focus towards wind farm development. Today, Orsted is a world-leading 'pure-play' company in the field of green energy generation. In order to keep a step ahead of its competitors, Orsted has started to offer customers the option to enhance their wind farms by adding electrolysis capacity to generate green hydrogen as an additional product. The hydrogen can then be stored and/or used to generate green electricity. Although the price of electricity generated from green hydrogen is currently still (too) high, the wind farm enhancement offers extra flexibility and an optional buffer. The facilities offered by Orsted are an excellent example of how green power can be used (directly) to generate green hydrogen. At present, many of these facilities are still operated as part of pilot projects, but their operators are learning a great deal along the way and each further project improves the economies of scale of this technology (albeit slowly).

These two examples clearly demonstrate that hydrogen and the technologies, industries and companies associated with it are an attractive investment topic for investors with a long-term horizon. In light of plans for substantial public funding in this area, there are now much more realistic prospects than in the past for companies in these sectors to achieve sustainable growth on the back of a large-scale hydrogen-based industry.

7 Conclusion

There is no lack of ambition. That much is clear from the large number of public investment programmes and the scale of the sums involved. Hydrogen and the sectors associated with it are an important element of these initiatives. This is good news because, if used more widely in industry, hydrogen – and green hydrogen in particular – can help to curb climate change. Together with other initiatives aimed at reducing carbon emissions, hydrogen will play an important role in achieving the Paris climate goals.

The coronavirus pandemic has indirectly impacted the financial support for hydrogen and the fight against climate change. The economic crisis triggered by the virus has led to a greater willingness among many politicians around the world to make large sums of money available for the promotion of innovation. And they have been quicker to respond and to launch new programmes than in previous crises. The funds now being made available could be the catalyst needed to transform large parts of industry into a more hydrogen-based economy.

But the road is long, the technology complex, and the costs high. Despite all the advantages that increased use of hydrogen would bring – especially in comparison with fossil fuels – H_2 has its own limitations that have to be taken on board in the implementation of a more comprehensive hydrogen strategy.

The capital markets appear to be convinced by these moves to transform the economy. Some companies operating in the areas of fuel cells, plant engineering and industrial gases have already benefited from the impetus created by an emerging hydrogen economy. But the volume of investment required and the potential increases in revenue and profit mean that hydrogen will remain a promising area in the future for investors looking for long-term, sustainable investments.

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