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CAN EUROPE'S POSITION ON HYDROGEN

Climate Action Network (CAN) Europe is Europe's leading NGO coalition fighting dangerous climate change. With over 170 member organisations from 38 European countries, representing over 1.500 NGOs and more than 47 million citizens, CAN Europe promotes sustainable climate, energy and development policies throughout Europe.

INTRODUCTION

The role of hydrogen in Europe's energy transition has become a significant topic of debate in recent months. This paper aims to set out Climate Action Network Europe's position on hydrogen, including production, appropriate end uses and infrastructure considerations.

To be in line with science and the 1.5°C objective of the Paris Agreement, Europe needs to reach **climate neutrality by 2040**. A full decarbonisation of the economy will require the EU to **halve energy demand** and triple primary energy supply from renewables by 2050, by integrating significant amounts of renewable energy sources into all sectors (industry, buildings, transport etc). This means achieving at least 65% greenhouse gas emission cuts, 45% energy savings and a 50% share of renewable energy by 2030[1]. It will also require a **high level of direct electrification** of the heating and cooling and transport sector. A prerequisite to reach these goals will be to integrate a circular economy approach.

Even if the EU achieves the above climate and energy targets and implements important circularity and resource use reduction efforts, **in certain sectors energy demand** that cannot be met by direct electrification **will remain**. Hydrogen and its derivatives[2] could supply up to one-fifth of the EU's final energy demand in 2050 (rising from 566 TWh in 2030, i.e. 6% of the EU's final energy demand, up to 1109 TWh in 2050)[3]. Hydrogen, if produced from renewable electricity, is one of the most promising technologies for meeting this need. However, as **renewable hydrogen** is not a primary source of energy but an energy carrier requiring conversion from renewable electricity and implying important energy losses, we can consider it a **limited resource**, needing reflection on its development and use and its ability to deliver at the scale and speed necessary.

Given that today almost all hydrogen comes from fossil fuels, there is a **significant risk that the European hydrogen sector could fail to shift completely to renewable hydrogen** and instead becomes a way to justify continued investments in fossil fuels and maintaining legacy or building new infrastructure that should instead be **decommissioned**.

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[1] See CAN Europe's and EEB's PAC Scenario report which describes an EU climate neutrality pathway by 2040. For instance, final energy demand will almost be halved and go down from more than 12,000 TWh in 2015 to approximately 6,000 TWh by 2050.
[2] Liquid synthetic fuels, renewable ammonia.
[3] PAC scenario, technical summary p.40.

HYDROGEN TECHNOLOGIES

Today, fossil gas-based hydrogen is mainly produced through **steam methane reformation** (SMR), a heat-consuming reaction splitting fossil gas and water molecules, which results in CO_2 escaping into the atmosphere (so called “grey hydrogen”). That is how a vast majority of the 8 million tons of hydrogen produced in the EU every year is made today, emitting between 60 million and 70 million tons of CO_2. If the CO_2 is captured through carbon capture and storage (CCS) then the hydrogen is called “blue hydrogen”. Blue hydrogen is at its very early stages, representing less than 1% of hydrogen production in Europe today.

Another way to produce hydrogen is through **electrolysis** splitting water molecules into hydrogen and oxygen. This reaction takes place in an electrolyser which requires electricity coming either from burning fossil fuels, from nuclear power (so-called “pink” or “yellow” hydrogen) or from renewables. Hydrogen produced through electrolysis is also water intensive. Today, renewable hydrogen makes up less than 0.1% of hydrogen produced in the EU.

Hydrogen can also be produced through **pyrolysis**, using heat to break down natural gas into gaseous hydrogen and solid carbon (so-called “turquoise” hydrogen).

