TARGETING NET ZERO 瞄准零碳

Exploring the Themes of COP26

The Role of UK-China Business

China-Britain Business Council 英中贸易协会

KPMG

Brought to you by

China-Britain Business Council
英中贸易协会

Principal Sponsor

KPMG

Chapter Sponsors

bp

HSBC

OXFORD INSTRUMENTS

University of Glasgow
Adam Smith Business School

wood.

CONTENTS

FOREWORDS

China-Britain Business Council
英中贸易协会

SIR SHERARD COWPER-COLES
CBBC CHAIR

Business has a clear role to play in the challenge to hit Net Zero carbon emissions in the coming decades. Without a coordinated effort from industry to bring down the costs of environmentally-friendly alternatives to fossil fuels, society will be unable to become more sustainable, and our world will suffer for it. Be it innovating ways to store hydrogen safely, pioneering discoveries in quantum computing to make number-crunching more efficient, or simply providing customers with alternatives to single-use plastics, the international business community can take incremental steps that will compound to result in a brighter, cleaner, and more prosperous world for all of us. This will be a fundamental change that affects all of us. Every business will need to reconsider how it works, how it views its relationship with our planet, and the ways it could be collaborating with other pioneering firms from around the world to play its part in achieving this shared goal.

British companies have already adopted this mindset, and the UK economy has become a world leader in the race to Net Zero. By proactively collaborating with businesses from across the globe to identify ways to develop green aviation fuels, improve the energy efficiency of data centres, lighten the materials we use to manufacture cars, and distil whisky in more environmentally friendly ways, UK companies are distinguishing themselves on the world stage. But it doesn't stop there; those are just some of the ways British companies are finding ways of contributing to this global goal through collaboration with like-minded firms in China.

Both the UK and China have made significant commitments on emissions reduction and are actively pursuing more sustainable models of economic growth. The UK has a legally binding Net Zero by 2050 target, while China is aiming to reach carbon neutrality by 2060. The case for deeper collaboration between the two nations has never been stronger.
China is a fellow world leader in this race; Chinese firms are working hard to support the UK and the goals of COP26 both at home in China and the UK, in third markets, and on the world stage. And there is certainly space for healthy competition and collaboration within our relationship: China overtook the UK this summer to have the world's largest installed capacity in offshore wind and now can produce over 11 gigawatts; that is in addition to the 280.8 gigawatts of onshore wind power generation capacity that China today operates, which is also the world's largest. Our two countries should continue to compare notes and experience as we seek to grow our respective capability in renewable energies – there is invaluable knowledge to be shared.

But UK-China collaboration is more than just wind: across green finance, transportation, power generation, the hospitality industry, and a whole host of other sectors and industries, the UK and China are finding ways to collaborate to bring the costs of this shared energy transition down, so that solutions to the climate crisis being dreamt up in R&D centres the world over are affordable and sustainable for consumers.

This report seeks to shed a light on the ways that British and Chinese firms are working together in a bid to lessen the devastating effects of climate change. Innovation and an industry-wide focus on low carbon alternatives will be key enablers for Net Zero, and I am sure that British and Chinese firms will continue to be amongst the loudest champions of the need for all of us to change how we do business to hit our target.

CCIEE
中国国际经济交流中心
China Center for
International Economic Exchanges

MR ZHANG XIAOQIANG
CCIEE EXECUTIVE VICE CHAIRMAN & CEO

China, as an active practitioner of the Paris Agreement, attaches great importance to addressing climate change. In September 2020, Chinese President Xi Jinping announced during a speech to the UN General Assembly that China aims to see its CO_2 emissions peak before 2030 and achieve carbon neutrality before 2060. At a series of significant international conferences since, he has made further announcements that China will increase its intended nationally determined contributions. In order to peak CO_2 emissions and achieve carbon neutrality, China will build a "1+N" policy system, under which it will issue implementation plans for curbing CO_2 emissions in key areas and sectors and roll out a series of supporting measures to promote structural adjustments in industry and energy, and vigorously develop renewable energy.

China has taken the promotion of green energy as an important tool in constructing an ecological civilisation, and the pursuit of significant reductions in air polluting emissions. The intensity of China's carbon emissions in 2019 was 48.1% lower than in 2005. Meanwhile, significant effort has been made in adjusting the structure of the energy sector and developing clean energy. By 2020, China's coal consumption accounted for 56.8% of its total energy usage, with a decrease of 7.2 percentage points compared with 2005. The share of clean energy in the energy mix has reached 24.3%. By the end of 2019, China's installed capacity of renewable energy accounted for approximately 30% of the world's total, and the cumulative investment in renewable energy since 2010 accounted for 30% of global investment during the same period.

Peaking CO_2 emissions and achieving carbon neutrality is an extensive and profound systematic reform involving energy transformation, industrial restructuring and lifestyle change, among other complex tasks. The time that China has pledged it will take between peak emissions and carbon neutrality is far shorter than developed countries have committed to. However, China is still in the midst of full-scale industrialisation and urbanisation and has to respect the objective laws and balance between development and emissions reduction, the whole and the sectoral, and the short-term and medium to long-term. In any case, international cooperation should be enhanced for China to play an even greater part in addressing climate change.

The UK has listed climate change and biodiversity as a strategic focus and priority, with UK-China cooperation a significant part of that. According to Global Data, the global installed capacity of offshore wind is expected to increase 7-fold by 2030, with that of China and the UK accounting for 41% of this growth. UK-China academic collaboration in clean energy, carbon neutral manufacturing and climate science is making considerable progress, with great potential for future expansion. We must make full use of the UK's experience in systems, standards and technology, and China's unique market scale and complete industrial system to strengthen cooperation in wind, hydrogen, carbon capture, and carbon trading. Each can complement the other's advantages, cooperating for win-win results, jointly making due contributions to the global response to climate change.

UK-Chinese Collaboration on Climate Change

COP26 now offers an opportunity for British leaders to make good on their promises and catch up with the positive examples of joint action that are already taking place all around the country.

Tackling climate change will probably be the most important issue facing the world's diplomatic and business communities this century. A global response is urgently needed, for according to the Sixth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC), without a reduction in greenhouse gas emissions, global warming could reach the critical tipping point of 1.5°C above temperatures in the pre-industrial period by the early 2030s, with catastrophic consequences for the world as we know it.[1]

In September 2020, Chinese President Xi Jinping announced during a speech to the UN General Assembly that China aims to see its CO_2 emissions peak before 2030 and achieve carbon neutrality before 2060[4]. President Xi reiterated this commitment earlier this year at the Leaders' Summit on Climate, adding that China would begin phasing out its polluting coal-fired plants from 2025[5] and has subsequently announced an immediate end to the funding of new coal-fired plants in third countries.

At a time of geo-political tensions in other areas, there seems to be common interest in including China in international efforts to address climate change. In April 2021, U.S. Special Presidential Envoy for Climate, John Kerry met his Chinese counterpart Xie Zhenhua. In their joint statement, both sides vowed to intensify their cooperation in the fields of renewable energy, industrial decarbonisation, and low-carbon transportation, among others.[6]

China is the world's largest emitter of CO_2, accounting for around 30% of global emissions; more than double that of the United States.[2] By contrast, the United Kingdom accounts for less than 1%, producing per capita emissions of 5.45 tonnes of CO_2 per person compared to 7 tonnes for China. However, whereas the UK managed to reduce its emissions by 38% compared to 1990 levels, outpacing the 25.1% reduction across EU member states, China's carbon dioxide output has soared by 380% in the same period.

Britain's impressive efforts will have limited impact without a global shift in policy – and China's role in this is crucial, both in its own carbon reduction efforts, and in its investment in green technologies and renewable energy[3]. Already facing environmental problems of its own, such as desertification and water shortages, China also has a strong self-interest in effective global action.

EU-China cooperation on Climate Change has also deepened. In 2018, European and Chinese leaders issued a statement expressing their mutual commitment to intensify political, technical, economic, and scientific cooperation on climate change and clean energy.[7] Both sides also signed a memorandum of cooperation on emission trading[8] and indicated that they would align their standards for green investment.[9]

UK-CHINA COOPERATION ON CLIMATE CHANGE

As the UK charts a new course outside the EU, international cooperation on climate change will be one of the main foreign policy areas where it can put the vision of 'Global Britain' into practice. The 2021 Integrated Review, which outlines Britain's strategic priorities in the next decade and beyond, lists climate change and biodiversity loss as major strategic concerns and the UK's international priority through COP26 and beyond.[10]

The Integrated Review not only calls for more investment in domestic green technologies, such as offshore windfarms and hydrogen power projects, but also for action to help accelerate the global transition to Net Zero. Cooperation with other major economies, especially those which are already heavily investing in green technologies, is therefore only logical.

Here collaboration with China plays a key role. The country is already the largest market for renewable energy. Last year alone, China increased its wind energy capacity by 60%, enough to power three times the number of homes in the UK.[11] By 2030, global offshore wind power capacities are expected to have grown sevenfold, with China accounting for 25% of the increase. The UK is expected to add the second largest amount, adding 16%, followed by the US with 11%, according to research by Global Data.[12]

While there is a longstanding and fruitful collaboration between businesses and researchers in both countries, coordination at the political level provides a vital policy context for this. the UK-China joint statement on climate change - which was released during Chinese Premier Li Keqiang's visit to the UK in 2014 - is one of the earliest and most ambitious bilateral documents in this area. A year later, both governments signed an agreement for a Clean Energy Partnership, vowing to support each other during the transition to a low carbon economy.

Recent government-level meetings between the UK and China - like the 10th Economic and Financial Dialogue in 2019 - have confirmed these goals and reiterated their mutual commitment to work together on ministerial level to enhance cooperation on key green technologies. Furthermore, both countries' central banks, the Bank of England and People's Bank of China agreed to collaborate on green finance standards and regulatory frameworks for climate-friendly financing. In September, President for COP26 Alok Sharma met China's Special Representative Xie Zhenhua in Tianjin to discuss China's crucial role in global climate diplomacy. Both agreed that more needs to be done and that all sides should accelerate their efforts to keep global temperatures from rising above 1.5 °C. Finally, in October, the head of China's chief energy regulator Zhang Jianhua held a video conference with Kwasi Kwarteng, UK Secretary for Business, Energy and Industrial Strategy to discuss both country's cooperation in the field of civil nuclear energy, offshore wind power generation and energy market reform.

While many of these initiatives where interrupted by the Covid-pandemic, the increased frequency of extreme weather events like the torrential floods in Zhengzhou make the joint combat against climate change and an even more pressing task. COP26 now offers an opportunity for leaders in both countries to re-join hands and enhance the positive examples of joint action that are already taking place.

THE ROLE OF BUSINESS

Businesses from the UK and China will be central players in the low carbon transition, through their investment, their technologies, and their services and it's this that the report aims to highlight.

KPMG, in the report's thought-provoking introduction, draws upon recent analysis to outline what it sees as the main opportunities that will emerge for companies from what is proving a difficult and challenging transition from a fossil fuel driven economy towards a sustainable and carbon-neutral one. They are at once plentiful and diverse and several play into proven synergies between the UK and China.

Following the five key themes outlined at the start of the UK's Presidency of COP26, each of our five Chapter Sponsors then goes on to share their own reflections on the challenges and technological advancements within their respective areas of expertise. Each chapter is then complimented with a set of four case studies, which serve to illustrate the wealth of solutions that British and Chinese firms are working on in support of our countries' ambitious climate targets.

The entrepreneurial spirit and technical ingenuity demonstrated herein will be a major contributing factor in helping our nations reverse the destructive trends of the past in Targeting Net Zero for the future.

[1] https://www.ipcc.ch/assessment-report/ar6/
[2] https://publications.jrc.ec.europa.eu/repository/handle/JRC121460
[3] Finamore, Barbara (2018), Will China Save the Planet?, Cambridge:Polity
[4] https://www.fmprc.gov.cn/mfa_eng/zxxx_662805/t1817098.shtml
[5] https://www.xinhuanet.com/english/2021-04/22/c_139899289.htm
[6] https://www.state.gov/u-s-china-joint-statememnt-addressing_the-climate-crisis/
[7] https://ec.europa.eu/clima/sites/default/files/news/20180713_statement_en.pdf
[8] https://ec.europa.eu/clima/sites/default/files/news/20180713_mou_en.pdf
[9] https://www.ft.com/content/cddd464f-9a37-41a0-8f35-62d98fa0cca0
[10] https://www.gov.uk/government/publications/global-britain-in-a-competitive-age-the-
[11] integrated-review-of-security-defence-development-and-forign-policy
[12] https://www.evwind.es/2020/08/25/china-to-account-for-over-25-global-offshore-wind-power-capacity-by-2030/76767

Principal Sponsor's Insight

BROUGHT TO YOU BY KPMG

Emerging Roles & Opportunities for UK-China Business in Combatting Climate Change

There is an increasing need for international cooperation to support Chinese companies' business transformation to fit the future low-carbon economy and achieve sustainable growth. There are opportunities for China and the UK to work together across aspects of policy, infrastructure, technology, financing and best practice sharing.

As the 26th Conference of the Parties (COP26) approaches, the signs of climate change are ever more visible around us. July 2021 was the hottest single month the world has ever experienced;[1] while record heatwaves hit Canada and North West America in June, wildfires have raged as far apart as California, the Mediterranean and Siberia, and severe flooding has hit many parts of the world.

Amidst a gathering sense of emergency, the report in August from the United Nation's Intergovernmental Panel on Climate Change (IPCC) warned starkly that the situation has become "code red for humanity". Its assessment concluded that some effects of climate change such as continued sea level rise are irreversible at least for centuries – but that, if the world can reach Net Zero by the middle of the century, it is not too late to avoid the worst impacts of climate breakdown.[2]

It is clear that the entire global community must pull together and every nation must stretch itself to make the biggest contribution it can. That being the case, what are the particular challenges and opportunities in front of the UK and China – and what potential is there for the two nations' business communities to support and invest in each other as part of the effort?

The two countries are in quite different positions as they each face up to the challenges ahead. KPMG's Net Zero Readiness Index,[3] published in October and comparing the likelihood of 32 major economies reaching Net Zero by 2050, places the UK at number two while China is further back at number 20. This is because the two economies are at different stages of development, with China having to accelerate its industrialisation phase and at huge scale. See our separate box-out section for a fuller analysis of the Index findings.*

The UK, which accounts for under 1% of global emissions, has already enshrined in law its commitment to achieve Net Zero by 2050. To enable this, it has further set what the government describes as "the world's most ambitious climate change target" of cutting emissions by 78% by 2035 compared to levels in 1990.[4] This would take the UK more than three quarters of the way towards hitting Net Zero by 2050. The UK's major achievement to date is the decarbonisation of its power sector and the simultaneous shift to renewables. The carbon intensity of the power sector has fallen from 481gCO_2/kWh in 2010 to 181gCO_2/kWh in 2020; while renewables' share of power generation has risen from around 7% to over 40% in the same period.[5]

The government has also announced some significant plans and aspirations for the coming years, such as the creation of four major industrial clusters for carbon capture usage and storage (CCUS) and hydrogen production by 2030; a ban on the sale of new internal combustion engine (ICE) vehicles from 2030 as the nation moves to electric; the full rollout of smart meters to help households more efficiently manage their energy usage and support the transition to a more flexible energy market by the end of 2025; and a potential ban on the sale of new gas-fired boilers by the mid-2030s in favour of hydrogen and heat pumps.

With a 10 Point Plan for a green industrial revolution setting the over-arching framework and an Industrial Decarbonisation Strategy in place, together with a recently published Hydrogen Strategy,[6] the UK has many of the building blocks in place – but still has a long way to go if it is to deliver on its ambitions, as the Climate Change Committee warned in its latest progress report to UK parliament.[7]

One challenge is the need - in common with all developed economies - to bring citizens with them on the journey and bring about changes in how people live, as Simon Virley, Vice Chair and Head of Energy & Natural Resources at KPMG in the UK observes:

"The next phase of decarbonisation in the UK is going to be much more intrusive than what has come before. It will involve changes in almost everything we do: the cars we drive, the way we heat our homes, our travel patterns, how we use our land, what we eat. There needs to be much greater engagement with the public on the choices ahead and what we can all do as individuals and in our communities if we are to get to Net Zero at least cost and ensure a Just Transition."

