Green hydrogen – hype or beacon of hope?

OPPORTUNITIES, RISKS AND STRATEGIES FOR GREEN HYDROGEN PRODUCTION IN THE GLOBAL SOUTH



2

Brot für die Welt

HEINRICH BÖLL STIFTUNG



Green hydrogen – hype or beacon of hope?

OPPORTUNITIES, RISKS AND STRATEGIES FOR GREEN HYDROGEN AND A JUST TRANSITION IN THE GLOBAL SOUTH

Based on the study: Teske S., Niklas S., Mey F., (2022), Renewable Hydrogen in the Global South – Opportunities and risks, July 2022, University of Technology Sydney – Institute for Sustainable Futures (UTS-ISF).
Written by: Michael Bukowski.

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Foreword

by Jaime Fernandez Medina, Brot für die Welt

Over the next years, the world energy system will need to undergo profound structural change in order to limit global warming to 1.5° Celsius. In this process, (green) hydrogen will also play an increasing role in the sustainable transformation of the energy supply system.

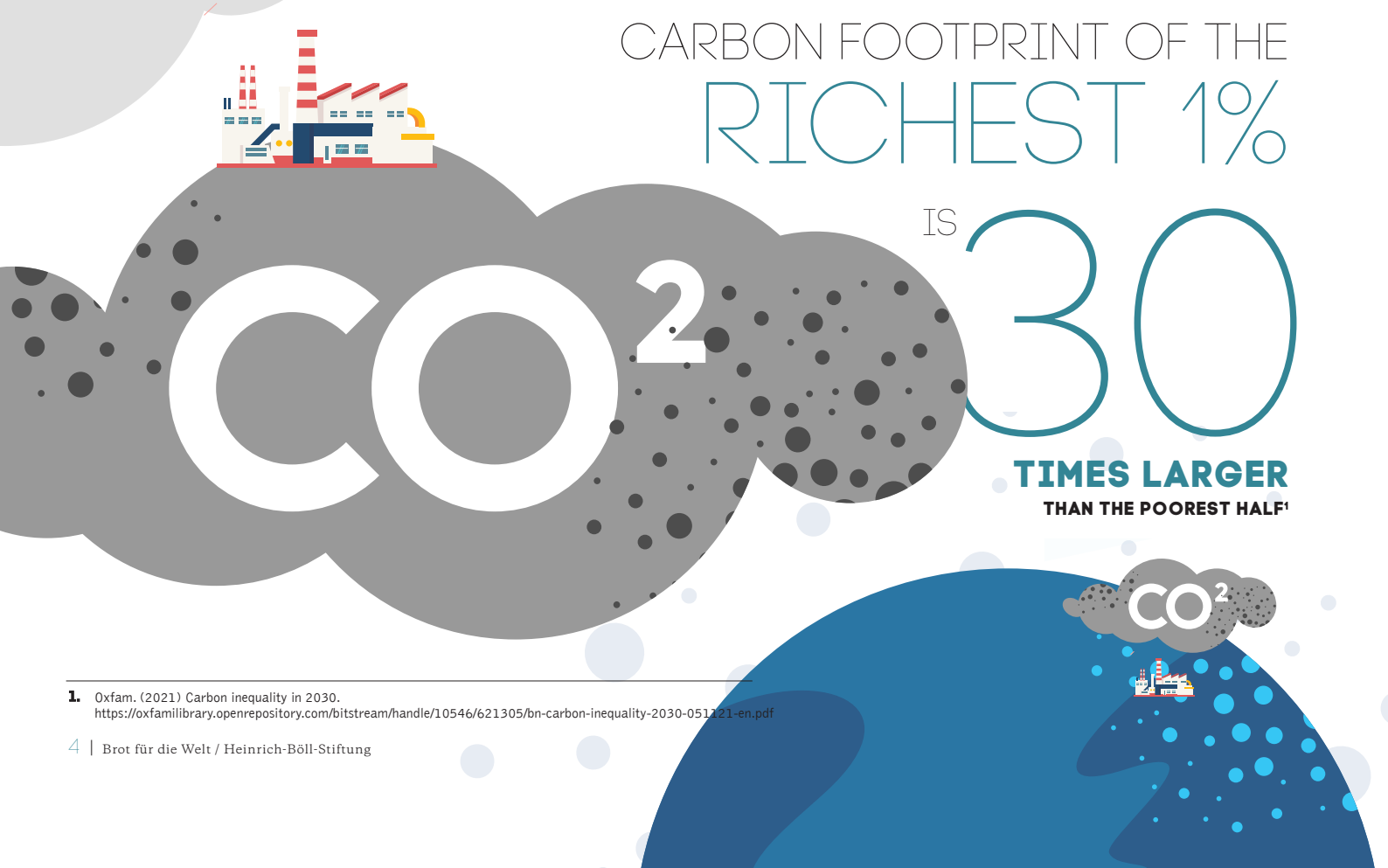
This publication is for everyone interested in learning about (green) hydrogen. "Green hydrogen - hype or beacon of hope?" is an easy introduction to the topic. It reviews trends in hydrogen generation and use today and potential challenges for tomorrow and provides stakeholders from civil society organizations and policy makers with concise, accurate and easy-to-understand information on hydrogen energy.