Several definitions circulate to label different categories of hydrogen stemming from different production processes (SMR, electrolysis etc.) or from different energy sources (renewables, fossil fuels, nuclear). Sometimes, categories of hydrogen are identified by colour (e.g. “green” refers to renewable-based hydrogen from electrolysis); in other cases, the labels are even broader (“low carbon” hydrogen can refer to both fossil-based hydrogen with CCS and nuclear-based hydrogen). **These labels**, which are unclear and often overlap, **are confusing and therefore should not be used**. To ensure transparency, reference should be made to the energy source as well as to the production process.

The use of fossil gas does not only emit carbon dioxide but also **methane**, a short-lived and very potent greenhouse gas emitted over the entire supply chain: during extraction, transport and use. Methane causes an estimated 25%[4] of global warming experienced today with the gas and oil sector being one of the leading emitters.

The only carbon-free and safe way of producing hydrogen requires **electrolysis from renewable electricity**. Renewable hydrogen as well as its derived products must be produced and **used only for specific sectors** where it is proven that it is an economically and environmentally effective solution. These sectors will need policy framing and support to access renewable hydrogen and to adapt their infrastructure for transport, storage, and production processes.

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[4] EDF calculation based on IPCC AR5 WGI Chapter 8.

Given the very limited amount of truly sustainable, renewables-based hydrogen, only sectors and uses for which no other solutions are available should benefit from renewable gases. The use for hydrogen should always be considered after direct electrification with renewables and energy efficiency and energy saving measures.

A DEDICATED POLICY FRAMEWORK FOR RENEWABLE HYDROGEN

Most clearly, decarbonising the economy in line with the 1.5°C objective leaves no room for any type of fossil fuels-based hydrogen. Therefore, the objective of this position paper is to define **landmarks of a dedicated policy framework for renewable hydrogen** while taking into account that it is still an immature technology which needs careful monitoring. Hydrogen should also not serve as an excuse to continue gas infrastructure development in a "business as usual mode" and create further stranded assets which will have to be borne by consumers. Nor should it prolong dominating energy import models from third countries which might have low levels of energy access or their own just transition challenges. Having this context in mind, this paper will:

- highlight key principles for the **targeted mobilisation in limited sectors** that lack alternatives for deep decarbonisation,
- define impacts on **infrastructure** and **renewable energy generation capacity**,
- include proposals for **market incentives** and **strong sustainability criteria, including taxonomy requirements**.

a) Renewable hydrogen use in specific sectors and for storage.

In a few sub-sectors, direct electrification with renewable energy sources is technically difficult or highly inefficient. Even after having massively reduced the energy demand of these sub-sectors, they still require energy carriers either with high energy density/high temperature or gaseous fuels as a feedstock. Developing renewable hydrogen requires primarily applying the energy efficiency first principle and secondly high levels of renewables based electrification. It will come in only once **ambitious energy demand reduction measures, modal shift and electrification** have been achieved.

This will be the case for certain **energy-intensive industrial sectors** currently using high temperature processes like steel production where hydrogen could be used as a reducing agent for producing direct iron ore (DRI). Another concrete application would be the chemical industry which uses hydrogen as a feedstock for producing fertilizers. To further reduce demand in these industrial sectors, there is an additional need to replace high temperature processes as much as possible with ones that can be powered directly by renewables. Relevant shares of renewable hydrogen will have to be introduced already during the 2020s in energy-intensive industries, to achieve a rapid coal exit by 2030 and a fossil gas phase-out by 2035[5].

To shift away from fossil oil products in **aviation and shipping**, alternatives such as renewable ammonia for ships and in particular liquid synthetic fuels for planes will have to cover a higher share of long-distance transport's final energy demand. In contrast to passenger cars, these sectors are difficult to convert to electric drives. For road freight, the guiding principle should be to electrify what is feasible. Fuel cell trucks may be an option – alongside direct electrification – for long-haul, heavy-duty trucks. For aviation, liquid synthetic fuels are the only mid-term renewable alternative (besides liquid biofuels which for sustainability reasons are not an option) to phase out the fossil oil product kerosene. Only a very swift and broad scaling up of renewable hydrogen generation allows for the fossil oil phase-out. In long distance shipping renewable ammonia could replace bunker fuels which however raises questions around pollution risks and sustainability that will have to be closely monitored over time.