China, meanwhile, has a population about twenty-five times the size of the UK and accounts for around 30% of global carbon emissions. However, its carbon usage per head of population is around half that of the United States and is also considerably lower than that of some other Western economies. While its fossil fuel usage is still growing, China has pledged that this will peak in 2030 and then decline, with a Net Zero target of 2060. It is backing this up with real action – already being the world's largest producer of renewable energy. In 2020, it had solar power capacity of 254,355 megawatts, far ahead of the US in second at 75,572, and it had triple the wind power installations of any other country too. China hopes that a quarter of its energy will be produced from non-fossil fuel sources by 2030 – and many analysts believe it may hit that target early.[8]

China's commitment to reducing carbon is becoming clearer. Xie Zhenhua, China's special envoy on climate change, has spoken publicly of the imminent release of a top-level design of China's so-called "1+N" policy framework for reaching peak carbon and carbon neutrality targets together with specific action plans for key emitting sectors. China also opened a national carbon emissions trading scheme in July 2021 covering more than 2,000 power plants, with plans to add other industrial sectors.

With China producing a significant proportion of the world's carbon emissions, its progress in reducing carbon is clearly of huge importance in itself. China has also taken steps to embed sustainability practices into its international Belt and Road infrastructure initiatives – with the Ministry of Commerce and the Ministry of Ecology and Environment jointly releasing in July an updated set of green development guidelines for overseas development and investment. With an emphasis on compliance with international practices, the guidelines reflect encouraging aspirations for higher environmental and green investment standards. More recently, China's President Xi Jinping made the surprise, but most welcome, pledge at the UN General Assembly in September that China would stop financing coal-fired projects abroad.

[1] https://www.noaa.gov/news/its-official-july-2021-was-earths-hottest-month-on-record
[2] https://www.ipcc.ch/assessment-report/ar6/
[3] https://home.kpmg/xx/en/home/insights/2021/09/net-zero-readiness-index.html
[4] https://www.gov.uk/government/news/uk-enshrines-new-target-in-law-to-slash-emissions-by-78-by-2035
[5] See KPMG report 'Hindsight is 2050 vision', https://assets.kpmg/content/dam/kpmg/uk/pdf/2021/06/kpmg-sse-hindsight-2050-report.pdf
[6] https://www.gov.uk/government/news/uk-government-launches-plan-for-a-world-leading-hydrogen-economy
[7] https://www.theccc.org.uk/publication/2021-progress-report-to-parliament/
[8] https://www.bbc.co.uk/news/world-asia-china-57483492

China indeed has a crucial role to play in enabling the global community to drive down carbon, as Simon Virley explains:

> "China can leverage immense economies of scale and reach price points that other countries simply can't match. We have seen that with solar, and the same can be true of other low carbon technologies, like electric vehicles and hydrogen. The lower the cost of these green technologies, the easier it will be to maintain public buy-in around the world for the energy transition."

By extension, this means there is significant potential for UK and Chinese businesses and investors to work together in the coming years in the pursuit of a common goal.

On the UK side, there is an opportunity for London to build on its pre-eminent position as a financial services centre and become the global centre for carbon trading. The various carbon trading schemes in existence around the world will need to be linked up at some point – and London could fit the bill. There is clear potential for the UK to become the standard setter for green finance – how to define it, verify it and audit it. Alongside this, the UK could become the leading pioneer for climate risk disclosures and reporting. There will be significant opportunities for UK professional services organisations in providing consulting, legal, assurance and accounting advice around these and related areas to businesses in China, and opportunities for testing, inspection and certification organisations too.

Other export opportunities for the UK to China include offshore wind where the UK has built up considerable expertise around the integration of wind into national energy systems and the skills and services needed to support that. Smart energy systems are another fertile potential area, with UK businesses like Octopus Energy developing leading-edge systems that utilize smart technology and AI to optimize energy usage and efficiency across different needs. The UK could also lead the way – and make some in-roads in China – around carbon capture technology as well as the shift to low carbon heating.

On the Chinese side, there has been some significant investment already into UK renewable energy, particularly offshore wind, and in the UK's nuclear industry and smart grid networks. There are likely to be increasing opportunities to invest in UK infrastructure projects such as the construction of its planned Carbon Capture, Utilisation and Storage (CCUS) clusters. China already has a strong track record of investment into major UK energy and infrastructure projects and this can continue in Net Zero related endeavours, bringing mutual benefit – generating a return for Chinese investors and bringing down the cost of capital for the UK.

UK-Chinese links should include collaboration over the scaling of new green technologies. It will not be possible to meet Net Zero targets by solely relying on the technologies available today. Britain has a strong track record in ground-breaking scientific R&D; China has the ability to scale new technologies to market. Finding synergies through co-operation could unlock success.

Then there is energy transition. Major oil & gas businesses have become leaders in decarbonising their business models and diversifying away from hydrocarbons towards renewable energy sources, although they themselves recognise there is a long way to go. The UK's oil & gas industry can export its knowledge and experience around this, including to the Chinese super-majors. There are win-wins to be gained here on both sides.

The UK and China have a strong trading history with each other. UK financial institutions and businesses in other sectors are benefitting from reforms and license approvals designed to increase foreign investment into China; while Chinese businesses have historically found the UK to be a welcoming and cosmopolitan place to do business.

There should be a focus on continuing and indeed increasing this where climate action is concerned, as Simon Virley says: "For the first time ever, we have China, the EU, the UK and the US all committed to Net Zero. Chinese companies are already investing heavily in the low carbon sector in the UK as the UK seeks to meet its Net Zero target, whilst a growing number of UK companies are investing in China. So, we have a great platform on which to build collaborative partnerships between the UK and China on the low carbon technologies and financing solutions needed to meet the global challenge of climate change."

Daisy Shen, Partner, Climate Change and Sustainable Development, KPMG in China, echoes this sentiment: "Since President Xi's announcement of China's top-level commitments in September 2020, the momentum has accelerated. Chinese companies have started committing to or setting science-based targets to reduce greenhouse gas emissions through the application of innovative energy saving initiatives and technologies, increased use of renewable energy, etc. There is an increasing need for international cooperation to support Chinese companies' business transformation to fit the future low-carbon economy and achieve sustainable growth. There are opportunities for China and the UK to work together across aspects of policy, infrastructure, technology, financing and best practice sharing."

Now, through COP26 and beyond, we need to use the opportunity to deepen collaboration between the UK and China on the Energy Transition in key areas such as:

- Offshore wind
- Hydrogen
- Carbon capture
- Electric vehicles
- Smart energy platforms
- Carbon trading
- Climate risk reporting

KPMG NET ZERO READINESS INDEX 2021

KPMG's Net Zero Readiness Index (NZRI) considers 103 indicators that are key drivers to achieving Net Zero in each of the 32 countries studied.

The UK ranked second in the NZRI, and China 20th. The top five countries were Norway, UK, Denmark, Sweden and Germany. Other major jurisdictions include the US (13th), Australia (14th) and Russia (25th).

China

China's target of peak carbon emissions before 2030 and Net Zero by 2060 may be later than the dates pledged by many other countries in the NZRI, but they mean the country would move from peak carbon to Net Zero in three decades - about half the time of other countries.

China already has the world's highest level of renewable energy capacity of 925GW in 2020, around three times as much as the US. It added 72GW of wind and 48GW of solar in 2020, both big increases on 2019. Despite this effort only 33 percent of its electricity came from low carbon sources in 2018, highlighting the need for the country to continue its rapid expansion of renewable generation.

Some key companies in high-emission sectors have announced timetables and goals to achieve carbon neutrality through measures covering energy consumption, energy efficiency and increasing use of renewables.

China is rated second among the 32 countries in the research on agriculture and land use, due to factors including relatively low consumption of dairy per person, and strong performance on limiting food losses and waste.

The country is ranked fourth in the transport sector, partly due to the high availability and use of public transport, having developed the world's longest high-speed rail network over recent decades. China also has the world's largest electric vehicle market, with 5.4 million in use in 2020 – nearly half of the global fleet. China's national target is to have 'new energy' vehicles making up 20 percent of new car sales by 2025.

UK

Cross-party political support and clear legally-backed targets have enabled the comparatively swift decarbonisation of the power sector in the UK, with the country ranking second in the electricity and heat sector. The last coal-fired power station is due to close by 2024 and the proportion of renewable energy used in electricity production rose from 7 percent in 2008 to above 40 percent in 2020.

Progress is also being made on converting industrial processes to using hydrogen and carbon capture, with the UK ranking third in the industry sector. On transport, overall adoption may be low at present, but electric cars and small vans are increasing in popularity; their lifetime costs may now be comparatively lower than fossil fuel alternatives, which the government has banned the sale of after 2030 (with new heavy good vehicles banned from 2040 at the latest).

However, regarding public engagement, most of the work which will directly affect citizens is yet to come. Despite mandatory building energy certification and high levels of household energy security which contribute to the country's fourth-placed rating in the buildings sector, many Britons live in poorly-insulated houses which were built many decades ago and around nine in ten are heated by natural gas. The government says that 600,000 homes a year will need to install a heat pump by 2028, while its Climate Change Committee puts the figure at 1 million annually by 2030. However, last year only around 30,000 heat pumps, which usually require the retrofitting of better insulation to be effective, were installed.

FOCUS ON HYDROGEN / DECARBONISATION

The UK government's Hydrogen Strategy envisages a "world-leading hydrogen economy" supporting over 9,000 UK jobs and unlocking GBP 4bn investment by 2030. The government predicts that 20-35% of the UK's energy consumption by 2050 could be hydrogen-based. A twin-track approach is planned – bolstering blue hydrogen and CCUS production through four industrial clusters whilst also supporting the development of green electrolytic hydrogen. Companies such as ITM Power are already leading the way in green hydrogen using Proton Exchange Membrane (PEM) technology - such technological innovation could become a significant export for the UK.

China is one of the biggest manufacturers of green hydrogen technology with a particular emphasis on alkaline technology. However, alkaline technology is suited to large-scale baseload industrial electrolysers, whereas PEM technology works better with intermittent renewable technologies such as solar and wind which will give it an increasingly prominent role in global deployment. China is also a leader in hydrogen fuel cell technology – hydrogen being potentially a key power source for heavy transportation, where electric batteries are less viable. There are already some 7,000 hydrogen fuel cell buses in operation in China.

With the UK's clear hydrogen focus, and China's 14th Five Year Plan labelling hydrogen a "frontier" area that the country pledges to advance, there could be scope for the two nations to cooperate and cross-invest.

FOCUS ON RENEWABLE ENERGY

Several of China's generation companies (gencos) have already made investments into renewables in the UK, such as:

- SDIC which acquired Edinburgh-based Red Rock Power in 2016
- CGN has extended its nuclear partnership with EDF to onshore wind assets
- China Resources Power, subsidiary of the Hong Kong based conglomerate China Resources Group, has invested in a major operating offshore wind project alongside the Norwegian energy giant Equinor

More broadly across Europe:

- CGN has been highly active since 2015
- China Three Gorges has built significant stakes in a wide range of Renewables assets including offshore wind, both through its participation in EDP and relationship with Energias de Portugais Renewables (EDPR); and also on a stand-alone basis

- **We have observed several further major gencos actively seek to enter the European Renewables market as they look to achieve their own international growth KPIs in Renewables**

Looking in the other direction, a few western strategic energy companies are active in China:

- **EDF has a partnership with China Energy Investment Corporation (CEI), focused on 502 MW of offshore wind projects in China**
- **Other major western oil & gas companies are already well established in China and may well be considering extending operations to offshore wind, in line with their strategic growth ambitions**

The focus for many of the major European (in particular) offshore wind developers is in neighbouring markets in the region – Japan, South Korea and Taiwan. Given the exciting growth potential of the Chinese offshore wind market, requiring an enormous scale of capital and strategic capability, it would be really positive to continue this trend of partnering across the major offshore wind activities.

Supply chains, meanwhile, are relatively settled. China already manufactures the great majority of the world's solar panels. Of the world's ten major wind turbine manufacturers, three are Chinese and these mainly supply their own national market. Of the other seven, some have factories in China.

FOCUS ON CLEAN TRANSPORTATION

With both countries already embracing progressive plans for EV adoption, but with battery life and range still potentially limiting factors, there may be scope for the nations to cooperate on R&D development in order to explore new battery technologies and chemistries, as well as to establish an effective circular economy in the battery value chain. As well as extending battery life, more cost-effective methods of recycling batteries – and/or extracting the valuable metals from them for re-use – are needed. There are also opportunities to drive cooperation across many areas of the mobility ecosystem.

Then there is hydrogen, which may have a key role to play as the powertrain for heavy and industrial vehicles. China leads the way in hydrogen buses. The UK has a leading hydrogen and low/zero emission bus maker in Alexander Dennis (that uses hydrogen fuel cells from Chinese manufacturer BYD), while operators like First Bus have launched hydrogen fleets in some locations. There will be scope for closer ties between the China and the UK in this growing area.

Engineering solutions for a net-zero world.

We believe a net-zero world is possible and we aim to deliver it.

At Wood, we are on a quest to unlock solutions to the world's most critical challenges in energy and the built environment. We work at the heart of the energy transition every day, discovering the answers that will create a cleaner, more efficient future for energy and make a net-zero world a reality.

woodplc.com/netzeroworld

wood.

CHAPTER

01

Energy Transition

The Decarbonisation of Industrial Clusters

As the eyes of the world turn towards Glasgow in November, the momentum behind the Net Zero agenda continues to gather further pace. The recent IPCC report which signalled 'a code red for humanity' underlined the pressing need to move beyond just setting Net Zero commitments and instead taking concrete actions that drive near-term reductions in carbon emissions.

There's no doubt that COP26 is being viewed as a bellwether moment. Agreements struck in Glasgow will determine if the world can get on track with the goals set out in the Paris Agreement and avoid the most catastrophic impacts of climate change. And while the scale of the challenge means every country across the globe has a role to play, how large and rapidly growing economies in Asia (China, India and Indonesia) evolve over the next decade will have a particularly significant bearing on whether the promise of a Net Zero future can be realised.

CHINA'S ROLE AT THE HEART OF NET ZERO

China is a particularly interesting case. It's the world's largest single emitter of CO_2 (albeit not on a per capita basis) and was responsible for 28% of global CO_2 emissions in 2020. The country remains heavily reliant on hydrocarbons as a primary energy source, including coal, and its Nationally Determined Contribution (NDC) rating is still inconsistent with holding global warming to well below 2C.

Given the scale of these figures, it's clear that any progress that China makes on its own decarbonisation agenda, will have a major bearing on global progress. Encouragingly, in late 2020, China committed to binding targets when President Xi set dual goals to achieve peak carbon by 2030 and become carbon neutral by 2060.

Furthermore, in the latest Five-Year-Plan (FYP) issued earlier this year, the Chinese leadership set additional targets including a goal to reduce carbon intensity by 18% by 2025 and establish 'a modern energy system', including a goal to increase non-fossil fuel primary energy usage to 20% in the same window.

All of these provide a clear signal on the overall direction of travel. The challenge now is assessing where near-term focus can be best applied to build early momentum in the race towards a Net Zero future.

> As COP is now upon us, a global mindset and collaborative spirit that has long characterised UK-Sino relations, will be key to securing the collective commitments required to help bring to life the promise of a Net Zero future.

AN INDUSTRIAL-SCALE CHALLENGE

At Wood, we believe China's industrial sectors merit particular focus. Over the last 30 years, industrial heartlands like Huizhou, Ningdong, Yulin, and Ningbo have all played a central role in powering China's impressive growth story. They remain an important part of the economy today, however the long-term future of industrial clusters across the country will be predicated on delivering the same output with a much-reduced environmental impact.