As a first step, an overview of the properties and use of hydrogen is presented. Furthermore, the meaning of the different colours of hydrogen is explained. This is followed by a brief portrait of the Chilean and Namibian hydrogen strategy. Finally, a look at potential risks and opportunities as well as policy development is presented. The policy development aspect is examined in terms of the criteria needed to improve the lives and rights of people in the global south. On the whole, the paper explores to what extent and under which conditions green hydrogen produced from renewable resources can contribute to our goal of achieving human-rights based responses to climate-related risks in the Global South.

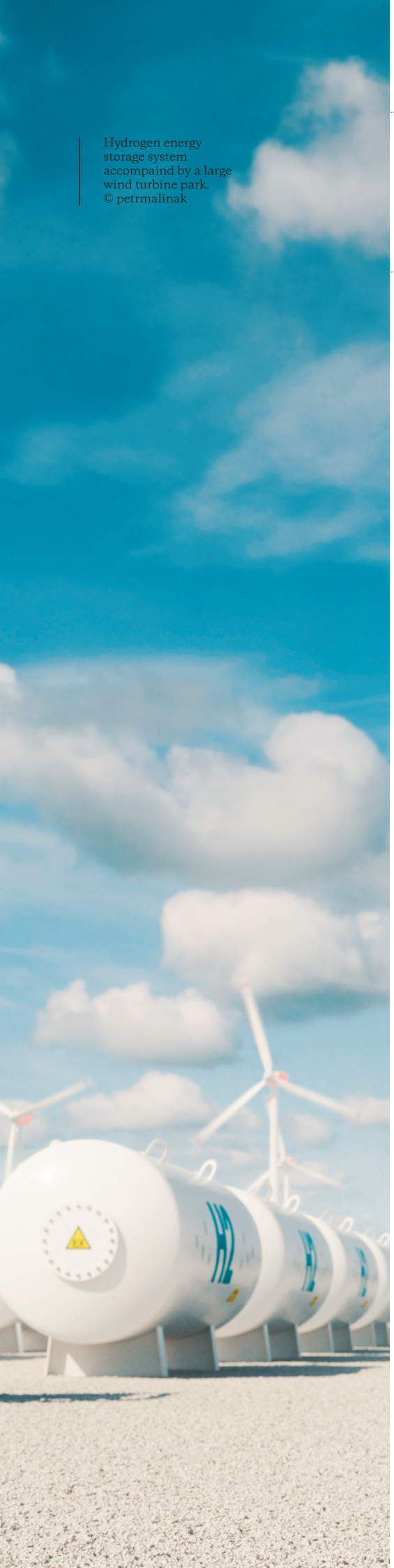
This publication's objective is to fuel the readers' reflective process as they start engaging in conversations and debate around hydrogen technology and, hence, does not cover the topic exhaustively. Through this material, Bread for the World and the Heinrich Böll Foundation aim to contribute to accelerating the orientation of stakeholders especially from civil society organizations towards an emerging hydrogen economy. Furthermore, the present publication aims to empower stakeholders to take informed decisions and responsible action for environmental integrity, economic viability and a just society, for present and future generations.

Bread for the World and the Heinrich Böll Foundation are very grateful to the author, Michael Bukowski, who contributed to this important brief. We also extend our sincere appreciation to the following peer reviewers for their kind efforts in providing invaluable insights and ideas: Bauke Baumann, Keren Ben-Zeev, Thoko Madonko, Sarah Niklas, Sarah Ribbert, Lea Truttenbach and Delia Villagrasa.

This publication is particularly needed now as a hydrogen market is emerging and increased participation of civil society groups is required to ensure a sustainable change.



1. Oxfam. (2021) Carbon inequality in 2030. https://oxfamilibrary.openrepository.com/bitstream/handle/10546/621305/bn-carbon-inequality-2030-051121-en.pdf



Hydrogen energy storage system accompaind by a large wind turbine park. © petrmalinak

01

Colours

The idea of using hydrogen in the energy system is not new. As far back as the 1700s, scientists debated the use of hydrogen to store energy. Today, hydrogen is mainly used in oil refining and the production of fertilisers. However, 99.9% of hydrogen currently produced stems from fossil fuels.

Colloquially, we are speaking of hydrogen but are referring to the H_2 molecule which consists of two hydrogen atoms, i.e. molecular hydrogen. This gas does not occur naturally, but can be synthesised using several starting materials.

Hydrogen is established as a technical gas in various industries; for example, for the production of ammonia, which is an important basic material for the manufacture of fertilisers. In refineries, hydrogen is needed to grade up fossil raw materials. A niche application is in rocket fuel. Additionally, hydrogen can serve as a substitute for natural gas in the heating and industrial sectors or in transportation.

Apart from conventional industrial applications, green hydrogen can potentially play a significant role in reaching the Paris climate goal. To this end, it is crucial to realise the difference between green and fossil-based hydrogen. At the end of the production process, the H_2 molecule is always the same, but the decisive factor is the method of production.

