From Growth to Wellbeing - a podcast by GIZ & partners

Green Hydrogen Economy

Hydrogen is said to be the last piece of the decorbization puzzle, but also the hardest

The world faces profound economic, environmental, and social challenges, as the international community comes to realize that the basic requirements and consumption needs of an ever-growing population cannot be sustainably met by simply maximizing economic output. The destruction of ecosystems and biodiversity in the world, through the massive conversion of natural areas into agricultural land and the excessive use of fossil fuels, has led to global warming and weather extremes, increasing pollution of soil, air and water, as well as serious health risks and effects on humans, animals and plants. The COVID-19 pandemic as well as the Russia-Ukraine war has shown serious implications on economies across the world and shown the interdependencies between social progress, economic prosperity and environmental sustainability. It has led to a global economic crisis with reinforced inequalities, jeopardizing the achievements of decades of development, hitting particularly the vulnerable in developing countries and putting at risk social cohesion.

There is a growing realization globally for the need of an economic transformation. More and more countries are moving away from fossil energy sources and are actively striving towards a social and green economic transformation. What are drivers of this economic transformation and how can this best be executed?

Addressing this question, hydrogen produced from renewable sources ("green H2") is recently attracting increasing attention as moving away from fossil energy sources and being an energy carrier for the last mile of decarbonization.

After energy efficiency, electrification of end-use applications (in transport: EVs, in heating and industry: heat pumps) and deployment of renewables such as solar and wind power, **green hydrogen is the last part of the puzzle for full decarbonization and net zero emissions**, which in turn are necessary for the world to stay under 2°C warming, as agreed at the COPP21 in Paris in 2015. As carbon-free fuel for long-distance carriage (e.g. shipping) and combustion processes in heavy industry (e.g. steel production) green H2 can replace fossil fuels where electrification does not provide a proper solution. Countries with high potential for power generation from renewable energies and low generation costs could become large-scale H2 producers and benefit from the energy transition home and abroad – if ecological risks are managed properly and growth is managed inclusively.

Due to high production costs green hydrogen will remain in relatively short supply in the foreseeable future. Thus, it should be used only where no less costly carbon neutral alternatives are available. Most likely applications are:

- **Steelmaking**. where hydrogen can be used instead of coking goal to produce iron fron iron ore
- **Refineries and chemical factories,** which require hydrogen as feedstock for fuels, plastics and other synthetic materials
- **Air and sea traffic as well as perhaps heavy road transport,** because these applications require a lot of energy and batteries would be too big and too heavy
- **High-temperature heat in industry**, where electrification isn't an option
- **Seasonal energy storage**

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On the other hand, using hydrogen in the following applications doesn't seem like the best way forward:

- **Residential heating**
- **Fuel-cell powered personal cars**
- **Internal combustion engine cars (today's gasoline and diesel cars).**

This would be wasteful because of the lower efficiency than the direct electrified applications. Additionally, large Infrastructure would be required for distributed use.

Anyways it is not easy to implement hydrogen, even though its needed. This has a variety of reasons:

- **Low-carbon hydrogen is at the moment much more expensive than other fuels such as natural gas, gasoline or diesel** (due to externalized costs). Fair competition must be enabled through a legal and regulatory framework that internalizes the environmental and social costs fo fossil fuels and thus levels the playing field. Furthermore, in the early stage of development, additional subsidies might be necessary for green hydrogen to reach economies of scale than can compete with fossil fuel industries.
- **Hydrogen is a different molecule than natural gas or gasoline and requires different infrastructure and different end-use applications.** Building new end-use applications and new infrastructure is required. In some cases, such as hydrogen ships, these technologies don't even exist yet and must be newly developed.
- **Green hydrogen production requires large amounts of renewable energy**, which means that first renewable power has to be built up even faster. And secondly the electrolyzer capacity has to speed up. Additionally, some countries, like Germany, are not big enough to install as much power on their own territory to fulfill their high demand and will have to import hydrogen or other types of synthetic fuels from countries with better renewable energy potentials.
- **Hydrogen production can also lead to harmful environmental effects**. Regions with high potential of renewables often lack of water and have competition on land use. Establishing hydrogen production might add stress because it needs both.

Given all that, are there reasons to be optimistic about hydrogen being more than hype (but a true enabler of the energy transition)?

Many experts would probably say yes, absolutely, but we're not there just yet:

- **The urgency of climate action has never been as apparent as today, and although not enough to keep the world on a 2°C pathway.** For example, global net zero targets today cover 80% of global population, 83% of all emissions, and 91% of global GDP, according to University of Oxford. 23% of all global greenhouse gas (GHG) emissions are now subject to a carbon tax or a cap-and-trade scheme, with an upward trend, according to World Bank.
- As of September 2021, **14 countries have adopted a hydrogen strategy,** two more were in consultation, and 20 more were announced, according to IEA. Many jurisdictions have implemented measures specifically tailored to promoting hydrogen (For example: definition of green hydrogen; quotas for transport and in future, industry; Carbon Border Adjustment Mechanism (CBAM) that will protect EU industry).
- **Solar and wind power costs have decreased substantially over the last 20 years worldwide.** Especially in some countries of the global south, exceptional potentials can be found, making them strong candidates for future green hydrogen exporters.
- **Access to finance for hydrogen projects has increased significantly.** First, billions of public funding have been earmarked for hydrogen economy which private investors can access. Secondly, we can already observe private capital being committed. For example, 20 electrolyzer manufactures, together with the European Commission, recently signed a joint declaration committing themselves to increasing their electrolyzer production capacities by 10x by 2025, which would be enough to meet EU´s green hydrogen goals.
- **Technical barriers to wide-scale use are being removed.** Especially efficiencies of electrolyzers and fuels cells have been improved over the last decades, but also applications on hydrogen are being developed. There are already numerous pilot and demonstration projects plant and running

globally in different states of the value chain.