Take China's steel industry as an example. The sector accounts for 15% of the country's total carbon emissions and 60% of global steel sector emissions. Earlier this year, in the city of Tangshan in Hebei province, authorities gave 23 steelmakers a clear choice; 'cut CO_2 emissions or cut production'. Increasingly, this will be the choice facing not just steel producers, but companies in other industrial markets including refining, chemicals and manufacturing.

Recent data from IRENA outlines the scale of the transformation required. By 2050, China must reduce annual industrial emissions by over a third, driving a reduction from 4.5GT to 3GT of CO_2 emissions per annum. Companies like Baowu Steel Group and Sinopec are responding to this challenge by setting their own goals, in this case a target to become carbon neutral by 2050, and many more will follow suit over the coming years as part of a decade of climate action.

While the 'what', the 'when' and the 'why' are well understood, the challenge still lies in the 'how'. We see an important role for a company like Wood to work with leading Chinese firms to identify the technical and commercial solutions that can help to bring about a Net Zero future.

ENGINEERING SOLUTIONS FOR A NET ZERO WORLD

Across many countries, including China, the near-term pathways to decarbonise industrial activity are not yet clear. While decarbonisation is clearly a business imperative for companies operating in industrial sectors, developing a credible roadmap towards Net Zero is a hugely complex challenge that requires multiple levers to be pulled as part of a blended solution.

Knowing where to start can often be the biggest challenge. At Wood, we are helping clients to tackle this very problem using our proprietary Decarbonisation SCORE methodology (Fig 1 below). SCORE is a structured and dynamic process that pinpoints key business drivers, sets targets, maps assets, identifies the right mix of solutions that can ultimately deliver against emissions goals.

The process can be applied to single or multiple assets, to a portfolio or across a specific geography or region. Given that industrial facilities in China can operate as stand-alone assets, as part of a cluster, or in some cases, as part of an 'industrial city', this optionality is key.

The term SCORE is an acronym that refers to the range of options we find are typically available when it comes to designing a pathway to Net Zero for industrial assets and clusters. The options include:

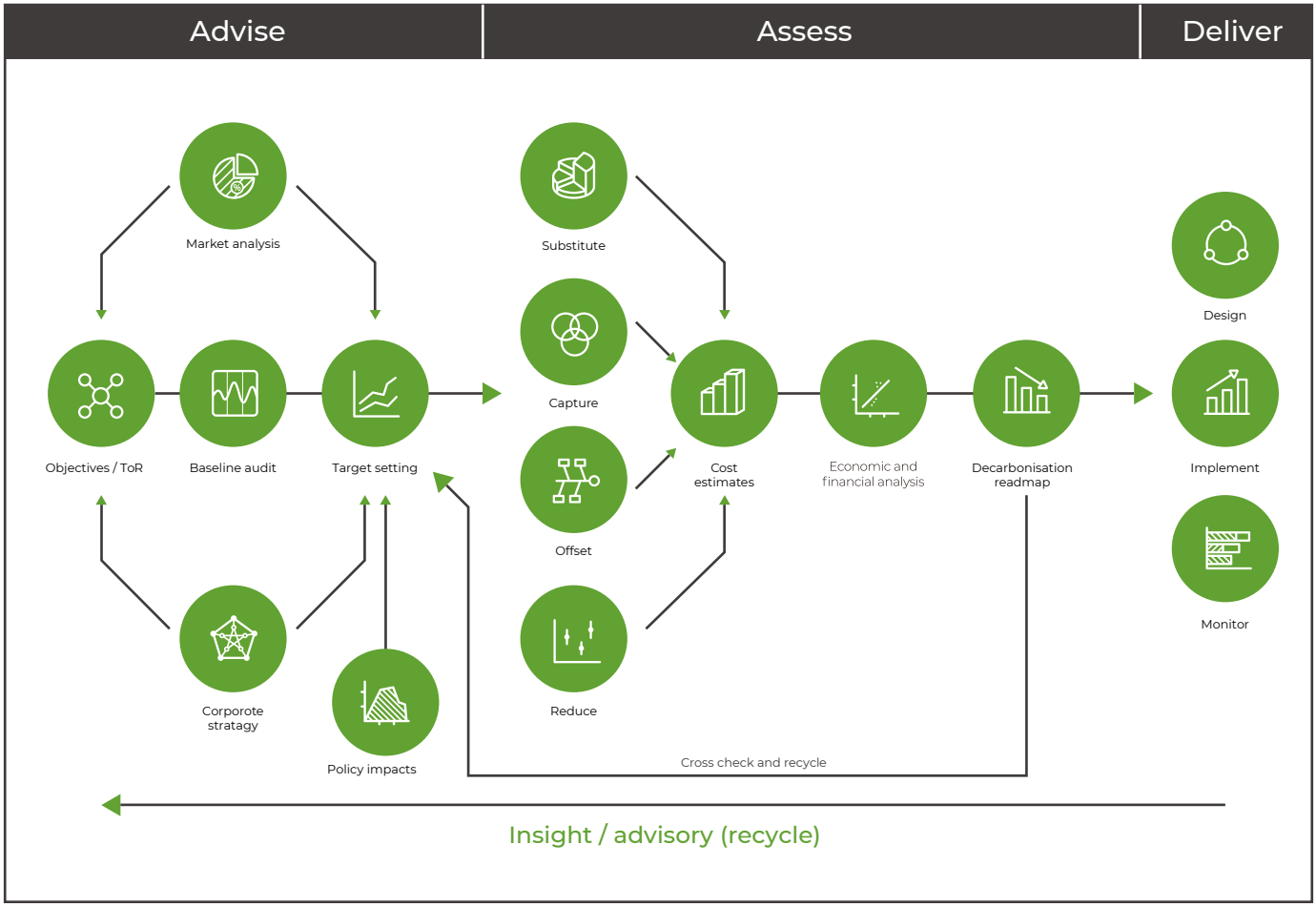


FIG 1 - WOOD'S DECARBONISATION SCORE METHODOLOGY TO BUILD A PATH TO NET ZERO

SUBSTITUTE

Switch fuel or feedstocks to renewable or less carbon intensive sources. Two good examples here are switching electricity provision to a renewable source like solar PV, or considering the use of renewable and bio feedstocks.

CAPTURE

Employ carbon capture or emissions control technologies to substantially reduce or eliminate harmful emissions.

OFFSET

Consider assets or product portfolios on a country or company-wide scale and explore opportunities to compensate in other areas for the carbon emissions that cannot be easily removed. Offset solutions can divide opinion but in our experience, they provide important flexibility particularly in industrial sectors where some emissions are more challenging to address.

REDUCE

Adopt a holistic approach to asset optimisation including energy efficiency, digitalisation and smart maintenance strategies to avoid potential emissions at source. Some of these represent 'quick win' opportunities while other steps will involve more comprehensive asset repurposing.

EVALUATE

Apply a structured and on-going evaluation process to drive continuous improvement towards Net Zero.

DATA-DRIVEN EMISSIONS REDUCTIONS

Earlier this year, China officially launched its national carbon emission trading scheme (ETS). It demonstrates China's commitment to climate action and given the country is the largest carbon market in the world by volume, it has the potential to be transformative. As new regulations come into force and markets for offsetting and trading emerge, data quality and auditability will be key, from basic operations all the way through to strategy definition.

At Wood, we are deploying ENVision, a real-time emissions monitoring and management tool, to provide high frequency, streamlined and automated data on emissions profile and regulatory calculations. The ability to derive insight is predicated on having access to quality data and this will be increasingly important in achieving emissions reductions and Net Zero targets.

Given the scale and complexity of the China market, it is vital that industrial clients track their real-time emissions footprint and performance metrics so that a clear, auditable and accurate view of emissions can be presented to regulators, operators and stakeholders.

Earlier this year, China officially launched its national carbon emission trading scheme (ETS).

AN OPPORTUNITY TO LEAD THE WORLD

China is already a world leader when it comes to manufacturing wind turbines, solar panels and battery storage solutions for electric vehicles. Given the vast scale of its industrial footprint, it also has a tremendous opportunity to lead the way on the development of cost-effective, scalable solutions to help decarbonise industrial sectors.

Market analysis shows that many of the technologies required to deliver a Net Zero world still cost a premium, however as these technologies are scaled, there are significant cost reduction opportunities. In this respect, China has a natural advantage on other markets. The volume of industrial cluster developments across the country means China can create a domestic market, learn at home and then take this expertise across Asia and to the rest of the world.

The level of investment being made in energy transition technologies across China highlights the opportunity here. Within the carbon capture and storage space there is real momentum, with IHS Markit data indicating China could add eight more large-scale CCUS projects by 2025. This is only going to grow, with BCG analysis suggesting that 100% adoption of CCS technology will be required for in-house power generation and heat production if China's industries are to align with a Net Zero future.

Investment in hydrogen technology is also accelerating – the country will account for two-thirds of the world's electrolysers by the end of 2022, and more than 20 provinces and 40 cities in China have published development plans worth trillions of Yuan for new hydrogen energy facilities.

According to Chinese media group Caixin, the China Hydrogen Alliance estimates the output value of the country's hydrogen energy industry will reach USD 152.6 billion by 2025 and the country's hydrogen demand will reach 35 million tons, accounting for at least 5% of China's energy system by 2030.

Another area where China has a competitive advantage is around its research and development programme. The country is investing heavily in both 'new' innovation and in scaling some of the existing technologies that will need to be much more widely adopted to deliver a low-carbon future.

COLLABORATION OPPORTUNITIES FOR THE UK AND CHINA

Today, some of the most progressive industrial decarbonisation projects being delivered are in the UK in communities like Humberside, Teesside and South Wales. The launch of the UK's industrial decarbonisation strategy in March 2021 means policy is now in place that will unlock the funding required to move these projects forward into the delivery phase.

Our work on Humber Zero to create a zero-carbon industrial cluster is a great example of industrial decarbonisation in action. Covering multiple assets including refineries, power plants and pipeline infrastructure, the decarbonisation solutions being applied on the project include green hydrogen via electrolysis, blue hydrogen via advanced steam methane reforming, post-combustion carbon capture on combined cycle gas turbines, steam boilers and refinery process units, as well as energy efficiency improvements across the various assets.

In total, the decarbonisation masterplan will help to save over 8m tons of CO_2 per annum, as well as creating a sustainable platform for industrial growth, economic development, and new job opportunities.

While this is a best-in-class example of a project of this nature, the size of the UK means there are a limited number of projects of this scale that will be commissioned. In a market like China, there's a much larger canvas to work on. This presents an opportunity to embrace some of the early lessons that emerge from major programmes like the Northern Endurance Partnership on Teesside or Zero Carbon Humber and use this to shape their own Net Zero industrial revolution across the country.

The UK and China have a long history of successful collaboration, and this is an area that's ripe for future collaboration with both countries committing to clear carbon reduction targets.

Now with another intensive round of climate negotiations complete, a global mindset and collaborative spirt that has long characterized UK-Sino relations, will be key to securing the collective commitments required to help bring to life the promise of a Net Zero future.

For further information, please contact Dr Shengke Zhi, Director, Growth & Development, Wood Plc shengke.zhi@woodplc.com "

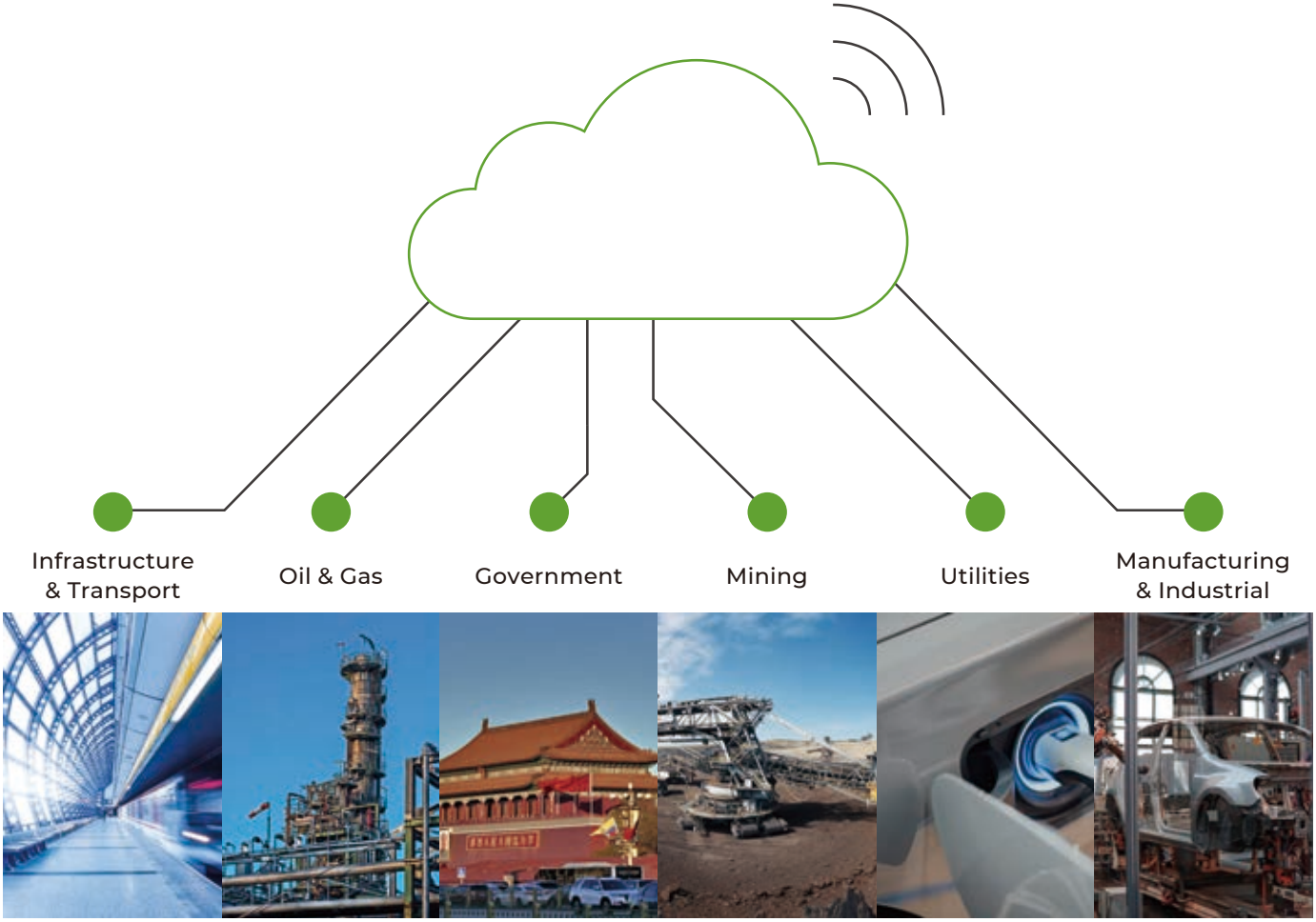


FIG 2 - WOOD'S ENVISION EMISSION MONITORING AND MANAGEMENT TOOL TO PROVIDE A REAL TIME INSIGHT OF EMISSIONS REDUCTIONS

CASE STUDY

Thermal Storage: The Enhancement of Renewable Energy Solutions

COMPANY PROFILE

SUNAMP LTD

Founded in 2006, Sunamp is the first company to establish a large team of engineers and chemists dedicated to the development and control of all components in-house, from PCM R&D and product manufacturing, to the design of core components and final assembly and commercialisation. To date we have subsidiaries in Switzerland, The Netherlands, Chile, and the US: with a growing number of partnerships and rapid business development underway.

Sunamp's thermal storage technology is transforming how we generate, store, use heat, and cool around the world and is impacting how we tackle climate change and safeguard our planet for future generations.