For a just transition to a fossil-free future, one of the available options is green hydrogen produced from renewable resources.

Colours

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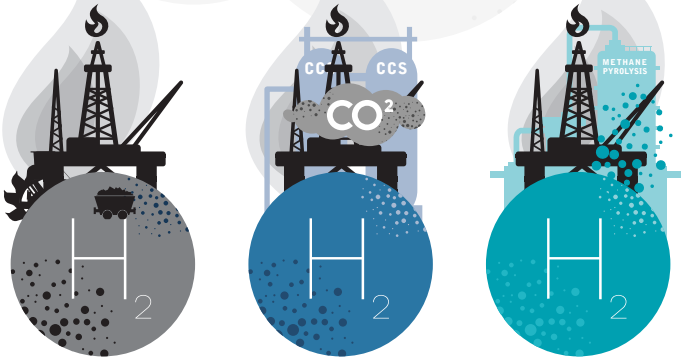


The distinction in production methods is usually made through the following colour scheme:

The big difference between green and other hydrogen.

GREEN

Green denotes production with water as the feedstock and electrical energy from renewable sources.



BLACK / BROWN / GREY

BLUE

TURQUOISE

Black, brown or grey refers to the production of hydrogen from coal, respectively lignite or natural gas. In addition to hydrogen, carbon dioxide is usually generated during the fossil fuel production process. The greenhouse gas emissions from fossil-based hydrogen are considerable.

Blue is grey hydrogen with the addition that CO_2 emissions are reduced through the use of carbon capture and storage (CCS) technology. While blue hydrogen is often described as climate-neutral, it is in fact problematic. The long-term consequences of CO_2 storage remain unknown, leakage can lead to emissions, and the use of natural gas should generally be avoided.

Turquoise hydrogen is produced from fossil gas by means of methane pyrolysis. This produces solid carbon instead of CO_2. Nevertheless, climate neutrality is likewise hardly possible, since emissions are produced during the extraction and transport of the starting material, which is fossil gas.

It is helpful to bear this colour spectrum differentiating between green and non-green afterwards in mind. Since all other coloured hydrogens rely on the use of fossil raw materials, only green hydrogen can be considered as one of the available options on the path to a just transition and a fossil-free future. Even with relatively emission-free production, non-green hydrogens perpetuate the demand for fossil raw materials. They thus prop up industry with high CO_2 emissions, which is the largest contributor to climate change. Therefore, this paper exclusively focuses on renewable hydrogen as the only climate-friendly technology.



A hydrogen fueling station in Irvine, CA . Station attendant Yanea Williams supervises. © Dennis Schroeder / NREL

02

Why Hydrogen?

Green hydrogen – the stuff of which a just transition towards a fossil-free future is made from?

Green hydrogen is considered an essential building block on the road to a zero-emission fossil-free future. It is important to understand that hydrogen is not an energy source in itself like the sun and wind, but an energy carrier, a storage medium and a feedstock.

The production of green hydrogen is facilitated by electrolysis. Electrolysers separate water into hydrogen (H_2) and oxygen (O_2). The hydrogen produced can be stored in either a gaseous or a liquid state. To produce emission-free "green" hydrogen, it is vital that the energy used stems from renewable energy sources.

Besides the established industrial application, green hydrogen is envisioned to be deployed in energy-intensive and hard-to-decarbonise sectors. It can be stored and transported relatively easily, the latter for instance in pipelines, and it can be used in liquid form as a fuel.

Why Hydrogen?

CONTINUED

Why all the hype and to what extent is it justified? Renewable Hydrogen is not only a green energy itself, but could also be a catalyst for the expansion of renewable energies.

In particular, synthetic fuels are considered indispensable for decarbonisation in sectors in which it is not technically feasible to use other renewable energy sources directly or to a sufficient extent. These include, for example, freight transport on roads or shipping and air traffic. The energy-intensive production of steel, aluminium, cement or chemical products in line with the Paris climate goal can also is very difficult without using green hydrogen. On the contrast, green hydrogen is unlikely to play a role in the foreseeable future as a fuel for passenger cars, since cars with electric drives are significantly cheaper and more efficient.

At present, green hydrogen production with electrolysers is relatively expensive, associated with efficiency losses and huge energy needs. In the medium term, however, the cost could decrease, if the production of hydrogen scales up – comparable to the solar and wind power generation or battery technology.

The extensive additional energy demand can only be covered through a massive expansion of renewable energy generation. Conversely, the sharply falling costs of renewable energies can help green hydrogen technology achieve a breakthrough.