When deriving liquid synthetic fuels from renewable hydrogen for transport use, carbon needs to be added to the hydrogen molecule. This carbon can be captured through direct air capture (DAC) processes, absorbing CO_2 from the air. The process of upgrading raw biogas to pure biomethane also releases carbon dioxide that could be used for the conversion of renewable hydrogen to synthetic methane. The carbon demand for converting renewable hydrogen into synthetic methane and/or liquid synthetic fuels can be covered on this basis without further introduction of carbon capture and usage technologies and is therefore in line with a fossil fuel phaseout. DAC has high costs and is not meant to be introduced as a large-scale carbon removal technology in view of the net-zero emissions target.

Renewable hydrogen will also play an important role in **balancing the electricity grid and seasonal storage.** Hydrogen provides short-term flexibility to the grid as electrolysers can react to renewable excess electricity and decrease pressure on the network and thereby prevent curtailment. The produced hydrogen can be stored long term and reconverted back to electricity in times of peak demand when solar and wind electricity are scarce. Storage can happen in natural underground caverns or tanks, either under gaseous or liquid form. Converting hydrogen from its gaseous to its liquid form however requires very low temperatures and is highly energy consuming. Gaseous hydrogen storage therefore is the preferred option.

b) Where will renewable electricity for hydrogen come from?

The electricity demand of electrolysers for producing renewable hydrogen needs to come from **additional renewable electricity generation capacities** and **excess renewable electricity** that otherwise risks to be curtailed. It needs to come on top of the renewable energy needs for direct electrification and heating in the other sectors of the economy.

[5] CAN Europe position paper on fossil gas demands a gas phase out by 2035.

Europe has important renewable energy potential[6] in terms of onshore and offshore wind, as well as solar PV which can be mobilised quickly and cost-efficiently with high local value added.

To exploit the full potential in the EU and to avoid displacing a greener grid from developing countries to Europe[7], renewable hydrogen imports from third countries should be avoided.[8] The European Union should not outsource its energy transition and make itself dependent on imported renewable hydrogen produced in third countries, possibly geopolitically unstable and potentially linked with social and environmental damage. This is even more relevant, if these third countries have not yet achieved a fuel switch to energy efficiency and renewable energy for their own domestic needs.

c) Impacts on infrastructure for renewable hydrogen

To assess renewable hydrogen infrastructure needs, the European network planning process needs to look into a number of topics which will guide decisions to be taken on the issue.

Additionality in renewable hydrogen production: First question that needs to be addressed is the need for additional renewable energy generation capacity[9] to cover hydrogen demand needs. This needs to be recognised and translated into an increased renewable energy target as well as increasing needs for electricity infrastructure.

Quantifying demand, identifying needs for localised infrastructure: Secondly hydrogen demand of the specific sectors identified above needs to be quantified adequately to avoid overestimates of overall hydrogen demand. The development of an EU wide hydrogen network as advocated for by the gas industry[10] is also not necessary. On the contrary, a careful geographical correlation needs to be made between localised points of production (renewable hydrogen hotspots) and points of consumption (e.g. industry clusters). This will give indications on the needs for either repurposing existing gas infrastructure, building new hydrogen infrastructure elements to exclusively transport hydrogen and certainly deploying and adapting the electricity grid. First elements of reflection can be found in this recent report[11]. If the **point of production is close to where the renewable electricity is generated**, pipelines to transport the renewable hydrogen to its point of consumption are