> "China has promised the world to reach carbon peak by 2030, and to become carbon neutral by 2060. Along the carbon neutral and energy transition roadmap, thermal storage technology plays an instrumental role in optimising renewable energy utilisation."

TIANYUE LI
BUSINESS DEVELOPMENT MANAGER, SUNAMP LTD

China has promised the world that it will reach carbon peak by 2030, and become carbon neutral by 2060. Along this carbon neutral and energy transition roadmap, thermal storage technology plays an instrumental role in optimising renewable energy utilisation.

In order to improve the cost effectiveness and to reduce the payback period of industrial thermal storage projects, suitable heat storage systems can be added to ORC power plants to either overcome the intermittency of solar energy or minimise the required capacity of deep geothermal boreholes. Based on partners' previous successes with ORC technologies and heat storages in both the UK and China, this consortium brings together comprehensive and complementary expertise to address key technical challenges, thus pushing forward the commercialisation of the proposed technology.

In residential application, thermal storage enables the utilisation of renewable energies from solar PV, heat pumps and lower price off-peak electricity, which provides a revolutionary solution to the substitution of fossil fuels like natural gas. In addition, shifting from water-based thermal storage to PCM-based thermal storage delivers compact, highly responsive and enhanced hygienic water system for residential hot water purposes. Therefore the electrification, and decarbonisation effortss together with other added-value have attracted high-end consumers like in Hitime project, and will have a promising future alongside the carbon neutral goal in China.

Based on the understanding that the world uses over twice as much heat as electricity, Sunamp Heat Batteries help solve numerous problems by storing energy as heat and releasing it when and where it is needed. This is achieved at a lower cost and higher efficiency than competing technologies (e.g. electrical batteries, hydrogen electrolysis or fuel cells) utilising inorganic, non-toxic, salt-based Phase Change Materials (PCM), which absorbs and releases latent thermal energy during the process of melting and freezing.

Sunamp has been developing the business in China and completed several projects and demo-sites for thermal storage applications in residential and industrial fields, for the goal of decarbonisation, renewable energy transition, and enhanced hygiene and comfort for residential hot water systems.

INDUSTRIAL PROJECT

An ORC power plant integrated with thermal energy storage to utilise renewable heat sources for distributed heating and power

Intermittent and low-grade renewable energy sources have unrealised potential to displace the use of fossil fuels, provided their inherent drawbacks can be overcome. We propose to couple novel heat storage technologies with the well-known Organic Rankine Cycle to produce distributed heat and power supply using a wide range of under-utilised renewable heat sources, such as solar and geothermal energy. These heat sources are normally too low-grade to be economically unviable for power generation using conventional technologies. ORC power plants are believed to be the most promising technology to utilise them.

FIGURE 1. INSTALLATION OF SUNAMP UNIQ 80 PRODUCT WITH AN ORC SYSTEM IN SHIJIAZHUANG, CHINA

A)

B)

C)

RESIDENTIAL PROJECT

Hitime North Bund Project

The Hitime North Bund estate project is located in the centre of Puxi, Shanghai, and covers an area of 20841m^2, with a total construction area of 165800m^2. In addition to the residential building planning, there is also a protected building, an office building and three ultra-high buildings of about 160-170 meters, which will become the highest building for Puxi residence. The project is designed by John Portman architectural design firm, which is the design team of Shanghai landmark Shanghai mall and Portman Hotel. AECOM serves as landscape designer.

As the progress of carbon neutralization develops in China, forward-thinking estate developers have been focusing on the renewable energy utilisation, reduction of natural gas usage, and in the meantime maintaining a high level of comfort for residents. In this project, since the equipment room was initially designed for combi-boilers, and the space is too limited for a water-based thermal storage system, using Sunamp's advanced UniQ products can solve all the above issues, and can bring added value to the properties' owners. In the show room, Sunamp's UniQ products (2 x eHW 12) are integrated with the high standard water supply system, including water purification system (BWT), copper pipes (Viega), stainless steel pipes (DPR), hydraulic balancing valve and thermostatic valve (Oventrop), draining system (SEKISUI) supporting system and fireproof sealing (Hilti).

FIGURE 2. A) AND B): INSTALLATION OF SUNAMP UNIQ EHW12 IN THE SHOW HOME OF HITIME PROJECT; C) HITIME PROJECT ILLUSTRATION

CASE STUDY

Pursuing Green Energy in the UK

COMPANY PROFILE

SDIC Red Rock Power Limited

RED ROCK POWER LIMITED

Red Rock Power is an Edinburgh-based renewable energy company. Established in 2016 by Beijing's SDIC Power, the company has tripled in size and is continuing to expand into the wider European market and other technology sectors. Our team of 80 are passionate about tackling climate change and supporting the Net Zero transition.

Our current wind portfolio includes two of Scotland's largest offshore wind farm projects, two onshore wind projects in the West of Scotland – one operational since 2018 and the other due to start construction next year – and an operational onshore wind farm in Sweden, which holds one of Europe's longest corporate Power Purchase Agreements.

As a developer and operator of renewable energy projects, we are at the centre of the Net Zero transition and efforts to tackle climate change. Our current operational wind farm projects, of which we part or fully own, generate enough clean electricity to power over half a million homes while those in development have the potential to power a further million.

Our key objective over the last year was to see Red Rock Power continue to expand in the UK and Europe, generating more clean energy and supporting the green economic recovery. We're passionate about collaborating with the supply chain and supporting new innovations to harness the renewable industry's success in delivering clean, affordable energy.

In the last year, we have acquired Överturingen, an operational wind farm in Sweden, marking our first project in the wider European market, and the Benbrack wind farm development in Dumfries & Galloway which will create substantial opportunities for local businesses. Our Inch Cape development is also continuing to progress towards construction and maximise opportunities to optimise the wind farm.

We also recently partnered with Italian energy company, Eni, to bid in the latest ScotWind leasing round and consider future potential opportunities. A key focus of our partnership is to support the oil and gas workforce transition into renewables and apply learnings to the decarbonisation of the North Sea.

As we grow our portfolio and expand into other markets, we are also looking at ways to improve and optimise our own operations, from increasing generation capacity to improving efficiencies. A key focus here has been to secure a number of International Organisation Standardisation certificates for Asset Management and Health, Safety, Environment & Quality which demonstrate our commitment to improving industry best practice.

"Despite the challenge of the last year, we have continued to grow and improve our business. More importantly, we have increased the amount of clean energy our company generates in support of the Net Zero transition as well as opportunities for local green economic recovery. We look forward to forming new partnerships and collaborations that will create benefits for both the business community and wider society."

NANCY ZHANG
RED ROCK POWER'S CHIEF CORPORATE OFFICER

CASE STUDY

Emissions Savings through Cable Efficiencies

COMPANY PROFILE

NINGBO ORIENT WIRES & CABLES CO., LTD.

Orient Cable is an established world leading cable system solution provider for underground/subsea power cables, inter-array cables, dynamic cables, umbilical as well as offshore engineering. We are capable of producing up to 1.1GW 500kV HVAC and 2GW 525kV HVDC cables to enable the long-distance large-capacity offshore renewable and interconnection projects. We also offer a full range of umbilical, inter-arrays, dynamic power cables and offshore EPCI solutions to support various offshore projects.

FLOATING WIND FARMS

Floating wind farm development is a cutting-edge technology in the renewable industry. Being further out to sea and in deeper waters not only provides more wind energy but also more consistent wind energy, meaning floating offshore wind farms will be a key part in the future energy portfolio. To enable this application, dynamic cables are one of the most critical parts. There is a special need for dynamic power cable in terms of the electrical and mechanical properties, which needs extensive expertise and experience in Umbilical and HVAC cables. Orient Cable (NBO) was successfully awarded a contract from Three Gorges to provide dynamic cables for a pilot floating wind project in The South China Sea. In this project, NBO provided 35kV dynamic cables connecting the terminal 5.5MW floating WTG to the fixed WTG. Despite many challenges, such as shallow water (28m water depth), global configuration design and bad weather (typhoons are common here), our dynamic cables were delivered in August 2021.

We were also awarded a project in Scotland for a 33kV subsea cable replacement which runs from Ardmore, Skye to Beacravik, Harris following a subsea cable fault on 16 October 2020. The replacement 33kV cable, which will provide increased capacity of between 8 and 10MW, was delivered to the UK in late June. NBO also launched the remote monitoring system (RMS) for chasing each production process to the client under the COVID-19 pandemic.

The successful development of dynamic cables will enable larger offshore floating windfarms to be connected earlier and help contribute to Net Zero energy reliability, security, as well as affordability.

The decision to proceed with the replacement at 33kV also avoids up to 200,000 tons of CO_2 emissions from the back-up stations. In order to help reach Net Zero, we launched the remote monitoring system (RMS) as a cloud platform, which enables the client to easily track the whole production process. With our own cloud system, it can substantially reduce the travel frequency. We are also developing our own cloud-based system to calculate the amount of CO_2 emissions in our whole supply chain - from raw material procurement right through to final product delivery.

> The successful development of dynamic cables will enable larger offshore floating windfarm to be connected earlier and help contribute to Net Zero energy reliability, security, as well as affordability.

DR QI TANG
GENERAL MANAGER - EUROPE

CASE STUDY

The Database Dilemma: Innovative Solutions in Fuel Substitution

COMPANY PROFILE

KAO DATA

KAO DATA

Located in Harlow, at the heart of the UK Innovation Corridor, Kao Data is a hyperscale-inspired specialist data centre offering the highest-grade colocation options for advanced HPC (High Performance Computing), intensive AI and machine learning workloads.

Built in 2018, on the very site where Nobel Prize-winning physicist, Sir Charles Kao made his pioneering discovery of the fibre optic cable, Kao Data's award-winning development is breaking new ground in technical excellence and best-in-class design.

The data centre houses several impressive clients including NVIDIA Cambridge-1, the UK's most powerful new supercomputer dedicated to AI research in healthcare and for Chinese and Eastern technology giants, presents a perfect landing-zone for colocation requirements within the UK.

> We are effectively eliminating fossil fuels from our data centre operations and helping to reduce Scope 3 emissions in our customers' supply chain, with absolutely no disruption to the service they receive.
>
> GÉRARD THIBAULT
> KAO DATA'S CTO

Given how data-dependant our society has become, there is a requirement from the data centre industry to become more sustainable. And Kao Data is leading the way with a responsible and impactful renewable energy/ sustainability strategy which aims to have Net Zero operations at our Harlow campus long before the industry's target of 2030.

In July 2021, Kao Data took the initial steps towards achieving its own Net Zero ambitions when it became the UK's first data centre to transition all its backup generators to HVO (Hydrotreated Vegetable Oil) fuel.

By doing this, Kao Data aims to eliminate up to 90% of net CO_2 from its backup generators, significantly reducing industrial greenhouse gas emissions such as nitrogen oxide, carbon monoxide and other particulate matter. HVO fuel is significantly better for the environment compared to traditional, mineral diesels as it is 100% renewable, biodegradable, sustainable and non-toxic – and the move is set to be transformative across the data centre sector.

Gérard Thibault, KAO Data's CTO, says: "This pioneering move to replace our generator's diesel provision with HVO fuel is a key step in the company's efforts to become Net Zero, and a further demonstration of our leadership in the international data centre sustainability field.

We are effectively eliminating fossil fuels from our data centre operations and helping to reduce Scope 3 emissions in our customers' supply chain, with absolutely no disruption to the service they receive.

Most importantly, we are showing how our industry can take a simple and highly beneficial step forward for the good of the environment, ahead of COP26."

Additionally, Kao Data has been certified as BREEAM Excellent according to the world's leading sustainability assessment method for master-planning projects, infrastructure and buildings - highlighting data centre's utmost commitment to sustainability.

For a colocation data centre like Kao Data, it's been extremely important to align green credentials alongside the more obvious customer requirements of reliability and good connectivity.

Kao Data is powered by 100% certified renewable energy and, because its power supply is carbon neutral, can report a zero CUE (Carbon Usage Effectiveness).

It is also proud to be the UK's first 100-percent free-cooling wholesale colocation campus. Innovative cooling technology, which removes the requirement for refrigerants, further minimises the data centre's environmental impact and associated global warming potential because there are no gas emissions. And due to excellent technical design, inspired by hyperscale, the data centre boasts an exceptionally low PUE rating of 1.2 (even at partial loads).

Significantly, Kao Data can pass its sustainability credentials on to its customers, enabling them to reduce their carbon footprint and become more environmentally stable too.

Clearly, sustainability has never been more important to a post-pandemic world and is key to attracting overseas investment. With a suite of sustainability and CSR awards, Kao Data is setting the standards for future energy-efficient data centre design. We hope that Chinese business and investors will consider Kao Data as the sustainable data centre of choice.

CHAPTER

02

Adaptation & Resilience

Emerging Technologies, UK-China Partnerships, and the Path to Net Zero

The 20th century saw unprecedented technological advances – we developed televisions, lasers, electric refrigerators, and personal computers. We even walked on the moon. However, in our quest for progress, we failed to heed the impact that our industries were having on the planet. Although we now know that human activity started influencing the climate as early as the 1830s[1], it wasn't until 1988 that Dr James Hansen, then director of NASA's Institute for Space Studies, stated "The greenhouse effect has been detected, and it is changing our climate now."

Nearly 35 years later, a range of approaches have been developed to address the problem. Unfortunately, we cannot simply reverse the damage, but we can adapt our actions and technologies to ensure no further damage incurs, and we can build climate resilience, in terms of our ability to anticipate, prepare for, and respond to climate disturbances.

As part of the international response to climate change, a growing number of governments are setting 'Net Zero' targets; China and the UK have both declared their own targets for reaching Net Zero by 2060 and 2050, respectively. As leading industrial nations, both countries have a moral responsibility and practical ability to impact greenhouse gas emissions.

One example of the China–UK partnership is the recent collaboration between researchers from UK and Chinese universities, for achieving low carbon cities across both countries. Funded under the Low Carbon Cities programme, the projects encourage collaborative UK and Chinese research to reduce the carbon emissions of existing technologies.[2][3] Such projects are important if we are to meet ambitious Net Zero goals and collectively minimise the environmental footprints of organisations across their operations, services and products.

REDUCING CARBON FOOTPRINTS THROUGH REMOTE WORK

It is worth noting that recent trends brought about by the COVID-19 pandemic have provided new opportunities for businesses to further reduce their carbon footprints. Lockdowns forced many companies to accelerate their investment in new approaches for remote communications, reducing the need for business travel and, at least for a certain period, employees' daily commutes. In particular, the mass grounding of flights during the peak of the 2020 coronavirus pandemic saw CO_2 aviation emissions reduce by up to 60%. As transport is the biggest source of carbon emissions, changes such as these have the potential to contribute significantly to Net Zero.

The need to adapt and transition to novel ways of working during the pandemic has enabled businesses to accelerate their development of digital solutions to improve customer service. For example, Oxford Instruments has developed Sentinel and Live Assist, solutions that provide customers with remote engineering support, including installation and diagnosis, resulting in an improved, faster service and contributing to a reduced carbon footprint.

Continuing practices such as these, developed out of necessity during the pandemic, offers the opportunity to have a more long-lasting impact on emissions reduction. From clean energies, advanced batteries, green transportation, more efficient semiconductor chips, and quantum computing technologies, to lighter materials, carbon capture, and climate change imaging, the world needs to better leverage a range of emerging technologies to reduce emissions, encouraging uptake to enable the human species to adapt and survive.

[1] Abram N et al. Early onset of industrial-era warming across the oceans and continents. Nature 536, 411–418 (2016). https://doi.org/10.1038/nature19082
[2] http://www.chinese-embassy.org.uk/eng/dshdjjh/t1824125.htm
[3] https://www.cam.ac.uk/news/new-partnerships-for-low-carbon-cities-in-the-uk-and-china

ADVANCING CLEAN ENERGIES

Clean energy derives from renewable, zero-emissions sources, as well as energy efficiency measures. Switching from fossil fuels to renewables, including wind and solar power to generate electricity, significantly reduces CO_2 emissions in many countries. However, to make the deeper cuts required to meet Net Zero, investment and innovation are needed to provide technologically viable and economically competitive alternatives.