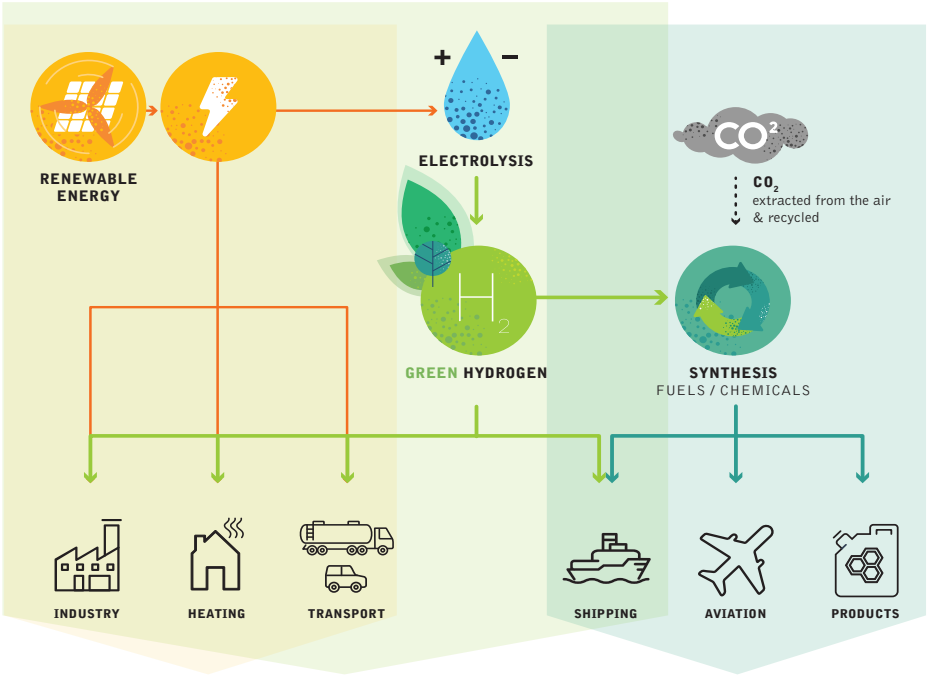
While much attention is paid to the opportunities of green hydrogen in reducing carbon emissions, much less attention is directed towards reducing energy use and energy waste, in particular in the Global North. In order to avoid green hydrogen becoming yet another "false solution" technology, it is important that it is considered a part of a broader strategy to reduce overall consumption of energy.

PtX

Hydrogen and Power-to-X (PtX)

The common term "PtX," the "P" for "power" refers to electricity and the energy input for production. The "X" stands for different end products, for example "power-to-gas" as a gaseous energy carrier or "power-to-liquid" as a liquid fuel. Hydrogen can be a "PtG" or a "PtL" depending on the aggregate state of storage. PtX technologies can "indirectly electrify" previously fossil-based sectors. That is, electricity generated from renewable energy is used to produce PtX products that replace fossil fuels and decarbonise sectors such as transportation, industry, and others.

Power-to-X:
carbon neutral fuels





Hydrogen renewable offshore energy production.
© Audio and advertising

03

International Strategies

Simply put, the worldwide green hydrogen strategy is divided into two different tendencies: Industrialised countries seek to export technology and import green hydrogen, while countries in the Global South strive to build infrastructure and export green hydrogen.

Numerous states have already adopted hydrogen strategies and the list continuously grows. The strategies vary according to regional possibilities and ambitions. A major factor is the respective potential of renewable energies.

Industrialised nations are focusing predominantly on developing technologies for green hydrogen production and on expanding the infrastructure for green hydrogen use. Developing countries are striving for green hydrogen production for domestic energy transitions and export. Particularly countries that are currently exporting fossil raw materials, will aim to compensate the future decline in demand for fossil feedstock in the wake of the Paris Climate Agreement.

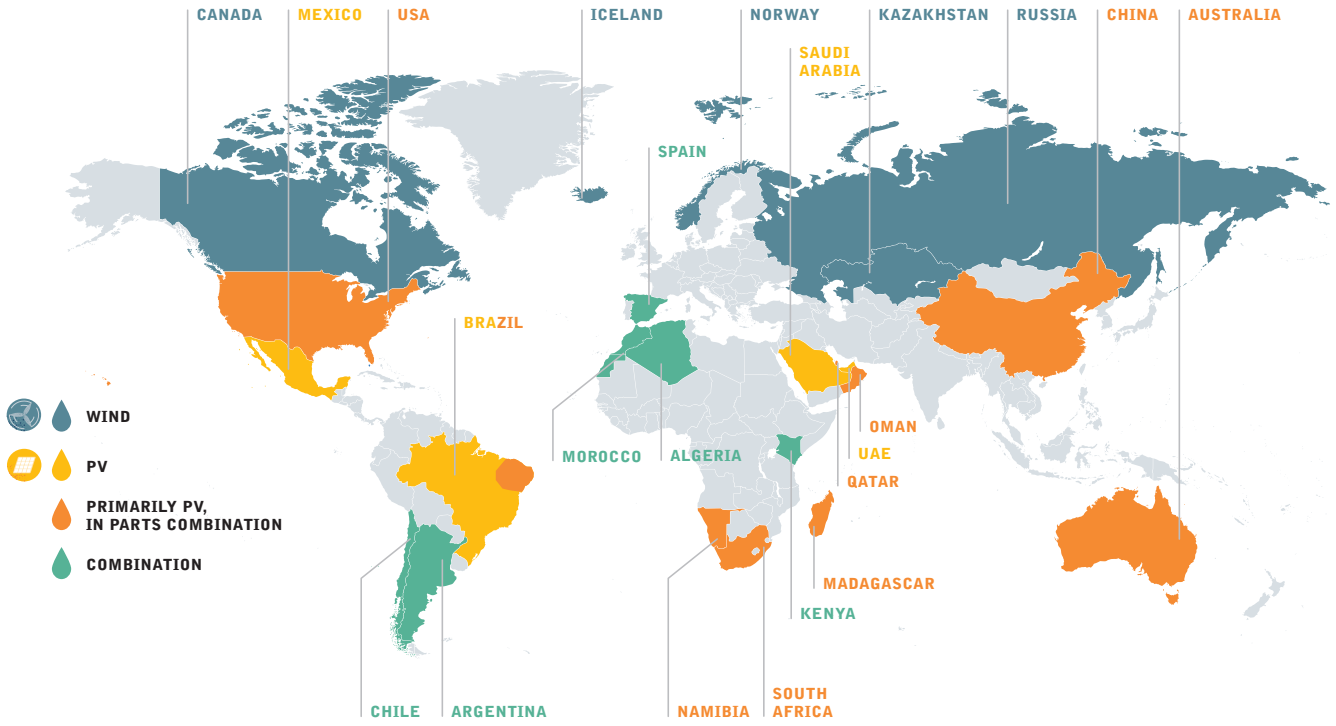
An example for industrialised nations is Germany with its focus on green hydrogen import. The country does not have anywhere near the renewable energy capacity to meet the future demand for green hydrogen. Germany, therefore, focuses on taking a leading role in the export of hydrogen technology. At the same time, Germany is like to have a strong interest in promoting a prosperous global green hydrogen market, in order to secure its own import needs.