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[6] For reaching a 100% renewable energy supply in the EU28 by 2040, the PAC scenario shows we need onshore and offshore wind turbines with ca. 990 GW of installed capacity plus solar PV panels with ca. 1,900 GW of installed capacity.
[7] Will the dash for hydrogen benefit sub-Saharan Africa? Energy Monitor, Jonathan Gaventa, October 2020
[8] This is a crucial element that was intensively discussed at the PAC scenario building workshops as well as in the context of the previous gas position. CAN members came to the conclusion that renewable hydrogen should predominantly be produced domestically and imports be avoided.
[9] Additionality in renewable hydrogen production. Joint contribution in the Council's energy working party from AT, DK, ES, IE, LU, PT, November 2020.
[10] European Hydrogen Backbone, Gas for Climate, July 2020.
[11] What energy infrastructure to support 1.5°C scenarios? Artélys, November 2020.

required. Those can be dedicated and new built hydrogen pipes connecting the electrolyser to an existing gas network. In that case, the existing gas network needs to be repurposed to transport renewable hydrogen to those industry sites where it is needed for production processes (steel, chemicals, cement etc). In case the **point of production is identical with the point of consumption** (i.e. the industry site itself where hydrogen will be consumed), renewable electricity will ideally be generated at the site itself or could be delivered through a Power Purchase Agreement with a 100% renewable energy company generating electricity at (or close by) the point of consumption. This might be preferable to taking the electricity from the grid as the carbon content of the EU's electricity mix is still very high.

Important infrastructure elements are electrolysers, pipelines (dedicated or existing), compressors, refuelling stations and grid capacity. Harbours and ships or trucks to transport liquefied hydrogen should not be a priority as hydrogen imports should not play a strong role and as liquefying hydrogen requires cooling it down to more than -250°C, which is a highly energy intensive and inefficient process. However, further reflection is needed regarding transport routes and means for synthetic liquid fuels, and possibly ammonia for long distance transport such as aviation and shipping. The infrastructure requirements will be very different for the industry and transport sectors, depending on physical properties of the energy carrier (hydrogen/gas or its derivatives/fuels/liquids). The transport sector for instance, will require its own specific infrastructure (e.g. refuelling stations).

The **costs of developing hydrogen infrastructure** such as building new and repurposing existing gas networks will have to be assessed and included into any cost benefit analysis for future projects. Stranded assets putting additional costs on consumers through unspecific infrastructure development should be avoided. The process of decommissioning obsolete gas infrastructure with no relevant utilisation rates anymore should start now.

Independent and science-based governance: To ensure that future hydrogen development is guided by science and the effort needed to limit temperature increase to 1.5°C, a good governance process is key. The planning and modelling of hydrogen infrastructure projects needs to be led by an independent and science-based body. Conflict of interest as seen in the EU's current infrastructure planning process (TEN-E) with the gas transmission industry in the lead (ENTSOG together with ENTSO-E), has led to increased gas consumption projections and continued eligibility of fossil gas projects for EU funding.[12] A similar situation should not be reproduced in the case of hydrogen planning. However, the currently dedicated EU structure, the Clean Hydrogen Alliance, is strongly steered by Hydrogen Europe, an industry-led association including numerous fossil fuel companies[13]. Conflict of interest needs to be eliminated throughout the different hydrogen relevant pieces of legislation or processes (TEN-E, Clean Hydrogen Alliance...).

[12] NGO briefing on the revision of Trans European energy infrastructure regulation, July 2020.
[13] NGOs, including CAN Europe are addressing this problem through participating in roundtables organised by the Clean Hydrogen Alliance.

An additional point for conflict of interest could be triggered through the displacement from the transmission grid over to the distribution grid because of more localised production and growing electrification of sectors. In both cases, questions of ownership of the grid/pipelines and conflict of interest between production and transmission operators need to be considered.

