Developing a bankable framework for CCUS and Hydrogen

The Paris Climate Agreements have triggered a wave of investments into burgeoning technologies and industries that may hold the key to a carbon-neutral future. One of the more promising is the potential for the omnipresent hydrogen to be the 'golden key' for future energy supply.

There is one major hurdle that constrains the sector and the capacity for 'carbon-friendly' hydrogen production; how the cost of carbon credits and the value derived from Carbon Capture Utilisation and Storage (CCUS) can become commercially viable at scale.

Ninety percent of all hydrogen currently produced, is done so through the carbon-intensive process known as 'Grey hydrogen' – one of three colour codes that differentiate the hydrogen production processes, the others being 'Blue' and 'Green' hydrogen.

LES TRICOLEURS

GREY hydrogen is produced as a chemical by-product of crude oil refining process by converting fossil fuels through Steam Methane Reactions (SMR) or Coal Gasification (CG), largely for refining processes and ammonium production. As the dominant source of hydrogen, the global carbon output for grey production is equivalent to the combined C02 output of the UK and Indonesia. It is an incredibly carbon-intensive process within the carbon-intensive refining sector.

BLUE hydrogen production is the bridge that will mitigate the carbon emissions of 'grey' while the technology for 'green' is developed and scaled. Blue hydrogen is the low-carbon fossil-based alternative to 'grey' – in that it utilises CCUS to capture the release of emissions and store carbon underground, or re-use it in the refining process.

GREEN hydrogen is created through the process of 'electrolysis'; at its essence, entails splitting water into its elemental components, forcing the hydrogen ions into a reaction with an external circuit and emitting hydrogen gas. All that is required are large quantities of water and large electrolysers to create carbon-free energy.

With a net-zero carbon objectives in mind, the energy potential and utility of green hydrogen is a central component to clean energy solutions, providing a multipurpose fuel source for cars, electricity, storage and large industry (among others).

PRICING FRAMEWORK

The European Commission's 'hydrogen strategy roadmap' views the fuel as key to reducing the gas consumption on the continent, seeking to grow the share of hydrogen (specifically carbon-free 'green' hydrogen) in the EU energy mix to 15% by 2050.

Europe will be the proving ground for these technologies, as the most outwardly dedicated region to hydrogen development. The EC believes that by 2050, up to €180-470 billion investment is required in renewable (green) hydrogen, while a further €3-18 billion in low-carbon fossil-based hydrogen.

In order to make CCUS a commercially viable technology, sufficient to attain cost parity with fossil-fuel returns, a carbon price of between €85-90/tonne is required – far off the current price of €25/tonne. However, this price itself has jumped from just €7/tonne in early March. Hydrogen optimists believe the price on carbon will rise counter to the fall in costs of low-carbon hydrogen development, which has enjoyed a 60% drop over the last decade alone.

How would a carbon-pricing framework encourage investors and business to incorporate these technologies into their plans for decarbonisation?

The most direct benefit, for the world's major industrial carbon emitters, would be to acquire carbon-tax credits based-upon their CCUS capacity and directly mitigate their carbon-emissions from the carbon-intensive refining process. A secondary benefit would be to sell additional capacity to other carbon-intensive industries and create new avenues for income.

One attractive emerging technology of CCUS is the process of Enhanced Oil Recovery (EOR), whereby oil and gas producers trap and capture the carbon at the point of extraction. By implementing these methods, oil and gas producers would directly limit their own carbon emissions and mitigate the need for carbon storage further down the line.

In order to purchase and sell carbon, countries have implemented Emission Trading Systems (ETS) that develop a framework to account for the economic impact of greenhouse gas (GHG) emissions. Leading this policy framework is the EU, who implemented market stability reserve (MSR) which increases or limits the quantity of allowances permitted based-on the market price.

The World Bank forecast the value of EU EST revenues to rise from $16 billion to $33 billion, based-off a carbon price of €17/tCO2e ($19/tC02e) – well below the current price of €21/tC02e. Delivering greater hope that carbon pricing can become a practical, commercial avenue to encourage carbon capture.

ATMOSPHERIC BENEFIT

The other, more pressing side to the carbon capture argument is that it provides a lasting benefit to the atmosphere. If the technology to capture and store carbon continues to improve and the costs continue to decrease as rapidly as they have – the process emerges as a critical factor in the energy transition.