International Strategies

CONTINUED

GLOBAL PIONEERS

Examples of high potential hydrogen producing countries



Different countries, different green hydrogen targets around the world.

More information on the various countries' and regions' specific goals of can be found in the study "Renewable Energies in the Global South". Here, the examples of Chile and Namibia are especially noteworthy.

SUPER POWER

Chile

– on the way to becoming a global pioneer

Contrasting other national strategies, Chile focuses entirely on green hydrogen. The Atacama Desert with photovoltaics and the Magallanes region with wind energy in particular, offer ideal climatic conditions for Chile's ambitious goal. The country aims to produce hydrogen at the lowest costs worldwide by 2030. The quality and abundance of renewable resources in the two regions mentioned should enable competitive large-scale production.

The Chilean government is planning to scale up hydrogen production in three phases. By 2025, the country will focus on national and preparatory actions that deepen know-how, establish supply chains, expand infrastructure, and attract investment. From 2025 onwards, domestic infrastructure is expected to scale to all those aforementioned elements. Thereby, Chile aims at becoming a key player in the green ammonia and green hydrogen export market. Beyond 2030, Chile intends to expand globally as a supplier of clean fuels.

Namibia

– on the way to becoming a green hydrogen super power

Namibia is, likewise, aiming to become a green hydrogen superpower. Similar to Chile, the country intends to take advantage of its climate – with over 3,500 sun hours a year – to both produce and export green hydrogen.

At COP26, the president of Namibia announced bold plans for the country to venture into green hydrogen. As part of this strategy, project developer HYPHEN Hydrogen Energy had been named the preferred bidder to develop the country's first large-scale vertically integrated green hydrogen project in the Tsau ǁKhaeb National Park. The project, worth an estimated USD 9.4 billion, will ultimately produce green hydrogen for regional and global markets, either as pure green hydrogen or as green ammonia.

This will give HYPHEN the right to construct and operate the project for 40 years following the conclusion of the feasibility study and sign-off from the Namibian government. The first phase is expected to enter production in 2026, creating 2 GW of renewable electricity, at an estimated capital cost of USD 4.4 billion.

Solar energy PV power plant in Atacama, Chile. © Abriendomundo / Shutterstock





Solar PV plant in Nambia. © Villatonete / Shutterstock

04

Opportunities / Risks

Green hydrogen could become an enormous driver of development and prosperity for the Global South – if the risks are understood and past mistakes are not repeated.

Worldwide, there is an atmosphere of optimism regarding the subject of green hydrogen. A steadily growing number of countries is promoting the development of a green hydrogen-based economy as part of their broader energy transition policies. The question is whether these policies are informed by an understanding that for energy transitions to be just, crosscutting economic and social transformations are vital to take place within a rights-based framework. Research has shown that, to varying degrees, many countries both in the Global North and South are implementing energy transition policies in support of a market-orientated transition regime that often rules out the opportunity of implementing just, rights-based renewable energy regimes.