For example, most solar panels have efficiencies of just 15–20%, so improving the efficiencies of solar cells, through the manufacture of thin-film photovoltaic (PV) devices or the improvement of conventional PV technologies, is a key goal. Meanwhile, an obstacle for off-shore wind power is the hostile environment that requires speciality steels and high strength carbon composites making the development of advanced materials for building off-shore wind farms, a crucial target.

Another emerging technology is nuclear fusion of hydrogen atoms into helium — the process that powers the sun — which promises an almost limitless supply of clean energy, assuming current projects (e.g. ITER, the world's largest fusion experiment, involving partners in Europe, Japan, China, Russia, the US, India and South Korea) are successful. Industry partners, such as Oxford Instruments, are working to enhance efficiencies and overcome practical challenges, such as the development of advanced materials needed for quality control and safety, and imaging tools for measuring ion temperatures and helium densities inside the reactor.

Irrespective of how clean energy is sourced, it must be stored for use so it can be used later as needed, rather than at the time it is generated – periods of high demand may not coincide with peak wind or solar production. Meanwhile, customers in the automotive and electronics industries require longer lifetimes, higher capacity, reduced weight, and lower costs. The solutions to both challenges lie in optimising battery performance, enhancing capacity, maximising power delivery and minimising degradation – all of which requires an understanding of materials processes at the nanoscale.

China dominates the world's production of new generation batteries, and it is widely acknowledged that, by 2025, China will be producing batteries with double the capacity of those produced by the rest of the world. Oxford Instruments is just one UK company that has worked closely with Chinese partners, such as BYD and Shanghai Jiaotong University, to surmount challenges in developing batteries that promote the uptake of clean transport, making an invaluable contribution on to mitigating the impacts of climate change.

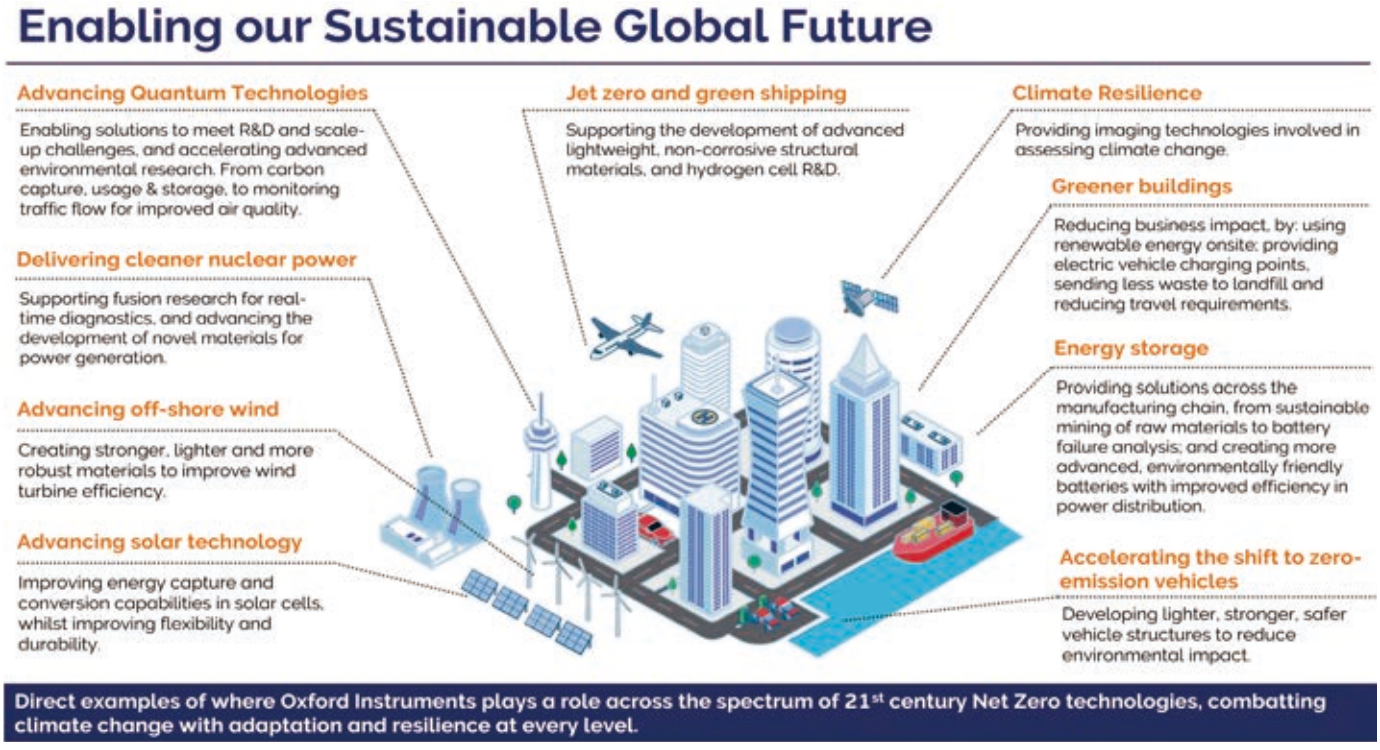


FIG 1 - ENABLING OUR SUSTAINABLE GLOBAL FUTURE

ACCELERATING THE SHIFT TO ZERO-EMISSION VEHICLES

Calculating the environmental impact of the shift to electric cars is not straightforward. In order to make a true shift to zero-emission vehicles, the entire electric car ecosystem needs to be involved, from downstream raw materials suppliers to component manufacturers, final component products and applications.

As well as advancing battery technologies to increase driving distance, battery life, and performance in terms of energy storage and release, we need more efficient and durable tyres, better power distribution control, cleaner manufacturing, and structural materials that are more lightweight for improved fuel efficiency, as well as recyclable, durable, and tough.

These and other new technologies will ensure that electric cars are truly zero-emission, from design to drive. Furthermore, evolving connectivity and smart technologies, supported by quantum computing, should soon allow traffic flow to be monitored to improve air quality and reduce carbon emissions.

As well as electric cars, there are plans to achieve zero-emission transatlantic flights ('jet zero'). Hydrogen fuel is one option that researchers and governments are keen to maximise. Hydrogen is soon expected to play a major role as the source of power in vehicles. Several research efforts are already underway to discover suitable alloys and coatings to store and use hydrogen in portable devices. Meanwhile, it is important to develop recyclable and lightweight structural materials that improve fuel efficiency.

INVESTING IN CARBON CAPTURE, USAGE AND STORAGE

Since CO_2 emissions are considered the overriding cause of climate change, an obvious solution is to remove it from the atmosphere, or capture it at the emission source. The UK and China are already working together on carbon capture, such as the China-UK Near Zero Emissions Coal (NZEC) Initiative, which has examined the merits of carbon capture and storage in China[4]. These technologies have significant potential to reduce emissions, but current approaches are expensive, with some critics pointing out that they use considerable extra energy themselves and pose some risk of leakages.

While capture technologies are still at a relatively early stage, quantum computing is helping to accelerate research into carbon capture and sustainability. Quantum computers are especially well suited to molecular simulations, and they could also pave the way to discovering new catalysts for carbon capture, heralding a new era of scrubbing carbon directly out of the air, and into products like metals, plastics and concrete.

In fact, the uptake of quantum computing will itself have an impact on carbon footprints. Currently, global data centres consume about 1% of global electricity, while the largest supercomputers today take enough energy to power a small town. Quantum computers are estimated to be 100 million times faster than a classical computer, making them vastly more energy efficient. As the quantum revolution unfolds, the footprint of our digital lives will dramatically reduce.

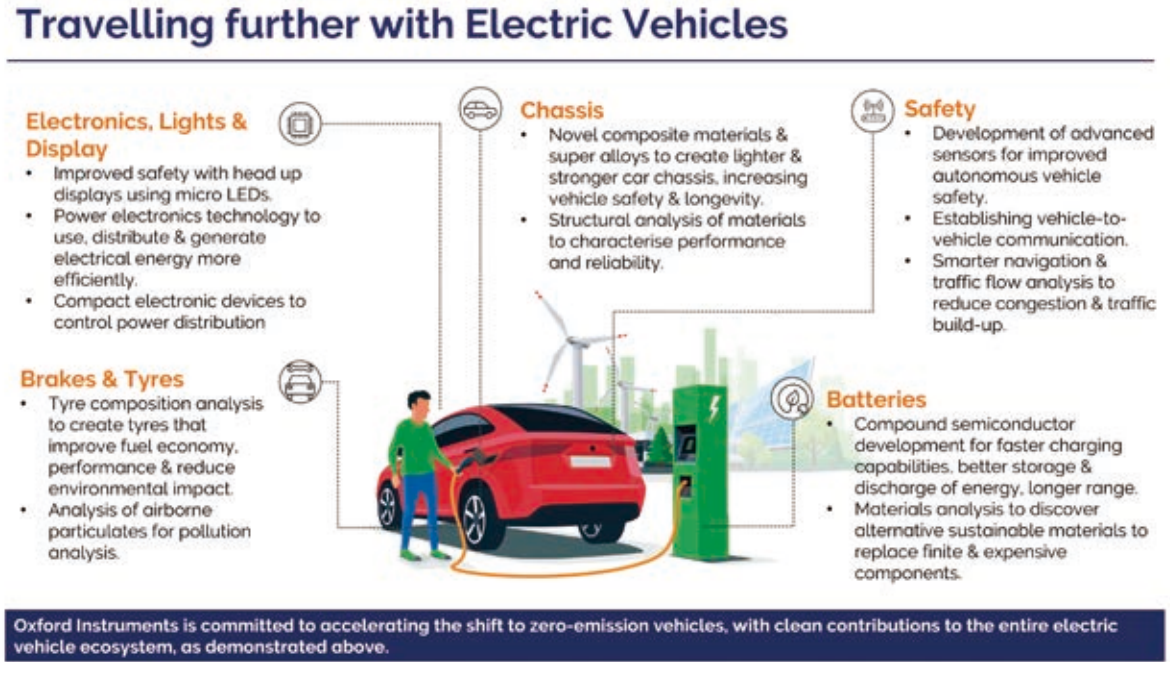


FIG 2 - TRAVELLING FURTHER WTH ELECTRIC VEHICLES

[4] https://ec.europa.eu/clima/sites/clima/files/docs/0028/china_uk_summary_en.pdf

CLIMATE RESILIENCE

Climate resilience involves assessing how climate change will impact current, climate-related risks, and taking steps to better cope with these risks. Although changes to the Earth's temperature were first recorded nearly 200 years ago, modern technologies offer far greater insights and understanding.

Innovations such as miniaturization of sensors, high-speed data transfer, and upgraded storage capabilities have made satellites an integral part of the climate change mission, as they provide essential information needed to understanding changes and feed into sophisticated models that predict the planet's future.

Combined with the promise of quantum computing and the solutions that quantum is expected to help us discover, we are currently well placed to monitor change, evaluate, and manage risk.

> Earlier this year, China officially launched its national carbon emission trading scheme (ETS).

CONCLUSION

Modern technologies offer clean, green solutions that give us the chance to save our planet from the damage of the past. Yet no country can do this alone. Climate change is a global challenge that pays no attention to national borders, and nations must work together if we are to win this race against time.

Oxford Instruments plays a role across the spectrum of Net Zero technologies, combating climate change with adaptation and resilience at every level. From dramatically reducing its own carbon footprint, to making important contributions to climate resilience, clean energies, zero-emission transport, and quantum technologies, we work with partners across the globe – including several prestigious institutes and organisations in China – in our mission of supporting the Green Industrial Revolution.

If we are to truly address climate change and shared global challenges, we must continue to work in partnership, encouraging cross-border collaborations and exchanges as well as uninterrupted trade with China in technologies which address these challenges.

Industry has a major role in supporting governments facing the challenges of climate change, but international collaboration is essential. This is demonstrated in the case studies presented in this chapter of UK–China collaborative projects that will help both countries achieve their Net Zero goals through adaptation and resilience.

CASE STUDY

Setting Global Standards for Carbon Neutrality

COMPANY PROFILE

BSI – BRITISH STANDARDS INSTITUTION

Founded in 1901, BSI is the first national standards body in the world with a mission to develop standards, certify organisations, and provide training. Its purpose is to "Inspire trust for a more resilent world", by helping clients to manage risk, reduce costs, and ensure sustainability.

"BSI is proud to work with organisations supporting them to reach their vision to become Carbon Neutral and take them through the journey by using relevant standards and demonstrating their achievement using the standard PAS2060 Carbon Neutrality"

PAULO LOPES
BSI'S DIRECTOR STRATEGIC PARTNERSHIPS, CHINA

BSI has been working very closely with Anjie IoT, a leading Chinese technology company specialising in energy-saving and low carbon technology, including IoT management systems, IoT controllable hardware and energy-saving strategies, for clients in the construction sector.

Anjie IoT had the objective to become carbon neutral in order to demonstrate its commitment to climate change, manage and reduce its greenhouse gas emissions, and to position itself as a green service provider to support the company's growth. Although the company had a bold vision, achieving these objectives was relatively challenging due to its limited experience in this area, and so was looking for a strategic partner to support it in its journey towards full carbon neutrality.

As the world's most experienced standards body and founding member of ISO, BSI leads the way in originating many of the world's most recognised standards, including ISO 9001 Quality Management, ISO 14001 Environmental Management, ISO 27001 Information Security, ISO 50001 Energy Management and PAS 2060 Carbon Neutrality.

PAS2060 Carbon Neutrality is an internationally recognised standard which helps organisations to demonstrate their carbon neutrality, providing a framework allowing users to implement other key climate standards, such as ISO 14064 to measure the carbon footprint, PAS2050 carbon footprint for products, as well as ISO 14001 to manage the environment systems.

BSI took Anjie IoT through the journey to reach full carbon neutrality and demonstrate these achievements. At the same time, Anjie IoT staff received all the necessary training and knowledge to achieve

CARBON NEUTRALITY JOURNEY

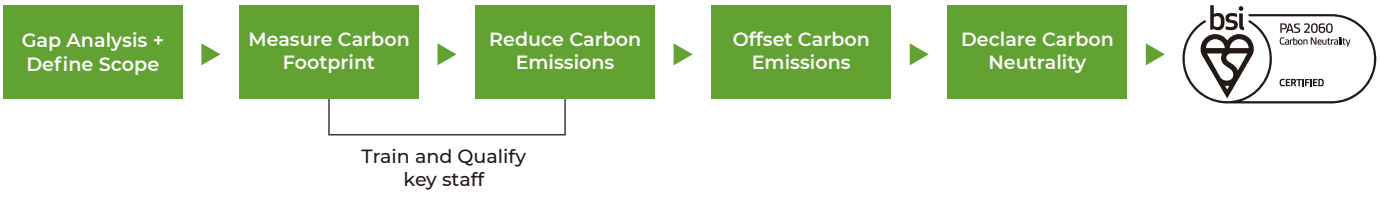


FIG 1 - CARBON NEUTRALITY JOURNEY

these objectives. The company's carbon footprint was measured, carbon emissions were reduced through more effective energy management systems, and remaining emissions were offset using Chinese carbon credits.

By using an internationally recognised standard and being certified by a trustworthy and reputable certification body, Anjie IoT was able to demonstrate its carbon neutrality claims more effectively, reduce its carbon footprint and energy costs, gain credibility, and develop a competitive edge allowing the company to win new business.

BSI is very proud to work with organisations in China to help them achieve carbon neutrality and support the country's vision to achieve Net Zero. As this case study demonstrates, the robust and credible standard PAS2060 Carbon Neutrality can help Chinese organisations to demonstrate their carbon neutrality claims and achieve Net Zero targets, by measuring carbon emissions, implementing a plan to manage and reduce emissions, and finally through carbon credit offsetting. The success of Anjie IoT can be replicated by other Chinese companies, helping them to achieve their mission to become carbon neutral and support the country's goal of reaching Net Zero by 2060.