Blending renewable hydrogen up to a certain percentage into existing (or new) gas pipelines, resulting in a mix of fossil gas and renewable hydrogen, is not an option as it leaves the door open for continued use of fossil gas. Specifically as many of the current hydrogen and gas industry actors are overlapping and pursuing the same goals of continued fossil gas use creating thereby a conflict of interest. Industries' and transport's demand for pure hydrogen anyway would not be satisfied with fossil gas that contains a limited share of hydrogen, as for many uses the hydrogen needs to be in its pure form.

d) Market introduction for renewable hydrogen

The production and transport of renewable hydrogen is not yet competitive as there are important losses of primary energy input but also because fossil fuels are still highly subsidised. Efficiencies of electrolysers and conversion processes gradually improve but levelised costs of renewable hydrogen remain still relatively high compared to direct electrification[14] or hydrogen sourced from fossil gas, with or without CCS.[15]

To make a targeted and sustainably sourced renewable hydrogen introduction a success, regulations and market design need to be addressed. The following elements need to be taken into account:

- Requiring all **hydrogen to be made from 100% renewable electricity** generation and therefore ensure that **additional renewable electricity generation capacities are deployed**.
- Require that Member States **prioritise efficiency measures**, in line with the Energy Efficiency First Principle.
- **Exclude any direct or indirect support to hydrogen that is not 100% renewable**. Such support would redirect aid towards fossil-based energy and create lock-in effects of gas instead of supporting the deployment of renewable energy capacity and technology.
- Require that any direct or indirect support to renewable hydrogen be based on an **assessment of projected demand and supply, and allocated based on priority**

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[14] ICCT; International Energy Agency: The future of hydrogen, June 2019; Cambridge Econometrics/Element Energy/European Climate Foundation: Towards fossil-free energy in 2050, March 2019; Agentur für Erneuerbare Energien (AEE, German Renewable Energies Agency): Metaanalyse Erneuerbare Gase in der Energiewende, March 2018; Agora Energiewende/Enervis: Power to gas/Power to liquid calculator, February 2018.
[15] Estimated costs today for renewable hydrogen are 2,5-5€/kg versus 1,5-1,7€/kg for fossil based hydrogen and 2,5€/kg for fossil based hydrogen with CCS.

sectors such as chemicals and steel for which other cleaner alternatives such as electrification and energy efficiency measures are not currently available.

- Address flaws and conflicts of interest in **infrastructure planning in the TYNDP** (Ten Year Network Development Programme) and the **TEN-E** (trans-European energy infrastructure regulation). Ensure that newly built infrastructure will serve **only for renewable hydrogen.**
- **Explicitly exclude certain sector*s*** from receiving any regulatory or financial support, e.g. residential boilers, hydrogen passenger vehicles, hydrogen trains.
- **Removing taxes on renewables and subsidies for fossil fuels**: While most of the fossil-based hydrogen is produced from fossil gas which attracts almost no taxes and levies, renewable hydrogen faces electricity taxes and levies which substantially increase its production costs. In parallel, all fossil fuel subsidies need to be removed entirely. From **2021 onwards** no public money (Connecting Europe Facility, Recovery Facility, EU strategic investment facility, Regional Funds, European Investment Bank) should be allocated to any fossil fuel projects (new or existing) including gas infrastructure.
- **Adequate carbon price**: Alongside removing fossil fuel subsidies and taxes and levies, a strong carbon price in line with the climate neutrality objective needs to be attributed to all carbon emitting technologies taking into account full lifecycle greenhouse gas emissions including scope 1 to 3 emissions.
- **Support schemes**: Introduce support schemes such as Contracts for Difference (CfD) for those sectors needing priority access to renewable hydrogen. The steel and chemical industry for instance could receive financial support under the form of a strike price to be able to cover the additional cost for 100% renewable hydrogen use[16] under certain strict conditions. Support for priority hydrogen users must be conditional on the firm having a clear and ambitious roadmap for achieving climate neutrality by 2050 at the latest and should not go towards the use of hydrogen for purposes that are not compatible with the EU's 2050 climate target (e.g. oil refining, any use of fossil fuels or CCS/U). Where a firm which is in receipt of support for hydrogen development has traditionally had a carbon-intensive production process, it must be able to clearly demonstrate that renewable hydrogen will displace pre-existing use of fossil fuels. The storage capacity of renewable electricity electrolysers should be recognized and therefore incentivised. It should also come in counterpart to free allocation schemes to exclude windfall profits.
- **Research funding**: To reach maturity of hydrogen technologies and accelerate its market introduction, research budgets need to be made available in the next two years for 100% renewable hydrogen projects only for instance under the EU ETS Innovation Fund, Horizon EU, Invest EU or Regional Funds with strong conditionalities attached allocating funds only to renewable hydrogen projects. Ensure that future **IPCEI's** (Important Projects of Common European Interest) are supporting renewable hydrogen projects only.