Tending to crops in a local community garden in garden.
© Kwame Amo / Shutterstock

SWOT for renewable hydrogen production in the Global South

Strengths

1. Use of local resources (solar, wind)
- **a.** Economic benefits for remote communities
- **b.** Deserts (solar)

2. Remote coastal areas (wind)
3. Sustainable as renewable energy projects are not finite resources such as fossil fuels
4. Young and growing population

Weaknesses

1. Political instability
- **a.** Weak institutions
- **b.** Weak democratic decision making processes

2. Low investment capacity
3. High legal uncertainty
4. Lack of required infrastructure
5. Long distance transport required

Opportunities

1. Fast-tracked access to energy services
- **a.** Rural Electrification
- **b.** Priority access to energy services for industry and (small) businesses

2. Enhanced access to education and training
3. Additional employment opportunities
4. Local economic development
- **a.** Local manufacturing of components
- **b.** Local funding via shares to re-distribute profits

Threats

1. Land use conflicts
2. Lack of social acceptance
- **a.** Corruption
- **b.** Project cost increase due to bad planning and/or corruption
- **c.** No transaction costs to conduct community engagement
- **d.** Lack of inclusion of local population in decision making

3. Conflicting use of water and water scarcity
4. Negative impacts on local ecosystems
5. Technology failures
6. Financial dependence on donor countries

Opportunities / Risks

CONTINUED

Green hydrogen is far more than a question of technology.

Major energy companies from the fossil fuel sector are increasing their investments in green hydrogen projects. Governments are launching market stimulation measures and developing regulatory frameworks for the continued strengthening of the future hydrogen industry. However, green hydrogen has yet to prove its competitiveness with fossil fuels.

The production of green hydrogen requires renewable energy generation on such a large scale that the Global South, with its vast resources, is almost bound to become a major player in this transition. This is also accompanied by social and environmental impacts (as follows later in this paper) in the countries of the Global South.

To recover the potential, it is essential for the countries in the Global South to control for the potential risks (see page 17). To ensure a just transformation process, the past mistakes must be avoided. Industrial nations and corporations must not exploit the Global South's energy resources, human rights must not be violated, and income and wealth from renewable energy projects must remain in the Global South and benefit the local population.

For the Global South, it is critical that governments develop energy policy frameworks that demonstrate a clear commitment towards energy justice and the role that green hydrogen can play in achieving this. Governments must, through their regulatory frameworks, support the transition by ensuring that households, companies, communities, as well as local authorities are able to work together to produce reliable, affordable, accessible, and clean renewable energy including the production and export of green hydrogen.

Government support and guidance is therefore essential to successfully establish green hydrogen. The regulatory framework should take the supposedly soft criteria, such as local acceptance and community participation, into account. Eventually, industrial nations and companies must also be interested in a socially balanced development of green hydrogen technology to secure their investments and imports. The example of Desertec illustrates the consequences the so-called soft criteria can have (see page 19).





In the Fulani village of Hore Mondji, located in southern Mauritania on the banks of the Senegal River, a women's cooperative uses solar energy to operate the borehole that supplies water to the market garden. In a country heavily impacted by drought and welding periods, solar energy represents an inexhaustible source of energy for the production of fruits, vegetables and aromatic plants for local consumption as well as for sale in the markets of neighboring towns. The women of the cooperative thus have a regular income as well as a rich variety of fruits and vegetables that promote dietary diversification and the well-being of their children. © Raphael Pouget / Climate Visuals Countdown

05

Economic Opportunities

Renewable energies can renew countries.

The decentralised nature of renewable technologies allows new prospects to be spread across all regions, whereas the fossil fuel industry is mostly concentrated in centralised locations. Provincial regions or remote communities are usually excluded from economic opportunities, but precisely these regions often have abundant wind and solar resources. While the land might not be fundamentally available for renewable energy, remote regions could benefit significantly from the expansion of renewable energies and green hydrogen production.

Economic Opportunities

CONTINUED

IMPROVE

THE LIVING CONDITIONS OF LOCAL PEOPLE

The expansion of green energies could create jobs for unskilled workers and well-trained specialists alike. Here, countries in the Global South have excellent prospects for raising education and training levels. Increased qualification is not only in the interest of governments; industry also needs skilled workers. The expansion of green technologies goes hand in hand with the qualification of local people. To meet this end, corresponding efforts must be made. In South Africa, for example, 30,000 people living in remote regions are currently undergoing training programs in renewable energy production.

The effect renewable energy generation and electrification of supply can have on regions without electricity, should not be underestimated. Hence, national governments and companies must ensure that the energy generated locally benefits the local population and does not just flow into production and export.