CASE STUDY

Better Climate Data for Stronger Resilience

COMPANY PROFILE

Met Office

THE MET OFFICE

Founded in 1854, the Met Office is the UK's national meteorological service; working at the forefront of weather and climate science to help people stay safe and thrive. The Met Office Hadley Centre is world-leading in climate science and services, providing science, consultancy and advice to governments, businesses, and the public. Through our years of pioneering research, our scientists and experts have been working in partnership alongside international researchers from over 1715 organisations, institutions and 138 countries outside of the UK.

CLIMATE SCIENCE FOR SERVICE PARTNERSHIP

Launched in 2014, the Climate Science for Service Partnership (CSSP) China project is stimulating scientific collaboration between research institutes in the UK and China. It focuses on producing world-leading scientific research that is fundamental to the development of climate services that support climate-resilient economic development and social welfare around the world.

The project is working to enhance collaborative research by supporting the UK climate science community in their work with Chinese research institutes. The CSSP China project is part of the Met Office's Weather and Climate Science for Service Partnership (WCSSP) programme, supported by the UK Government's Newton Fund. Through CSSP China, we are developing strong scientific partnerships between the Met Office, the China Meteorological Administration, the Institute of Atmospheric Physics at the Chinese Academy of Sciences, and other key institutes in China and the UK.

Climate variability and change is a global challenge. A key focus of CSSP China is the development of climate services that provide individuals and organisations with the climate information they need to overcome the challenges of extreme weather and climate events. So far, these climate services have ranged from providing seasonal rainfall forecasts for the Yangtze River Basin to providing tools for urban planners to protect cities from the risks of weather events such as heatwaves or flooding.

The project is also developing new scientific capability to improve the seasonal forecasting of typhoons to support disaster risk reduction and working to address global challenges such as food security.

Many climate services depend on the ability to skilfully predict climate. CSSP China is improving the performance of climate models used for climate prediction by working together to include crucial processes and reduce sources of error. These climate models will provide information used to shape climate science and policy internationally for years to come.

CSSP China has developed UNSEEN - UNprecedented Simulation of Extremes with ENsembles – an innovative technique that simulates possible extreme weather events that haven't yet been recorded. This helps build climate resilience by enabling a more complete estimation of risks in forward planning, and has been used in CSSP China (as well as in other countries including the UK) to help develop climate services including seasonal forecast services, present day risk profiles, and rapid attribution of extreme events. As an example, prototype urban climate services developed by CSSP China provide robust climate information for city decision makers to plan for the future and help cities become more resilient to climate change.

The project also responds to impactful weather events, such as recent typhoons, flooding and drought, and provides relevant information to help decision-makers understand these as well as enhancing our understanding of future risk and ability to forecast similar events.

> "This project has provided unique opportunities for UK and Chinese scientists to work closely together, developing new and exciting science and pulling that through into services that address real world problems. Being able to talk to decision-makers and learn first-hand about how they use climate information, and having access to the latest climate science capability to try to make that decision-making process more robust, more impactful and more relevant is hugely rewarding."

NICOLA GOLDING
MET OFFICE INTERNATIONAL
CLIMATE SERVICES MANAGER

URBAN CLIMATE SERVICES IN CSSP CHINA

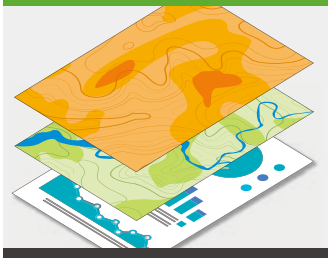
Cities in China are densely populated and major economic centres, with an estimated 60% of the population living in urban areas. Many cities in China are affected by weather and climate hazards such as heatwaves, heavy rainfall and typhoons. The frequency and intensity of such events may change in the future. Urban characteristics such as the urban heat island and impermeable surfaces can increase climate risks and adversely affect human comfort, productivity and effciency of city assets.The Climate Science for Service Partnership (CSSP) China is using scientific research to develop prototype urban climate services that will provide robust climate information for city decision makers to plan for the future and help cities become more resilient to climate change.

WHAT ARE THE BENEFITS OF URBAN CLIMATE SERVICES?

Increasing city resilience

Creating a city level evidence base of climate hazards to help cities prepare for climate impacts and demand on city services.

Useful tools for decision making



Presenting climate information in a useable format to help city stakeholders make effective decisions and inform policy.

Adaptation and strategic planning

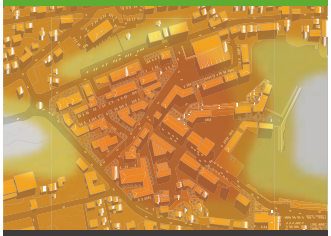
Tailored climate information highlighting areas of the city most vulnerable to climate impacts to inform adaptation, strategic planning and urban design.

URBAN CLIMATE SERVICES IN DEVELOPMENT

City Packs

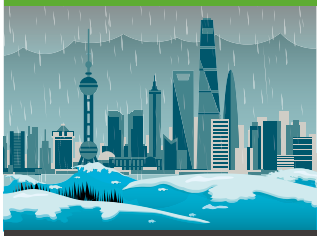
Creating a city level evidence base of climate hazards to help cities prepare for climate impacts and demand on city services.

Urban Heat Services



Mapping of current and future heat hazards, integrated with socio-economic and landuse data to identify vulnerable areas in the city.

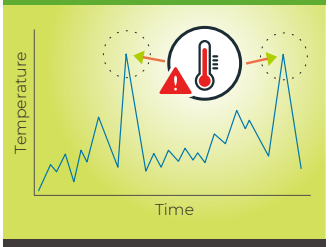
Urban Flooding



Using high resolution climate model data to provide information on current and future tropical cyclone hazards and urban flooding.

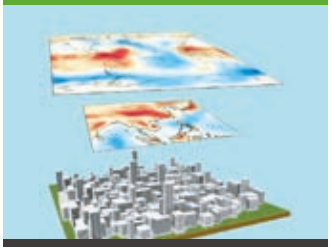
WHAT RESEARCH CAN FEED INTO URBAN CLIMATE SERVICES?

Modelling extreme heat events



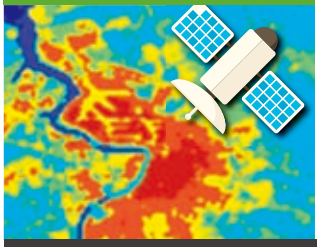
Creating a city level evidence base of climate hazards to help cities prepare for climate impacts and demand on city services.

Urban Modelling



Mapping of current and future heat hazards, integrated with socio-economic and landuse data to identify vulnerable areas in the city.

Land Surface Temperature Analysis



Using data from satellites to better understand how the urban heat island has changed across Chinese cities as the city has developed.

FIND OUT MORE

CSSP China is part of the Weather and Climate Science for Service Partnership Programme, supported by the UK-China Research and Innovation Partnership Fund as part of the Newton Fund. For more information, see https://www.metoffice.gov.uk/research/approach/collaboration/newton/cssp-china/index | https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=CN

CASE STUDY

Leveraging Technology to Transform Agriculture

COMPANY PROFILE

XAG

Founded in 2007, XAG is a Chinese robotics and AI company which leverages technology to empower agriculture and help create a food-secure, low-carbon future. Facing global challenges such as labour shortages and climate change, XAG has developed six product lines - Agricultural Drones, Unmanned Ground Vehicles, Remote Sensing Drones, Autopilot Consoles, Agriculture IoT Systems, and Smart Agriculture Management Systems - to help farmers grow more with less.

Up to December 2020, XAG's digital agriculture solutions have served over 9.31 million farmers across 42 countries and regions, cutting down 760,000 tons of carbon emissions: the equivalent to planting 10.32 million trees.

> "Connecting the farmland, farmers and the rural economy in the digital space is a paradigm shift that is comparable to the Industrial Revolution. XAG and its UK partners are working to introduce autonomous, electric, lightweight technology, such as drones and robots, to help farmers cope with the need to improve yields and fight against climate change."

UNFOLDING THE AGRIFUTURE WITH LOW-CARBON FARM ROBOTS

Since 2018, XAG has been collaborating with Harper Adams University as strategic partners to introduce digital agriculture technologies to the UK market. The project aims to scale up the use of drones, robots, and AI in farming and create a low-carbon food system where farmers would cultivate their crops with less Greenhouse Gas (GHG) emissions and chemical sprays.

According to the United Nations, agriculture and other related activities account for one third of the world's GHG emissions. Specifically, large-scale operations of agricultural machinery powered by fossil fuel generate a large amount of carbon dioxides, while excessive use of pesticides on farmland removes the ability of soil as carbon sink and causes soils to release carbon.

To provoke a fundamental change towards Net Zero farming, XAG developed the first-ever ground-air farming solutions that feature an autonomous, all-electric agricultural drone and R150 farm robot. It has been closely working with Harper Adams University to launch these lightweight, electric-powered equipment into Europe. They can help farmers sow seeds, spray pesticides, and spread fertilisers with high precision and less dosage.

Through replacing oil-fired tractors with electric battery power, the application of agricultural drones and R150 farm robots can significantly reduce carbon emissions. Crops can be grown without burning hydrocarbons, making agriculture greener and more resilient to climate change.

The project is also expected to help offset greenhouse gases by improving soil health and protecting soil carbon stores in the farmland ecosystem. Both XAG's drones and farm robots can conduct precision spraying on target areas and cause no or less damage on the soils. Farmers can largely cut down the use of pesticides and fertilisers to prevent soil pollution, which gives the full play to the carbon offsetting potential of soils to soak up more carbon from the atmosphere.

XAG takes this project as an important step to sustainable farming and combatting global warming. It can contribute to the UK's Net Zero farming goal through both reducing carbon emission and restoring soils that capture and store carbon.

According to Department for Business, Energy, and Industrial Strategy (BEIS), agriculture accounts for 10% of the UK's total greenhouse gas emissions. As the National Farmers Union (NFU) has set an ambitious goal of reaching Net Zero GHG emissions in agriculture by 2040, autonomous drones and farm robots are gradually being recognised for their potential to boost productivity and reduce carbon footprints.

Since March 2020, XAG's R150 farm robot has been introduced and trialled in a variety of orchards across the UK, ranging from apple trees, strawberries, to gooseberries and blackcurrant bushes. The UK has become the first European country to embrace autonomous robots for crop spraying. It is anticipated that high-quality fruit crops can be farmed without causing pollution of soils or consuming any fossil fuel.

Next, the plan is for both sides to spearhead a campaign scaling up the use of autonomous drones and robots in British farms. A demonstration tour will be held from county to county to educate farmers on green technology and provide technical training.

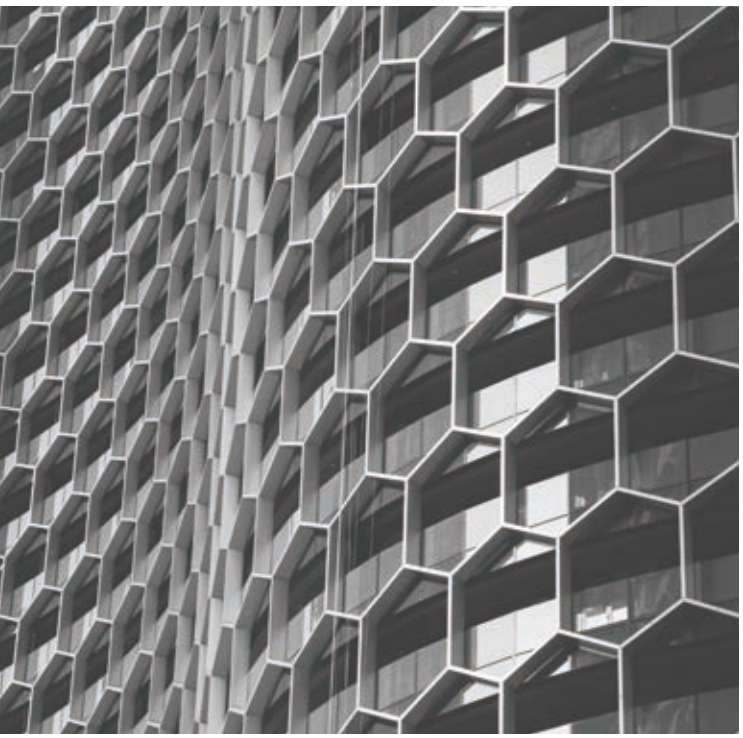
Green Software for Net Zero

COMPANY PROFILE

thoughtworks

THOUGHTWORKS

ThoughtWorks is a global software technology consultancy that integrates strategy, design and software engineering to drive business changes. Our customers are all over the world, in the fields of automobile, finance, insurance, healthcare, tourism, transportation, retail, e-commerce, energy, and public utilities. We have 45 offices in 17 countries/regions, with more than 9,000 employees. Since entering China in 2004, we have opened 7 offices in Beijing, Hong Kong, Shanghai, Chengdu, Shanghai, Wuhan and Shenzhen, totaling over 2,000 employees. Over the past 27 years, we have leveraged our technical advantages to help customers solve many complex business problems, and worked together to deliver extraordinary impact!



> "We believe companies need to make software an integral part of their sustainability efforts by taking its carbon footprint into account in the way it is designed, developed, and deployed."

Climate change is one of the most pressing challenges faced by humanity and the tech sector contributes a rapidly escalating amount of emissions. At ThoughtWorks, we believe that issues like climate change can only be resolved through global solidarity. Thus, in addition to taking action on our own footprint with our commitment to the Science Based Target Initiative, we are joining the Green Software Foundation as founding members to help our clients, partners and the broader industry drive towards a more sustainable future together.

ThoughtWorks, together with Accenture, Microsoft, and GitHub, is a founding member of the Green Software Foundation, a non-profit under the Linux Foundation, that aims to build a trusted ecosystem of people, standards, tooling and leading practices for green software engineering.

The Foundation will focus on the following key areas:

- Establish Green Software Industry Standards: create and publish green software standards, green patterns and practices across various computing disciplines and technology domains. The group will encourage voluntary adoption and help guide government policy toward those standards for a consistent approach for measuring and reporting green software emissions.
- Accelerate Innovation: To grow the green software field, we need to nurture the creation of trusted open-source and open-data projects that support the creation of green software applications. The Foundation will work alongside our non-profit partners and academia to support research into green software.
- Drive Awareness and Grow Advocacy: If we want companies to build greener applications, they need people who know how to build them. As such, one of our key missions is to drive widespread adoption of green software across the industry through ambassador programs, training and education which leads to certification and events to facilitate the growth of green software.

We believe companies need to make software an integral part of their sustainability efforts by taking its carbon footprint into account in the

way it is designed, developed, and deployed. The Foundation aims to make sustainability a core priority for software teams by growing awareness, developing industry standards and best practices, and nurturing open-source and open-data projects that support the creation of green software applications.

One example the Foundation will explore is around proposing a standard method of calculation and reporting of application carbon intensities. Applications have a carbon intensity, sometimes referred to as a "carbon score". It can be thought of as measuring each application's carbon emissions per unit of work. We believe clear guidance is needed for calculating this number, so that each organisation calculates and reports this number in the same way, providing consistency and improving interoperability.

Another standard or best practice the group will explore is around energy-related patterns in AI development. Energy is one of the most significant drivers of carbon emissions for software applications and especially machine learning applications. There are pattens of software engineering which, if used, can increase the energy efficiency of ML applications. We will explore patterns for inference (using a machine learning model), consider how to define these patterns and determine what unit of measurement that patterns should optimise for.

The Green Software Foundation's mission is to build a trusted ecosystem of people, standards, tooling and best practices for green software engineering.

from IOC to IEC

CHAPTER

03

Cleaner Transportation

Green Mobility in China

Transport accounts for around a quarter of carbon emissions from the combustion of fossil fuels. In China, the number is around 10%. These emissions will have to be significantly reduced if the world is to achieve Net Zero emissions. But transport energy demand is growing – extrapolating from recent trends, bp analysis suggests that the number of cars on the world's roads could double from one to two billion in the next two decades.

