https://doi.org/10.1595/205651322X16545305867699 *Johnson Matthey Technol. Rev.*, 2022, **66**, (3), 228–229

JOHNSON MATTHEY
TECHNOLOGY REVIEW
www.technology.matthey.com

Guest Editorial: Recover, Renew, Reimagine – Industrial Decarbonisation

NON-PEER REVIEWED FEATURE

Received 31st May 2022; Online 12th July 2022

Introduction

The race to net zero is truly underway with over 127 countries now committed to net zero targets, accounting for 90% of global gross domestic product and 85% of the global population (1). By achieving net zero together, we can all limit global warming to 1.5ºC above pre-industrial levels; however, urgent action is required if we're going to meet the targets of the Paris Agreement (2). At the 26th United Nations Climate Change Conference of the Parties (COP26), it was widely recognised that not enough progress is being made to achieve the goals agreed in Paris, and the Glasgow Climate Pact calls for each country to strengthen their climate plans this year to achieve 45% reductions in CO_2 emissions by the end of the decade (3).

The Price of Industrial Emissions

Carbon pricing aims to reduce emissions of greenhouse gases (GHGs) by directly pushing the costs of emissions back onto emitters; where those operators may choose to continue to emit and pay for it through carbon pricing or invest in transforming their operations to mitigate emissions and cut their future cost of carbon (4). Approaches to carbon pricing include carbon tax credits, such as in the USA, and cap-and-trade schemes, such as the European Union (EU) Emissions Trading Scheme (ETS). These operate differently, but when used alongside policy and regulations they can help move funds from the biggest emitters towards innovation in clean technology, and their deployment at scale which is critical in driving down costs.

Direct emissions of CO_2 from industrials sits at approximately 9 billion tonnes per year, with steel and cement the top emitters, while chemicals and petrochemicals make the top three with 18% of the total (5). These sectors typically have hard-to-abate CO_2; those that are technically challenging and therefore costly to reduce, locking in carbon from both the combustion (such as fuel) and use (such as feedstock) of fossil fuels within their processes.

All these sectors are looking for cost effective decarbonisation solutions to mitigate emissions, secure a license to operate and future proof against higher CO_2 costs. The adoption of low carbon solutions to both existing and future asset investments is critical to their success, and catalysis and process technology will sit at the heart of delivering those solutions.

Measure and Report

As companies start to embark on their net zero strategy, a critical early step is to understand where they stand today in existing operations. Only by knowing the baseline can a company commit to their future GHG emissions reductions and define a pathway to achieving those commitments. There will be decisions taken on the extent of carbon reduction targets, at what pace and affordability, and the risk companies are prepared to take on the direction of future government policy.

To make reporting more transparent, the measurement of emissions is defined in 'Scopes': Scope 1 are direct GHG emissions from the company's processes, Scope 2 are indirect GHG emissions from imported electricity and steam and Scope 3 are other indirect GHG emissions in a company's upstream (supplier operations) or downstream (customer operations) value chain.

Following the definition of baseline and setting of strategy, the assessment of pathways to reduce Scope 1–3 emissions is started. These decisions on decarbonisation are complex as there are a very large number of alternative options

now available at varying levels of technical and commercial readiness. Options can be segmented into three types:

- Low capital expenditure (CAPEX): easy to implement solutions that can be executed at pace, such as changing raw materials or shifting to renewable energy
- Retrofit: addressing hard-to-abate emissions through deployment of proven and cost-effective solutions, such as carbon capture and storage (CCS)
- Transformational technology: demonstration and scaling of new 'blue' and 'green' technologies; in this issue of *Johnson Matthey Technology Review* you'll read about development and progress in both green ammonia synthesis and progress in liquid hydrogen organic carriers.

Reduce and Replace

In each of the three areas listed above, companies need to define their execution plans to replace or reduce carbon, which could be made on a whole site basis, or more typically from each of the process units.

With regard to 'replace', there are options to replace fuel and process heat with electrified heating (using renewable energy), or to replace fossil fuel feedstocks with renewables, such as recycled plastics, bio-based materials and municipal solid waste for conversion to sustainable fuels and chemicals. In the generation of green hydrogen, water and renewable energy are now new feedstocks, and when combined with CO_2 captured from the air there then exists a pathway to green methanol, such as in the Haru Oni project in Chile (6), and to sustainable synthetic fuels using HyCOgen™ and FT CANS™ technology (7).

Now when considering 'reduce', it is possible to change to a catalyst that reduces the overall carbon intensity of a product, such as CATACEL SSR™ for the production of hydrogen (8). However, to maximise carbon reduction *versus* the baseline of today's operations, capital investment may be required, and this is where CCS is being evaluated across the industrial space. However, issues remain with the levels of CO_2 reduction that can be achieved at a reasonable capital cost and plant footprint, though it is possible to retrofit plants, such as in hydrogen and methanol, so that up to 95% CO_2 reduction is achieved with significantly reduced capital cost and space requirement compared to post combustion carbon capture (9). Finally, there are options for blue hydrogen, which provides a long-term, scalable and cost-effective replacement for fossil fuels, to enable the decarbonisation of industry, transport and heat (10).

To make decisions on low CAPEX options for transformational technology, or whether a replace or reduce strategy is required, companies will evaluate the potential of process improvements, calculate the reduction in carbon intensity, and identify the technology readiness level and availability of proposed solutions. With the options now available, the industrials are well positioned to make big steps towards the decarbonisation targets of the next decade.

MARK DANKS
Johnson Matthey, 10 Eastbourne Terrace, London, W2 6LG, UK
Email: mark.danks@matthey.com

References

1. Net Zero Tracker: https://zerotracker.net/ (Accessed on 7th June 2022)
2. 'The Paris Agreement', United Nations, New York, USA, 2015, 27 pp
3. 26th UN Climate Change Conference of the Parties (COP26), 31st October–13th November, 2021, Glasgow, UK
4. 'What is Carbon Pricing?', Carbon Pricing Dashboard, World Bank: https://carbonpricingdashboard.worldbank.org/what-carbon-pricing (Accessed on 7th June 2022)
5. "The Future of Hydrogen", International Energy Agency, Paris, France, June 2019, 199 pp
6. 'JM Technology Selected for World's First Climate Neutral Methanol Plant, Advancing Production of Sustainable Fuels', Johnson Matthey, London, UK, 24th March, 2021
7. 'HyCOgen and FT CANS, Innovative Technologies to Enable Sustainable Fuel Production Selected for Repsol and Aramco's Synthetic Fuel Plant in Bilbao', Johnson Matthey, London, UK, 24th May, 2022
8. 'CATACEL SSR Catalyst', Johnson Matthey, London, UK: https://matthey.com/products-and-markets/chemicals/catacel-ssr-catalyst (Accessed on 7th June 2022)
9. 'Low Carbon Solutions', Johnson Matthey, London, UK: https://matthey.com/products-and-markets/chemicals/low-carbon-solutions (Accessed on 7th June 2022)
10. HyNet North West: https://hynet.co.uk/ (Accessed on 7th June 2022)