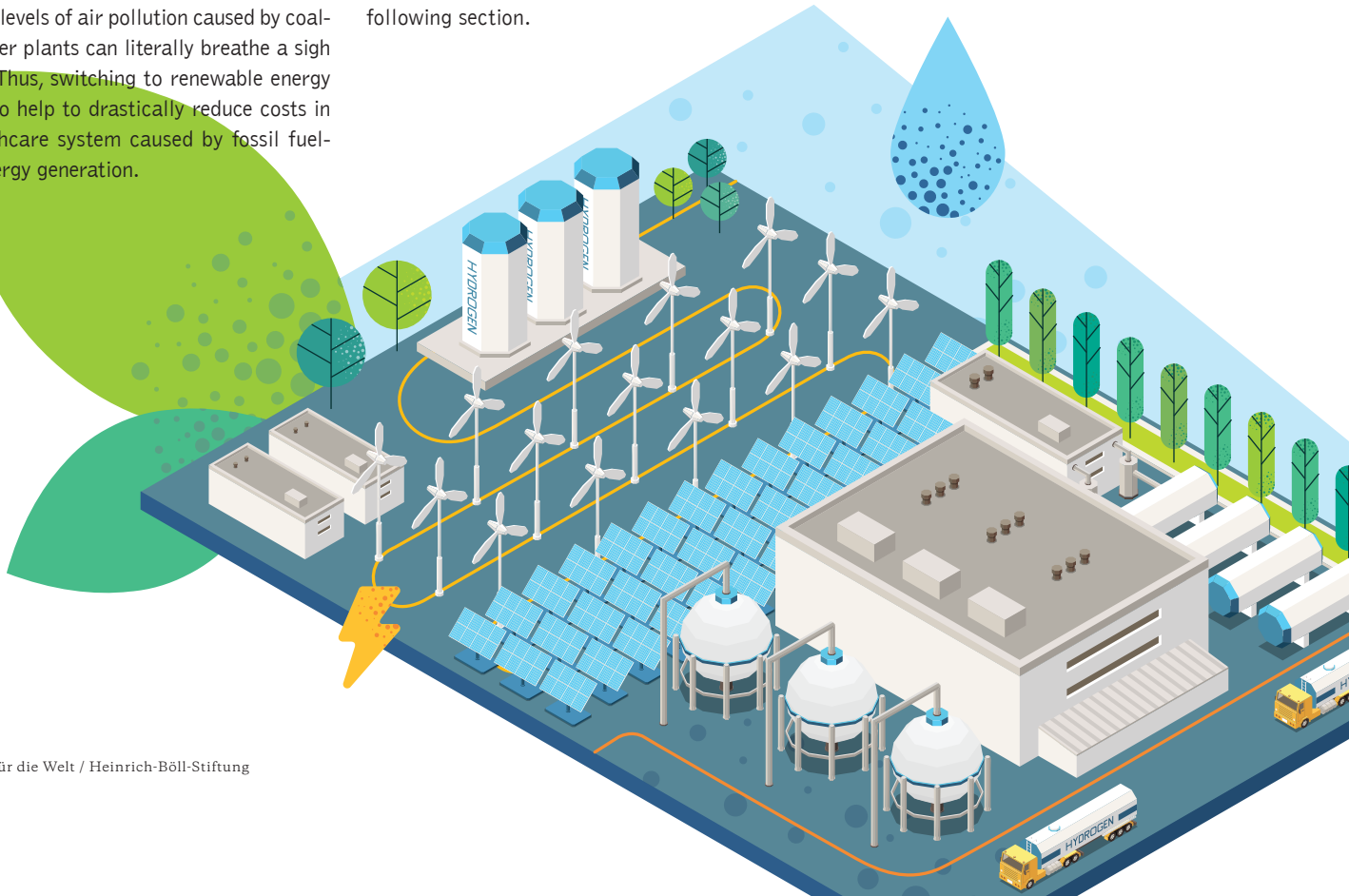
The expansion of renewables also has a positive impact on health. For example, regions with high levels of air pollution caused by coal-fired power plants can literally breathe a sigh of relief. Thus, switching to renewable energy might also help to drastically reduce costs in the healthcare system caused by fossil fuel-based energy generation.

Another perspective is offered by community participation and ownership models. Local (co-) ownership of renewable energy projects can bring numerous advantages in terms of acceptance and increased security of supply and investment. A simple rule of thumb is that the more income generated from local projects, the more the local economy benefits as a whole.

In summary, renewable energy production and green hydrogen production can lead to a real boom in the countries of the Global South. Beyond economic flourishing, decentralised clean energy additionally offers the potential for more stable, social and healthy societies.

The prerequisite for this is that rights-based local and social criteria are considered in all renewable energy projects in addition to economic ones. The new energies must first and foremost improve the lives of local people – in case benefits are exported, a multitude of risks lurks here, as explored in the following section.

The expansion of renewable energies and green hydrogen technologies can create jobs, prosperity and stability. Crucially, they will improve the living conditions of local people.





A shepherd herding his goats through the wind farm. Kanyakumari, India. © Braden Gunem

06

Risks

Even renewable energies can do more harm than good if one falls into the trap of technology blindness. Those who ignore social and ecological criteria are building their green hydrogen projects on sand.

Green hydrogen projects require significant renewable energy capacity. However, their expansion can have serious consequences for land use, water supply or resource access. There are also various socio-economic implications. In poorer regions with inadequate energy supplies, ill-conceived infrastructure projects can lead to social tensions. In the worst case, those tensions might jeopardise the energy transition or even lead to destabilised societies.

One critical factor is the so-called "additionality". This implies that green hydrogen must be produced from additional renewable sources. Thereby, developers can ensure that no existing energy capacities are diverted into exports at the expense of local populations.

Risks

CONTINUED

No green hydrogen without water and land

The use of water as a basic resource is of particular importance. Various estimates are circulating about how much water is needed for the electrolysis of green hydrogen. One calculation, for example, shows that around 1.4 litres of water are required for the electrolytic production of one litre of kerosene. According to the International Energy Agency (IEA), about 9 litres of water are employed to produce one kilogram of green hydrogen. Besides the exact figures, there is consensus on the considerable use of water required for hydrogen production, water availability can be problematic, especially in arid regions.