Any serious mitigation of GHGs from the production and refining processes eases the environmental and atmospheric degradation. These breakthroughs are yet to be made and rolled-out, and the status quo requires a renewable-led energy transition.

CCUS has thus far captured 40 million metric tonnes per annum (Mtpa) of CO2 from the atmosphere, a number the IEA believes will increase twenty-fold to 800 Mtpa in the next decade. This is clearly a positive addition to the climate crisis, except the sheer quantity of 36 billion metric tonnes of atmospheric CO2 entails the sector will require far greater exponential growth to become a serious solution.

REGIONAL BENEFIT

Europe, North America and China will naturally assume the lead in developing and deploying CCUS. There are 51 operating, under construction or planned CCUS facilities around the world, the vast majority of which are situated in these jurisdictions.

North American CCUS industry is largely US focused, with one CCUS facility in Mexico and Canada each. The US has 60% of the global operating capacity, benefitting from a surprisingly progressive policy and investment framework that provides tax-credits per metric tonne of CO2 captured.

Columbia Centre for Global Energy Policy believes this per-metric-tonne incentive provides disproportionate benefits to facilities that release greater quantities of carbon.

The price-per-metric-tonne value ($35/mt for EOR-stored carbon, $50/mt for geologically-stored) is far more encouraging to the more carbon-intensive coal-generation than gas-powered plants – however, the Centre believes this benefit plateaus at a tax credit of between $60-110/mt (due to the costs of retrofitting facilities). Additionally, the US is advantaged by access to geological storage sites that are within 100km of 85% of power plants.

Europe has shown an encouraging interest in creating a continental ecosystem to develop hydrogen infrastructure, mainly focused towards the construction and development of green hydrogen. It is just one element of the EU's wider vision for a carbon-neutral society, whereas the US views CCUS as a method to balance carbon emissions.

The EU ETS framework has positively influenced the commercial viability of carbon-pricing in Europe, leading to the development of 10 large-scale facilities across the continent and the introduction of 'The Innovation Fund' – a €10 billion fund focused on CCUS technology, infrastructure and deployment. Moreover, Europe benefits exceptionally from its national and supranational structure, in that it can build 'hydrogen clusters' that operate independently, but are connected in the wider ecosystem, driving down costs across the board.

Asia Pacific holds the greatest potential for carbon-capture, creating over half the world's CO2 emissions and projected to account for 60% of global energy consumption by 2024. Despite the lack of policy or investment incentives by governments, nineteen CCUS facilities are in various stages of development. China, Japan, India and Australia are the most significant actors in the region due to their extensive use of coal and natural gas power plants, and their comparative economic strength to other APAC states.

China is the world's biggest emitter of GHGs, and while their CCUS infrastructure has just one operational facility and seven facilities in development, the Chinese government's announcement of reaching carbon-neutrality by 2060 will certainly hasten this sector.

India is an important actor as the world's 3rd worst carbon-emitter; however, the country does not yet have an operational facility. If India were to follow the IEA's 'Clean Energy Scenario', then by 2060 the country would capture 20% of the world's emissions. The time to start is now.

Japan, on the other hand, has been slow to embrace the technology but has made it central to its energy plans for the future. As one of the world's leading technological forces, Japan views their vision to become the 'world's leading carbon-free hydrogen society' as a feasible and obtainable goal. With five pilot and demonstration facilities in development and a bi-lateral agreement with Australia to co-operate in the space, expect the advances to be swift.

Australia joins their regional neighbours as significant carbon-emitter through their use of coal and gas-powered plants. Australia's comparative advantage are their generous geographical storage options, which they are utilising to construct the world's largest storage facility.

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Possible Conclusion:

It is the view of The Energy Council that the global ecosystem of hydrogen is a significant driver in the transition from 'dirty' to 'clean' sources of energy. And while in it's infancy, the potential for returns on investment as the price for carbon rises could be significant – especially, as ESG policies and decarbonisation processes are made law for large-scale emitters.

The most telling sign that the Hydrogen-age may soon be upon us, is the clear and dedicated commitment by China, the EU, the United States of America and Japan to develop the necessary infrastructure and technology. This is not some "Hail Mary" to secure clean energy, there is serious and significant scientific knowledge to embed and grow Hydrogen as a key component of the energy economy.