Reducing emissions from transport will require action to decarbonise the internal combustion engine as well as deploying battery electric vehicles. Analysis for bp's 2020 Energy Outlook suggests that by 2050, electric vehicles will account for between 80-85% of the stock of passenger cars in our Rapid Transition scenario and Net Zero scenario, and 35% in Business-as-Usual (BAU) scenario. The corresponding numbers for light and medium-duty trucks are 70-80% and 20%.

Furthermore, electrification may not be commercially or technically feasible in other parts of the transport sector such as long-distance haulage, shipping or aviation, or in certain geographies. A range of technologies, including biofuels, 'e-fuels' and hydrogen, may be required as well as making use of developments in the broader mobility revolution such as autonomous vehicles and shared mobility services.

POLICY ENABLERS

bp supports the rapid decarbonisation of road transport and believes sophisticated policy is needed to tackle this complex challenge at a system level.

GASOLINE & DIESEL PHASE OUT

we support phasing out sales of new gasoline and diesel cars as one way to help decarbonise road transport. To enable and accelerate such a phase-out – and make it successful – will require system transformation and the development of alternative low carbon behaviours, technologies, fuels, markets and infrastructure, including: modal shift; vehicle efficiency; improved battery and fuel cell technology; ultra-fast charging technology; greening of the grid; and hydrogen/associated infrastructure.

VEHICLE EFFICIENCY

Vehicle efficiency regulations are an essential component. Our analysis in the 2020 Energy Outlook Rapid Transition scenario suggests that vehicle efficiency improvements can reduce oil use in passenger cars (and hence carbon emissions) by roughly twice as much as electrification. So, it is important to identify cleaner and better fuels and lubricants, increase the use of alternative fuels and 'drop-in' biofuels - those compatible with existing infrastructure and vehicles – in order to reduce emissions. These should provide regulatory certainty to automakers, while seeking to incentivise emissions reductions from all technologies. This also includes greater recognition of the benefits of new, more advanced fuels and lubricants, increasing access to ultra-fast charging and support for sustainable biofuels.

ACCESS TO ULTRA-FAST CHARGING

Easy access to ultra-fast charging will help address concerns over range and provide a solution for those that cannot charge at home, enabling mass adoption of electric vehicles. bp believes ultra-fast charging infrastructure (>150kW) is critical to overcoming some of the key barriers to consumer acceptance and mass deployment of EVs such as range anxiety and convenient access to charge points, especially for those without access at home. Governments need to support incentives for faster charging battery technology and to encourage the motor manufacturers to adopt ultrafast charging capability. Also, governments should encourage market competition and support a level playing field for parties to provide charging access for consumers.

bp IS ADVANCING FAST CHARGING IN CHINA

bp officially entered the E-mobility market at the end of 2017 and quickly accumulated experiences in charging site development and operations, enabled by digital platform operations leading technology investment, and an integrated offer with our Mobility & Convenience business. In 2018, bp announced investment of USD 10 million into NIO Capital, the leading e-mobility PE Fund of China, to explore new opportunities in the mobility space jointly. bp has also launched charging at its branded retail stations in Shandong, which provided customers with quality fuel and also fast charging services. In 2019, bp invested in PowerShare, a leading integrated hardware and software solutions provider for electric vehicle (EV) charging in China. Also in 2019, bp joined hands with Didi to form a joint venture, bp-xiaoju, aiming to develop a fast-charging network in selected regions across China. As of the end of June 2021, the joint venture has grown our network to nearly 2,000 charge points across 81 charging stations in China. bp aims to scale up to over 50,000 charge points by 2030 in China, through various business models including joint equity investment, and franchise operations.

LOW CARBON CHARGING

Furthermore, bp is actively decarbonising our charging business, through exploring options to reduce carbon emissions through technology improvements to reduce power losses and the potential to acquire low carbon power, as the emissions savings of electric vehicles (EVs) will be dependent on the carbon intensity of the grid that charges them.

In 2021, bp has launched a carbon neutral charging offer in China. The new offer means that customers in China charging EVs at any bp sites will automatically have the lifecycle carbon emissions from the power purchased offset. This is China's first carbon neutral EV charging offer and is based on international and national standards for carbon neutrality. To meet the specified standards, the lifecycle carbon emissions associated with the charging network have been quantified and offset from 2020 in-line with ISO 14064-1. bp-xiaoju plans to retain the carbon neutral charging offer in the future.

bp will also proactively explore the adoption of green-power supply to its charging sites and other low carbon solutions, such as power storage etc.

INTEGRATION

bp is confident in the growth of China's electric vehicle market and will continue to explore the value chain to provide energy solutions to EV customers. bp shall explore collaborating with our other businesses, such as Castrol, to provide integrated services for our partners and EV owners.

We are also watching the development of the battery swap market for both 4-wheeler and 2/3-wheelers and exploring collaborations in areas including technology, business models, partnership models and will monitor the integration with our digital solutions.

> Reducing transport emissions with electrification is likely to be a major challenge.

bp is working on longer-term solutions such as e-fuels and hydrogen that could significantly decarbonise aviation, shipping, and heavy road transport and were the first refinery to use green hydrogen in the production of fossil diesel.

[2]The international standard BSI PAS2060: 2010 Specification for the Demonstration of Carbon Neutrality and the national Guidance for Carbon Neutral Large-Scale Events (pilot version) published in 2019 by China's Ministry of Environment and Ecology.

CLEAN HYDROGEN

bp aims to become a leader in delivering efficient decarbonisation solutions, particularly through hydrogen. Hydrogen's versatility is an important asset and can improve the resilience and flexibility of the whole energy system. In our Paris consistent scenarios, it grows to 9-22% of final energy consumption by 2050. Long-haul, heavy-payload trucks could be cheaper to run using hydrogen fuel cells than diesel engines by 2031 – which means investing and scaling-up infrastructure now.

However, the clean hydrogen market is relatively immature and there is a lot of uncertainty as to how the market will scale. We think the right things are starting to align – the technology is advancing; our understanding is developing every day and government support is building momentum. bp supports sectoral and sub-sectoral targets/mandates to drive market growth for hydrogen. Specific demand-side targets to drive future demand while reducing emissions in hard-to-abate sectors. Targets for certain end-users' sectors should include heavy industry and transport.

Meanwhile, bp is building up its experience in clean hydrogen supply. In November 2020, bp and Ørsted signed a letter of intent to work together to develop a project for industrial scale production of green hydrogen. In 2020, we also announced a feasibility study in Australia with ARENA (Australian Renewable Energy Agency) to explore the use of solar energy to power the production of green hydrogen.

In China, bp thinks clean hydrogen will play an important role in helping China reach carbon neutrality, especially through decarbonising heavy-duty transportation. bp is interested in exploring collaborations with downstream partners to explore investment, construction, and the operation of hydrogen refuelling stations in specific transport application scenarios.

BIOFUEL

We see sustainable liquid biofuels playing a significant role in providing low and zero carbon solutions for ground transport, particularly in hard to decarbonise transport sectors such as aviation, marine and heavy goods vehicles. In 2030, our Rapid Transition Scenario sees road transport biofuels grow by around 2 million barrels a day – getting towards double the current demand of 2.6 million barrels a day with the market share growing from 6% today to 11%.

bp agrees with the views of multiple studies that – with improved technology and agricultural productivity – there is adequate land to meet food, feed and local community demands out to 2050 as well as providing for sustainable bioenergy supply.

bp is a leader in biofuels. We have invested in Fulcrum Bioenergy, which has developed a process to convert domestic waste into transport and biojet fuel. This is not yet in production. We are reducing the carbon content of some of our fuels by co-processing renewable feedstocks in some refineries.

bp sees that the challenge in transport is to significantly reduce emissions while meeting the growing global need for mobility. Electrification will play a major role in decarbonisation but will need support from other technologies such as biofuels and hydrogen. In the meantime, it's important to keep focused on improving the efficiency of the internal combustion engine to help reduce emissions and improve air quality. Decarbonising transport will require a range of well-designed policies.

Bringing eMobility to Britain

COMPANY PROFILE

BYD (UK) CO LTD

BYD Company Ltd is one of China's largest privately-owned enterprises. Since 1995, the company has pioneered the development of rechargeable batteries and remains fully committed to the global programme of decarbonsation, successfully expanding its renewable energy solutions with operations in over 50 countries and regions. Its creation of a Zero Emissions Energy Ecosystem comprises electric passenger transport and road transport, rail transit, affordable solar power generation, reliable energy storage, rechargeable batteries, solar panels and other new energy products.

BYD UK was established in 2013, and now based in Iver, Buckinghamshire, is primarily engaged in providing UK customers with BYD new energy solutions, including electric vehicles, rechargeable batteries, solar panels, energy storage systems, rail transit and other new energy products, supported by dedicated aftersales services.

LOCAL PARTNERSHIPS – BUILT IN BRITAIN

After having entered the UK market in 2013, BYD UK has quickly established its number one position in the electric bus industry, remaining at the forefront of the switch to eMobility in towns and cities right across the country. In 2015, BYD UK joined forces with Alexander Dennis Ltd. (ADL), one of the best-known names in British vehicle manufacturing. Together, the BYD ADL partnership draws on the strength of two major forces in global bus manufacturing. BYD, with its electric-only strategy in Europe, is a pioneer in the development of electric battery technology, electric motors, New Energy generation and utilisation. Completed BYD chassis and powertrains are delivered to ADL, whose industry-leading expertise in body design and manufacture focuses on assembling completed, right-hand-drive, electric buses.

"eMobility has emerged as the most viable method of delivering sustainable, emissions-free public transport. We are delighted the UK Government is backing eMobility and hope further funding is forthcoming across the UK.

Working in partnership with Public Transport Operators has allowed us to develop solutions that benefit customers out on the road and also back at the depot. These close relationships are helping bring clean, sustainable public transport to more and more people in towns and cities across the UK.

We firmly believe the future of the transport industry lies in the development of New Energy vehicles, specifically, battery-powered pure-electric vehicles. Electric buses represent the best long-term solution for public transport operators, delivering tangible, sustainable benefits today and also for the future."

FRANK THORPE
MANAGING DIRECTOR AT BYD UK

The partnership's two base models include the BYD ADL Enviro200EV single-deck and BYD ADL Enviro400EV double-deck. The BYD ADL partnership has developed into a hugely successful collaboration.

In 2021, ADL and BYD UK jointly announced that their electric vehicle partnership has taken an order for 22 BYD ADL Enviro200EV electric single deck buses from First Bus. The buses, which are part-funded by the Scottish Government, will operate as official shuttles for COP26 delegates.

Today, the BYD ADL partnership has over 500 electric buses in service in the UK, clocking-up over 25-million pure-electric miles and reducing CO_2 emissions by 40,000-tonnes. A further 500 vehicles are on order for public transport operators right across the country.

BUS2GRID – A UK-FIRST PROJECT

BYD is also playing a key role in the UK's innovative Bus2Grid Project, delivering its technological expertise for the switching-on of the world's first high-power discharge facility at Go-Ahead London's Northumberland Park bus depot. A fleet of 28 BYD ADL Enviro400EV double-deck electric buses are also being deployed for the project, with the vehicles providing bi-directional charging, capable of returning energy back to the power grid.

Along with its partners – SSE Enterprise, UK Power Networks and Leeds University – BYD has helped install innovative new 'Vehicle-2-Grid' (V2G) infrastructure and is the first company in the commercial vehicle sector to provide high-power discharge technology as a V2G capability for electric buses. Vehicles are recharged overnight when energy demand is low, and tariffs cheaper, with electricity fed back to the grid when demand is high, thus helping to balance the network and increase efficiency. The project also provides further evidence of BYD's commitment to helping the UK government deliver its 'Net Zero' greenhouse gas emissions by 2050.

Green Materials for a Green Future

COMPANY PROFILE

Goodfellow
Your global supplier for materials

GOODFELLOW

With over 70 years of experience facilitating scientific innovation, Goodfellow is a leading global supplier of metals, alloys, ceramics, glasses, polymers, compounds, composites and other materials to meet the research, development and specialist production requirements of science and industry.

Goodfellow was established in London, UK, in 1946 and since then has grown operations across France, Germany, the USA and China. The company has a vast range of 70,000 catalogue products, all of which are underpinned by the most rigorous quality accreditations. This includes the ISO 9001 quality accreditation.

Providing materials that help green innovations is an important focus for Goodfellow. For example, materials that allow the research and development of electric cars, which ultimately cut the emissions of CO_2 in comparison to petrol vehicles. Even with the manufacture of the batteries used in these cars, they're still a greener option.

It's well known that China is both the largest manufacturer and buyer of electric vehicles in the world. New energy vehicles, including battery-powered, plug-in hybrid and hydrogen fuel-cell cars, grew 164% year on year, as stated by the China Association of Automobile Manufacturers (CAAM), predicting that new energy vehicles will dominate the local market by 2030.

In the creation of electrical vehicles, materials that are lightweight, resistant and do not interfere with any magnetic properties of the motor are essential. This was a key consideration for the Formula Student Team. In this international engineering design competition, which spreads to the UK and China - hundreds of teams create vehicles to take part in a series of international events. Goodfellow supported the development of two vehicle prototypes in this worldwide competition.

One challenge was the grounding of the cars parts due to it being an electric vehicle that runs with high voltage (600 V). Goodfellow would need to review different material options in order to come up with an alternative to using cables. Another issue faced was the development of bespoke electric motors which needed a specific material for the shaft.

To solve the first challenge regarding the grounding issue, Goodfellow supplied around 3.5m2 of copper mesh to be used in the chassis monocoque of one of the vehicles. This material was used to put the whole the car on the same potential, like a Faraday Cage, preventing the driver from conducting high voltage electricity.

The experts at Goodfellow know what's needed in applications like this. For example, the team knew that the use of Titanium would help meet their goals, as a lightweight, non-magnetic and robust material.

Electric vehicles have zero emissions and so by contributing to the technology used in these applications, Goodfellow are working towards a Net Zero goal. The next steps are essentially to contribute to more prototypes and full use electrical vehicles across industries and applications. By providing both innovative materials and unrivalled technical knowledge, Goodfellow fully supports its customers in reaching their goals.

The Green Production brochure by Goodfellow offers an extensive guide for green materials, from biopolymers and green production Graphene to lightweight and recyclable solutions such as foams and recyclable metals. This, along with Goodfellow's vast range of Net Zero initiatives, facilitate conscientious choices for our customers.

> "Providing materials that help green innovations is an important focus for Goodfellow. For example, materials such as metal foams or honeycombs (where less material can be used in lightweight structures and components, resulting in conservation of resources) lower material cost and the energy associated benefits, allowing the research and development of electric cars, which ultimately cut the emissions of CO_2 in comparison to petrol vehicles. We're proud to be contributing to a greener future! "

JAMES BRUCE
GLOBAL MARKETING MANAGER, GOODFELLOW

CASE STUDY

Supply Chain Sustainability for the Automotive Sector

COMPANY PROFILE

GXS PARTNERS

We support our clients to undertake profitable growth and expansion, achieve efficiency to scale, and optimise their operations and organisational performance in China and the UK.

We work with many of the world's leading organisations, as well as high growth enterprises and ambitious market innovators, across a wide range of sectors including manufacturing; advanced materials and technology; transport and infrastructure; building and construction; oil and gas; chemicals; engineering and industrials; power and utilities; alternative energy; and financial services.

In one recent project the goal was to identify strategies to increase penetration of advanced polymers in automotive applications. While the main production capacity is in the UK, 80% of potential growth is in China. These polymers have many sustainability benefits over traditional products based on cross-linked polymers in both NEV and ICE vehicles, including:

- Reduction of energy for processing;
- Recyclability of all production wastes;
- Lightweighting due to lower density, thus contributing to vehicle fuel economy;
- Full recyclability as opposed to incumbents which go to waste at vehicle end of life;
- Engineering versatility advantages offering the possibility to reduce the number of parts in car systems, contributing to overall light weighing (increasing metal replacement) as well as circularity through ease of dismantling.

