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Hydrogen, carbon prices and electricity markets - Can we decarbonize faster?

The hydrogen economy, particularly green hydrogen has a long growth path ahead.

The next decade will determine the success of the hydrogen economy, but this will involve overcoming key challenges. A recent article in Nature Energy describes the challenges well: short-term supply scarcity and long-term policy uncertainty mean hydrogen supply will likely be under 1% of final global energy by 2035. It could be higher, but that is uncertain. By 2035 forecasts vary between 3.2-11.2% in the EU and globally between 0.7-3.3%. Although more optimistic, the recent IEA Global Hydrogen Review 2022 echoes the lack of sufficient green hydrogen supply to meet Net-Zero targets.

It's clear that hydrogen is a high-potential economic and sustainability driver with a large pipeline of projects, but it is early-stage within the global energy context. Blue hydrogen will see the most short-term growth because natural gas is an available feedstock. The key is to be able to manage the byproduct from this process – carbon – through capture, storage or use. That buys time to develop green hydrogen technology, projects and feedstock supply further. Many forecasts think green and blue hydrogen will only reach production price parity by 2030.

The most likely and efficient demand driver to scale the hydrogen economy is focusing on industrial molecule markets. Initially, it is relatively easy to match project-level demand and supply,

especially in energy-intensive industries such as chemical, cement, steel, etc. But where does this leave hydrogen-to-power? What is its potential role in the hydrogen economy?

It starts with getting the price right.

In Europe, there is a lot of talk about electricity market price reform. The challenge is the marginal cost market pricing structure. The issue is that using the marginal price of the most expensive technology to clear the market distorts competition because cheaper, low-carbon-emitting technologies, such as renewables, are at a disadvantage. As a result, fossil fuel-based power plants can often operate more cheaply than renewables under the current price mechanism. This challenge is raising its head in various markets and is affecting market price design; even IRENA has waded in on the matter with a report this month.

Various solutions are proposed, such as shifting to a floor or average system price. But without including a transparent carbon price, it is a bit like making a pizza and forgetting the cheese – you can eat it, but it ain't no pizza! Coupling a transparent price to carbon per kilowatt generated will show some exciting developments. The most obvious ones are:

1) Accelerate penetration of mature green balancing technologies such as battery storage and pumped hydro, as

they will become more affordable due to the avoided carbon cost of coal or natural gas.

2) Increase the development of the next generation of balancing technologies more attractive – a clear pricing target will help to attract investment and reduce market uncertainty. These technologies include green hydrogen, new chemical and physical storage, and other technologies.

3) Create a seamless and active transition from blue to green hydrogen – if the carbon pricing structure rewards both forms of hydrogen but prioritizes rewarding green hydrogen for avoiding carbon versus blue hydrogen's carbon mitigation/management, it maps the path for a long-term transition.

But there is an even more significant benefit – market depth

Any new industry needs market depth to gain critical momentum. The first hydrogen project molecules will have committed buyers great for incremental growth matching dedicated supply to committed demand. But for exponential growth, speculative supply is needed. It is doubtful that anyone will take the risk of speculatively building capacity in a new industry. That is where an electricity market price structure with correct carbon pricing can encourage hydrogen-to-power, creating market depth!

Underpin the market to accelerate hy-

drogen development

As a hydrogen producer, having a back-up market for the product where you can sell any excess production, enables you to go big, much bigger than you would otherwise. Even if the price you get may not be as great as you could for selling to contracted buyers, if it covers your marginal cost and makes some fixed contribution, it creates a safety cushion for your business case. For hydrogen to be strategically relevant in the future energy economy, you need low-cost leadership, which requires economies of scale and significant market demand.

This sounds good for the hydrogen producer, but how would the power generator in the balancing market create the safety cushion and, at the same time, benefit from this?

To use the hydrogen molecule, you need thermal power generation technology (think engines or turbines) that is either hydrogen-only or flexible fuel. Flexible fuel means running a blend of hydrogen and gas, or pure gas, if no hydrogen is available. 100% hydrogen plants are dedicated assets and could contribute to incremental growth with industrial off-takers buying the hydrogen molecules. But because of their dedicated fuel, they have less use in creating market depth. It would be best having an asset that is autonomous of hydrogen as a fuel source, but that can benefit from using hydrogen based on carbon pricing incentives.

The value of hydrogen for thermal balancers

If you have a thermal balancing power plant, it needs to be very flexible. Many markets have already moved to 5-minute electricity dispatch/buying win-

dows. More and more markets are moving in this direction and even talking of shorter dispatch windows – especially as battery storage systems and digitalization become more prominent.

If carbon pricing is fair, the key is to have cost-effective, fast thermal balancing technology with flexible fuel. Effectively, whenever you can get green- or other carbon-scarce hydrogen, you will take as much as possible and enjoy a more competitive electricity dispatch and earnings model because of the carbon price benefits. When no hydrogen is blended, you can still run natural gas to stabilize the grid and earn a decent return.

That, in turn, is great for the green hydrogen producers as there is a steady market for excess hydrogen that can't be sold as molecules. It also allows the power generator to seamlessly switch from natural gas to, say, blue hydrogen and then to green as the supply structures change. With the level of hydrogen penetration forecasted by 2035, you will only need to transition to full hydrogen engines by the time the flexible fuel plants have reached the end of their economic life.

Who pays for the carbon premium?

The one key question is if users can afford the extra carbon price. The Energy Transitions Commission published a report last year looking at the impact of clean hydrogen use on intermediate and final products. The conclusion: a significant effect on intermediate products, but a much smaller (below 3,2%) impact on final product prices in most sectors. The hydrogen economy transition will be a long game. Potentially, this means that the total value chain impact could be less than the current inflation

spike we are experiencing. Assuming your carbon price reflects the benefits of hydrogen, it offers policymakers room to phase in this cost. This strategy could also absorb current subsidies that help manage the impact of energy inflation. Some disclaimers to this article.

This article is intended as a thought piece; nothing is as simple as the statements I have made. Likewise, the forecasts from the quoted articles are just that - forecasts. In such a rapidly evolving sector they will inevitably be off the mark. But you need assumptions and forecasts to craft strategy. There is a lot of ongoing discussion on these topics, and it will be useful to think about what we can do to strengthen and improve these statements. I firmly believe that we need to find different ways to help truly accelerate the hydrogen economy – it has massive potential but could benefit from even more support to gain momentum.

Whether the instrument is a tax or a market price, carbon pricing will play a vital role in accelerating the hydrogen economy. This will differ by country depending on local renewable resources, country policy and economics.

For carbon pricing to work globally, it is essential to have carbon price parity. One country can't accurately apply carbon prices, and the next set ridiculously low or no prices. This will distort fair international trade flows. Therefore, the effect of carbon on trade flows needs to be understood and balanced by policy (including customs) to level the carbon playing field. Corporations also have a significant role in this, and their Scope 3 carbon footprint and accounting must be coordinated with government strategy.

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