Of course, green hydrogen production must not interfere with local supplies to the population as well as to agriculture, or even result in rising water costs. The MENA region (Middle East and North Africa) is, for example, already one of the driest regions in the world. Climate change will exacerbate the shortage. If these regions are deprived of additional water, even small amounts can cause entire societies or ecosystems to collapse.

Instead, municipalities and regions should, on the contrary, benefit from the new infrastructure. In 2019, the Ökoinstitut – a German think tank – concluded that green hydrogen production can also have positive consequences for water supply. Even in regions with water scarcity, seawater desalination plants can potentially increase water supply. At the same time, local ecological effects can also occur as a result of the return of brine enriched with salt and chemicals. To avoid risks, it is essential that national governments and municipalities are regulating the resource of water in green hydrogen production in a sustainable manner, in both social and environmental terms.

Although, green hydrogen plants as such will take up little space, renewable energy generation requires significant land area. Thereby, renewable hydrogen deployment can lead to direct and indirect land use change and impact social criteria and ecosystems. Hence, land use along the entire value chain of renewable hydrogen must comply with the United Nations Sustainable Development Goals (SDGs).

Furthermore, the challenge in expanding the green hydrogen infrastructure lies in juggling an, often complex, mix of different criteria. As the example of Desertec (see page 19) illustrates, the general trap lurks in focusing projects purely on technological feasibility and economic viability. However, environmental standards, the acceptance and participation of the population, secure access to supply, and political conditions must all be considered.

Green is not per se good for everyone.

SDG COMPLIANCE



Sukhdev Vishwakarma and his daughter Meenu both farm workers, use water pumped from a solar water pump in Jagadhri. © Prashanth Vishwanathan / IWMI



07

Policy Development

Renewable energies and green hydrogen with “local first” propulsion.

The transformation to renewable energy offers enormous opportunities for the countries of the Global South. For example, many regions have inexhaustible resources of sun and wind. However, this alone is no guarantee for a successful expansion of renewable energies. It is misleading to view renewable energy as a panacea that will ultimately trigger social and economic prosperity. In North Africa, solar plants in Tunisia (TuNur Solar Project) and Morocco (Ouarzazate Solar Plant) are examples of renewable energy expansion which were developed without community approval or consent and therefore resulted in lack of access to local land.

Policy Development

CONTINUED

Aspects of justice, human rights and sustainability cannot be excluded. In principle, the multi-layered field can be broken down to a single question:

How can green hydrogen improve the lives and rights of people in the Global South?

> The new energies and infrastructures must be developed with the appropriate framework conditions for countries of the Global South to prosper as a result. The "local first" principle applies here.

In the past, some projects were drafted in a way that Global North states or companies benefited unilaterally, while the local populations were exploited, displaced, ignored and left empty-handed as well as energy poor. It is, therefore, crucial to consider the following criteria when expanding renewable energy and the green hydrogen industry:

Environmental standards: The development of a sustainable, global green hydrogen industry must be guided by climate-safe and environmental standards. This excludes energy sources that:

- are highly carbon-intensive or produce significant quantities of other dangerous greenhouse gas emissions through their production, combustion, distribution processes, or the direct or indirect land use change caused by their development,
- abuse the rights of local communities,
- result in deforestation or forest degradation,
- result in the production of toxic waste,
- result in significant air, land or water pollution, and
- deplete non-renewable resources.





Social standards: Access to energy is a basic human right and a necessary condition of a dignified life. It is essential to integrate green hydrogen projects in the needs of the communities using them as well as to their local and regional environmental, economic, social and cultural contexts. Appropriate political regulations must be designed for this purpose.

Education and economic development: In the Global South, renewable energy can create jobs, provide a boost, and have a positive impact on diversifying regional economies. In this context, education and qualification are important. When implementing technology projects, the training of suitable specialists should be planned from the outset.

Energy sovereignty: In a just renewable energy system, renewable energy projects must first meet the local population's needs, including energy access and equity, before they meet the production needs of green hydrogen for export.

Participation and ownership: International studies have shown that where new energy infrastructure projects incorporate community participation and co-ownership models, they have a positive social and economic impact, such as improved security of supply or increased local value creation. Communities should have free, prior and informed consent, the right to justice and also rights of redress/compensation and/or remuneration in relation to the production and use of renewable energy and green hydrogen. Greater acceptance of industrial projects also contributes to investment security.

Finance for renewable energy and green hydrogen: Countries in the Global North must make their development finance contribution towards the just transition efforts of countries in the Global South in line with their fair share and the principles of equity, justice and repayment of the climate debt.

For a successful national green hydrogen strategy, the countries of the Global South can learn from the mistakes of the past as well as from today's pioneers. The study "Renewable Hydrogen in the Global South" highlights positive developments, such as in Chile or in South Africa, in more detail.

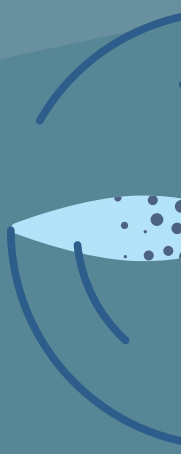


LOCAL FIRST



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