[16] e.g. electrolysers or replacement of technical equipment

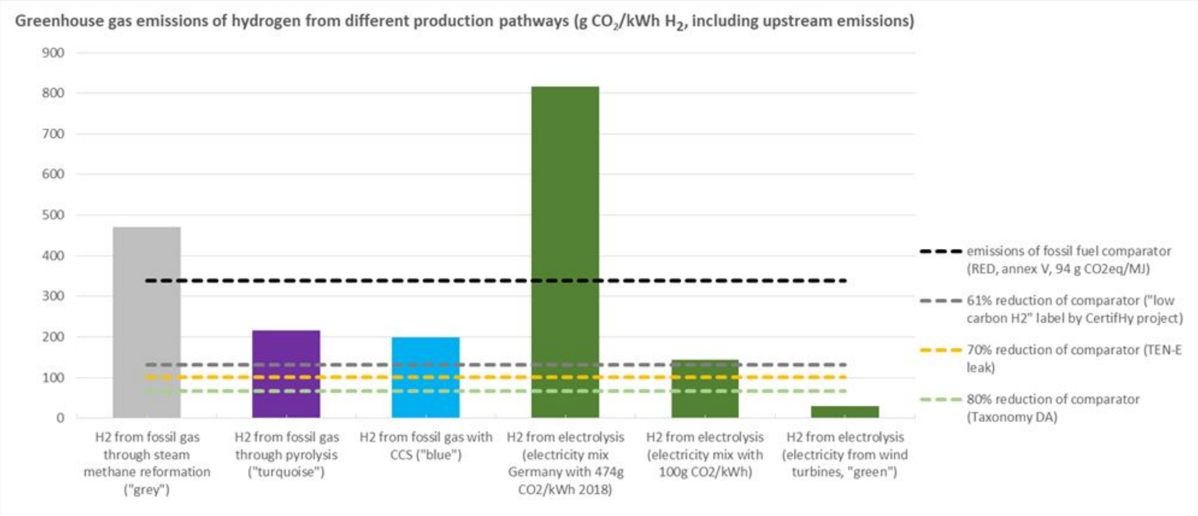
- **Setting only a renewable hydrogen target**: Under no circumstances, an unspecific or loosely defined (i.e. decarbonised, clean) hydrogen target (or quotas) should be adopted, neither under the Renewables Directive nor under any other legislative instrument. The same applies for a **Guarantees of Origin (GoO) scheme** designed for decarbonised gases. This would leave the door open to the gas industry, eager to obtain lifetime extension for their fossil products and infrastructure. However if a GoO scheme for 100% renewable hydrogen was to be developed it should respond to transparent, verifiable sustainability criteria including proof of origin. There should also be no blending target for a certain percentage of renewable hydrogen to be added to fossil gas. If a **purely renewable hydrogen target** would be introduced then this should be coupled to (a) an increase of the renewable energy target, (b) a trajectory for phasing out natural gas by 2035 at the latest, and (c) dedicated to those sectors which cannot be electrified.

e) Sustainability criteria for hydrogen, outlook into taxonomy and other aspects

The taxonomy delegated acts (to be adopted) develop a classification system labelling sustainable investments (private funds and spill over to EU funds) as well as the definition of sustainability criteria for gas projects under the revised TEN-E[17] and the requirements under the current Renewable Energy Directive for the carbon content of electricity to be used for producing hydrogen. This classification system will strongly impact on how different types of hydrogen will be qualified and granted support from private investors and public funding sources.