What does all this mean for the cooperation with the countries of the global South?

The developed countries of the global north will need to import large quantities of green hydrogen or its derivates from the countries with better renewable energy potentials. Among these are many developing countries of the global south. This begs the question of how the relationship between them can be designed so as to make it a win-win cooperation.

Certainly, there are opportunities for the exporting countries:

- **A catalyst for domestic decarbonization**. The technologies and know-how that hydrogen production entails are also central for decarbonizing the domestic economies of potential hydrogen exporters. The opportunities for the hosting countries to profit from technology and especially from skills transfer are substantial and can help that countries to meet their own climate goals.
- **Jobs creation.** How many and what kind of jobs are created depends on the scope of hydrogen economy, as well as who organizes the value chain. Especially operating facilities usually require highly skilled work force. It would be advisable for the investors from the global North and their governments to help building capacities of the workforce as well as of public and academic stakeholders to create sutainable conditions of hydrogen production. Governments should set conditions for investment that foster participation of domeestic businesses along the whole value chain to allow for employment effects beyond the large project developers. And skills development should be aligned with general labor market policies to avoid competition for qualified staff between H2 and other sectors that are key for development.
- **Revenues** depend on the value chain an exporting country participates in (e.g. just providing the physical space and renewables potential to foreign investors; owning the hydrogen production assets; etc.). It has to be noted that most of the available investment capital today is controlled by countries and companies of the global North. Therefore, at least at the beginning, we can probably expect that most hydrogen production facilities in the countries of the global South will be foreign-owned. This makes it all the more important to find ways to allow for participation in revenue streams, e-g- trough appropriate financial instruments, e.g. taxes, sovereign wealth funds, asset shareholding of governments/municipalities/local companies/ ctizens, etc.. Local content requirements for key assets might be another way but also carry risks (detrimental effects on trade) and require significant capacities for implementation.
- **Technology development** comes with similar questions. Only if research instituions and businesses in H2 producing countries of the global south participate in technological progess, economic and social benefits can be expected. Hence, technology transfer through R&D cooperation domestically (between research, academia, businesses, entrepreneurials initiatives and public institutions) and inernationally is crucial.
- **Involvement of local communities** can foster the energy transition or block the transformation process if managed properly. This also applies to the development of H" countries. Thus, early-stage consultations and continous management of community relations in areas where H" projects are planned is key.

However, hydrogen production on industrial scale also entails risks for the exporting countries:

- **Competition for renewable energy resources.** Every country, even those with enough wind and sun to become fully carbon neutral on their own and still have renewable energy left to export, will have to weigh the benefits of the exports against its own needs. It is imperative that foreign investors – and the rich countries' governments supporting them – do not take advantage, but rather take the interests of host countries into account.
- **Competing uses for land.** This problem is adjacent to competition for renewable energy sources. Hydrogen production requires land not only for electrolyzers but also for wind and solar farms, the power grid, the desalination plants, etc. This is sometimes in direct competition with other uses such as agriculture, natural habitats and natural reserves, industry, urban centers and other infrastructure such as roads and railways.

» **Increased water stress.** Especially sun-rich places already tend to suffer from water stress, which is in many places expected to increase due to climate change. Producing hydrogen from water, as well as other activities associated with it (cleaning solar panels, needs of the staff), can further exacerbate the water stress. That faces interests of water supply of the local population. Water desalination can help mitigate water stress, but it is generally only possible in places near the coast and can have its own negative environmental effects if not done properly.

» **Increased social inequality and tensions.** If sustainability aspects and the interests of the local populations are not taken into account, and huge multinational companies from the global North swoop in and claim the resources while offering nothing in return, this can give local populations an easy target for their frustrations and exacerbate social tensions. The western governments who need green energy from the global South must develop and enforce the necessary standards due to higher financial power.

Besides opportunities and risks, there is a practical challenge that has to be overcome for the hydrogen production to take off:

» **Transport capacities.** Hydrogen is not easy to store and transport, due to its physical characteristics. Today, hydrogen transport infrastructure does not yet exist. One option for hydrogen transport would be pipelines. However, pipelines take very long to build. Another option would be to transport hydrogen via ships. This is the cheaper option for very long distances, e.g. from South America or Sub-Saharan Africa. Instead of molecular hydrogen, energy carriers made from hydrogen such as ammonia can also be transported, however in the end it is much more energy intensive.

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