The draft taxonomy delegated acts and the TEN-E proposal require hydrogen to comply with at least 70% or 80% greenhouse gas emission reductions compared to the fossil fuel comparator of the Renewable Energy Directive (94 g CO_2eq/MJ) for any production of hydrogen to be labelled as sustainable activity. This 70% or even 80% reduction can only be achieved by **renewable hydrogen produced from electricity with not more than ca. 50 g CO_2/kWh**, thus only wind, solar and hydropower.[18] Hydrogen produced from SMR including CCS or not (so called “blue” or “grey” hydrogen), or from electrolysis with a fossil based electricity mix would not qualify for being “low carbon” or sustainable, if the life cycle emissions have been taken into account correctly. Those requirements as set now should therefore be supported and used as a benchmark for further discussions on hydrogen. The above is illustrated by the following graph[19]:

[17] Regulation on trans european energy infrastructure networks, 2020/0360 (COD).
[18] However this would also include hydrogen produced from nuclear power.
[19] It is worthwhile mentioning that the blue column “H2 from fossil gas with CCS” represents the upper threshold for that category with almost 200 gCO2/kwh. Figures published by the UK Climate Change Committee show that the lowest emissions from so called “blue” hydrogen projects can be just 50g CO2/kwh which applies to very efficient production processes on top of a very high carbon capture rate. Most “blue” hydrogen projects in reality will have higher emissions, for example, the highest range quoted by the UKCCC is 188g CO2/kwh.



Sources: European Commission/Trinomics: Hydrogen generation in Europe: Overview of costs and key benefits, July 2020.
CertifHy: CertifHy scheme. Subsidiary document hydrogen criteria, March 2019.
Öko Institute: Not to be taken for granted: climate protection and sustainability through PtX, September 2019.
Greenpeace Energy: Blauer Wasserstoff. Perspektiven und Grenzen eines neuen Technologiepfades, January 2020.

Particular attention will also need to be given to the required resources which have to be sustainably sourced: either **water** which by the process of electrolysis is split into hydrogen and oxygen, or **carbon** for producing synthetic fuels and synthetic methane. Electrolysis does require significant volumes of pure water. This is of course a critical resource and its use needs to be closely monitored. Research on using sea water to produce hydrogen has shown promising results[20] and might be an option for a sustainable production process.

[20] https://news.stanford.edu/2019/03/18/new-way-generate-hydrogen-fuel-seawater/

GLOSSARY

Non-fossil gases and fuels

Gaseous energy carriers that are either produced with renewable electricity through electrolysis (renewable hydrogen, renewable ammonia, synthetic methane, liquid synthetic fuels) or produced with sustainably sourced biomass such as organic waste, residues and manure (biogas, biomethane). In this paper we cover non-fossil gases and fuels derived from hydrogen only.

Renewable hydrogen

Chemical element that is produced by splitting water into its component parts, oxygen and hydrogen (H_2), in an electrolyser that uses renewable electricity. It is the base for producing renewable ammonia, synthetic methane and liquid synthetic fuels.

Synthetic methane

Gaseous energy carrier that is produced on the base of renewable hydrogen, transformed into methane by adding carbon dioxide using the Sabatier process (methanation). Physically, it is identical with fossil gas and biomethane (CH_4).

Liquid synthetic fuels

Any fuel, such as gasoline, diesel, or **kerosene** produced through the synthesis of hydrogen gas, is considered a synthetic fuel. Synthetic fuels can be produced from renewable hydrogen and are meant to be used in aviation.

Renewable ammonia

Gaseous or liquid carrier of converted renewable hydrogen used predominantly for shipping.