While ultimately beneficial in lowering overall life-cycle energy requirements, the replacement of incumbent materials with more sustainable options in the automotive supply chain faces many challenges, including:

- **The conservative nature of the automotive industry, which is often reluctant to adopt new materials due to long and costly qualification processes;**
- **The automotive industry is composed of complex (sometimes global) value chains in which each stakeholder (OEM, Tier 1s, raw material suppliers) have different investments, interests, and motivations for (or against) change;**
- **Sustainability and monetary benefits may not be spread evenly across the value chain.**

Numerous different approaches aimed at bringing together increased business and sustainability benefits were used to support a successful commercial strategy:

- **Identifying the many different specific OEM/Tier combinations for the heaviest parts in the car that could be replaced by advanced polymers, including deep dives into specific China EV ecosystems;**
- **Developing an advocacy plan leveraging "value-in-use calculations" thereby monetising through modeling the costs and benefits of switching to advanced materials;**
- **Documenting the competencies required to promote conversion to advanced polymers, particularly critical for China as the country is still in the early adoption and learning phase for some relevant technologies.**

Increasing penetration of this project's advanced polymers from 2kg per vehicle to 3kg per vehicle (lightweighing cars by about 200g) would abate global carbon emissions by approximately 700 thousand tons per year, equivalent to taking more than 200,000 cars off the road. The benefits of this material also apply to EVs for which lightweighting provides extended range. Moreover, the fit of these advanced polymers is increased given EVs' design and technical requirements.

Given its market size, growth, focus on NEVs and emphasis on innovation, China is the biggest lever to achieve these benefits. Besides, while the automotive sector is quite conservative, new OEMs, Tiers, and production facilities offer the best chance to bring on new techniques. This is happening in China, as quick growth offers opportunities to influence investments that would lock in novel technical solutions for the foreseeable future.

Next steps include supporting continued penetration of advanced polymers in cars and buses by leveraging their recyclability and contributions to circularity. This will require a holistic approach to working with Tiers, OEMs, regulators, and the waste/recycling industry to identify vehicle dismantling ecosystems and creating alliances to "close the loop".

> "Small changes can have big impacts; and there are substantive benefits within the automotive sector and its chemical-based supply chain that can benefit the consumer and all stakeholders. For example, increasing penetration of the advanced polymers included in our project from 2kg per vehicle to 3kg per vehicle could reduce global carbon emissions by approximately 700 thousand tons per year. Achieving these impacts means making sure to not only articulate the benefits in a compelling way, but also ensuring that you map the value chain clearly and address the needs of every link."
>
> WILLIAM HAHN
> DIRECTOR, GXS PARTNERS

CASE STUDY

How New Fuel Cells can Fuel the Transport of Tomorrow

COMPANY PROFILE

Johnson Matthey
Inspiring science, enhancing life

JOHNSON MATTHEY

Johnson Matthey (JM) is a global leader in sustainable technologies that was founded over 200 years ago. Our fuel cell technology dates back to almost when JM was first founded. We supplied the platinum when William Grove first demonstrated a fuel cell in 1830 and in the 1960s we supplied the electrocatalysts for the Apollo space missions. More recently, we were the first company to commit to a dedicated membrane electrode assembly (MEA) manufacturing site, which is based in Swindon, UK.

Today Johnson Matthey is a world leader in electrocatalysts, catalyst coated membranes (CCM) and membrane electrode assemblies (MEA) – the high technology components that drive performance of a fuel cell. JM have provided solutions to problems for some of the world's most established fuel cell players, expanding our reach globally and investing heavily in our R&D along the way. Ensuring exceptional performance and durability, we are continually developing next generation catalysts, membranes, and the associated coating and manufacturing technologies.

"I'm delighted that we have reached this important milestone at our brand new, state of the art facility in China, which will allow us to serve our customer base there even more closely with our leading technology. It's great, too, to see the Chinese government's support for fuel cell technologies as a key enabling technology for a cleaner, healthier world."

ROBERT MACLEOD
CHIEF EXECUTIVE, JOHNSON MATTHEY

CLEAN TRANSPORTATION

Johnson Matthey's fuel cell component manufacturing expertise at Swindon is being harnessed to develop JM's green hydrogen business, where catalyst coated membranes (CCM) are being commercialised to enable the production of 'green' hydrogen without generating carbon emissions. JM's manufacturing capacity for the production of CCMs is initially for tens of megawatts of hydrogen production – enough to power several thousand homes. JM's recent acquisition of the assets and IP of Oxis Energy Ltd near Oxford is part of a roadmap to scale to multi-gigawatt manufacturing capacity in line with customer growth as the market continues to evolve.

Hydrogen has the potential to significantly contribute to the fight to tackle the climate crisis by decarbonising industries that are difficult to electrify, such as heavy industry, heavy mobility, aviation and

shipping. This is a critical step in helping societies meet their ambitious Net Zero targets. For example, fuel cells are an attractive solution as societies act to decarbonise emissions from transportation – one of the most significant contributors to greenhouse gas emissions globally. Fuel cells use clean or low carbon fuels, such as hydrogen, to generate power and produce no harmful emissions, with water as the only by-product. They have proved ideal in heavy duty or high usage applications, such as trucks and buses, because of their longer range, low relative weight, and fast refuelling times compared to battery alternatives. As such, 5% of trucks globally are expected to be fuel cell powered by 2030, rising to a third in 2040.

In January 2021, to demonstrate the company's commitment to supporting customer growth and full value chain development in China, Johnson Matthey commenced operations of a GBP 7.5 million state of the art fuel cell component facility in Shanghai, with the capacity to produce 4 million MEA components annually. It is the first in a series of investments planned in China. The on-road fuel cell CCM market for trucks expected to grow to more than GBP 1 billion p.a. in 2030, with around 40% of global demand in China. The market is expected to accelerate significantly post 2030.

Through many years of collaborating with fuel cell suppliers in China, Johnson Matthey's fuel cell technology is already powering more than 700 fuel cell buses and commercial vehicles on China's roads today. These have clocked up more than 6.5 million kilometres of zero emission travel - equivalent to 350 round trips from Johnson Matthey's UK site in Swindon to the new facility in Shanghai. In 2021 1,000 vehicles will be built using our materials in China, increasing to 3,000 in 2022. Overall plant capacity is enough to power more than 10,000 buses and commercial vehicles, avoiding 125,000 tonnes of CO_2 emissions from China's roads every year.

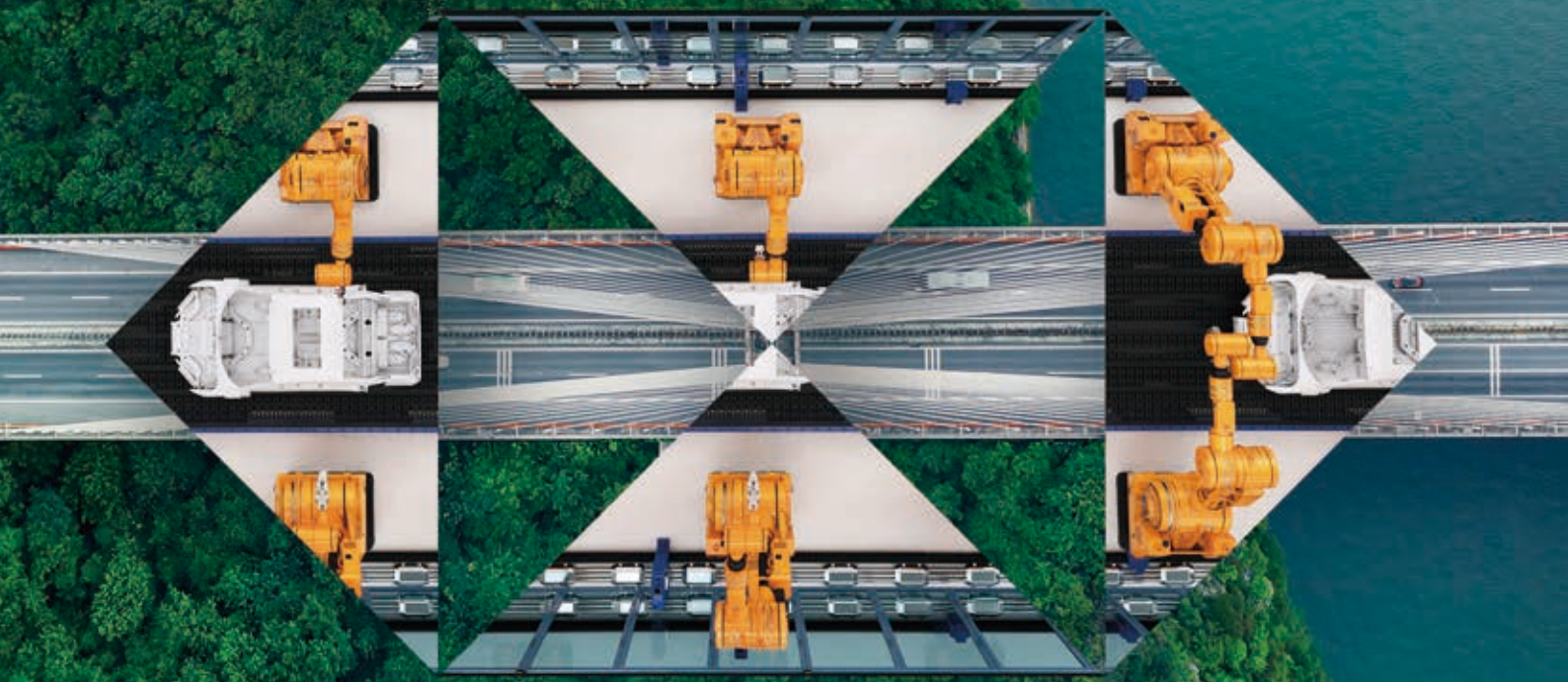
This facility marks only the beginning of our investments to help China deliver upon its environmental and sustainability targets, specifically those around achieving high performance fuel cells and a local supply chain. Johnson Matthey's future aspirations for expanding its participation in China's fuel cell market include local manufacturing of CCM components and the addition of R&D capabilities to enable the continued delivery of next generation fuel cell technology into China. Many of these activities will be achieved through close collaboration with our Chinese partners.

一起构建可持续商业未来

Building a Sustainable Business Future

汇丰致力于推动绿色产业的发展与国际化，高效对接国内与国际绿色金融标准，
助力企业融入全球绿色供应链生态圈，实现低碳转型。
HSBC is committed to promoting the development and internationalisation of green industries.
By connecting green industries with domestic and international standards of green finance,
we support Chinese businesses in achieving low carbon transition,
and integrating into a global green supply chain ecosystem.

加入「爱地球 汇商机」，共筑绿色未来
Join us for Business Plan for the Planet and take part in building a green future.
www.business.hsbc.com.cn/zh-cn/bpfp



汇丰
HSBC

CHAPTER

04

Green Finance

Cross-border Collaboration in Green Finance

China will further implement the Belt and Road Initiative's "Green Investment Principles" and has gone significantly further by pledging at the UN General Assembly in September to step up support for other developing countries in developing green and low-carbon energy, and to end the building of new coal-fired power projects abroad.

THE CHINA CHALLENGE

China's energy consumption mix currently relies heavily on coal, but China has demonstrated its determination to shift to more renewable sources of energy – investing USD 83.4 billion in renewables in 2019, almost as much as the US, Japan, Germany, France and the UK combined (USD 86.1 billion).

To achieve carbon neutrality before 2060 as it has pledged to do, it is estimated that China will need to invest RMB 2.2tn (5% of 2019's GDP) from now to 2030, and RMB 3.9tn (9.5% of 2019's GDP) from 2030 to 2060, and that during the next 5 to 10 years China will need to focus on developing the technology, regulations, and markets for a more drastic carbon reduction after 2030.

In the latest 14th Five-Year Plan, ambitious targets have been set to increase renewable energy including non-fossil fuels by 20%, and nuclear energy by 40% by 2025, and to significantly increase energy efficiency as well as a number of other climate change-related goals.

At the same time the Central Bank (PBoC) is driving more climate-friendly regulations. The Green Bond Endorsed Project Catalogue was updated in April 2021 to better align with global standards, and now the so-called clean coal and secondary oil and gas extraction projects will no longer qualify for fundraising via green bonds. We are also seeing efforts co-chaired by China and the EU under the auspices of the EU International Platform on Sustainable Finance to work towards a "Common Ground" Taxonomy to help investors to be able to determine which projects and activities are sustainable.

The PBoC is also considering how to provide low-cost funds for carbon emission reduction, as well as promoting and building green finance pilot zones. Lastly, a national unified carbon emissions trading market was established in July 2021 to contribute to the effective control and gradual reduction of carbon emissions in China and to the achievement of green and low-carbon development. All these steps provide opportunities for international cooperation which China is actively promoting including co-chairing a G20 Sustainable Finance Research Group alongside the US.

China will further implement the Belt and Road Initiative's "Green Investment Principles" and has gone significantly further by pledging at the UN General Assembly in September to step up support for other developing countries in developing green and low-carbon energy, and to end the building of new coal-fired power projects abroad.

CHAPTER 04

OPPORTUNITIES AND CHALLENGES IN THE CHINA MARKET

China's carbon neutralisation pledge and the delivery of its Net Zero commitments have pushed green finance much higher up the agenda. The development of China's green finance capacity still needs to progress alongside the setting of its green finance standards, bringing them more in line with international standards where appropriate. We would also encourage more disclosure of carbon footprints for invested projects as well as possible incentives to spur innovation in green finance products. In addition to the above efforts to develop climate-related opportunities, China's prudential regulators, along with other members of the Network for Greening the Financial System (NGFS) will continue to work on the effective management of climate-related risks. This will include the development of stress tests for the stability of the financial sector against environmental and climate-related credit risk.

Given the huge scale of investment required, public funding alone will never be able to achieve carbon neutrality and China's policy-makers will need therefore to encourage the rapid mobilisation of private sources of capital. As action on climate change becomes an increasing priority for China's policy makers over the next decade and the Chinese market continues to open, so the opportunities for overseas investment and financial institutions in China's green finance markets will grow.

Those banks and intitutions that fail to transition to Net Zero will increasingly risk finding stranded assets on their balance sheets and in their investment portfolios. They may also face legal "liability" risks for undermining efforts to transition, or for failing to declare accurately their 'green' exposures.

HSBC AS A NET ZERO EMISSIONS BANK

We are committed to becoming a Net Zero emissions bank by 2050, in alignment with the goals of the 2015 Paris Agreement. That commitment covers our own operations, our supply chain, and our financed emissions.

We want to take our customers with us on this journey. We have pledged to provide between USD750bn and USD1tn of sustainable finance and investment by 2030 to support them in their transition to lower carbon emissions. In order to unlock new climate solutions, we are working with a range of partners to increase investment in natural resources, clean technology, and sustainable infrastructure through our FAST-Infra initiative. We also plan to donate USD100m to support efforts to bring climate solutions to scale over the next five years.

The Net Zero transition requires cooperation. Banks and other financial institutions currently lack standardised, trusted methodologies to track, adequately and transparently emissions reductions. As a founding member of the Net Zero Banking Alliance , part of GFANZ, the Glasgow Financial Alliance for Net Zero, HSBC is leading industry efforts to remedy this deficit. A key part of this work, through the Financial Services Task Force (chaired by Group Chief Executive, Noel Quinn) , part of the Sustainable Markets Initiative , is the creation of a Practitioner's Guide, which will act as a signpost for Net Zero efforts within the industry.

We know the scale of the challenge that lies ahead. But there is a huge opportunity, too. An opportunity to set the global economy on a more sustainable, resilient and inclusive path. An opportunity to protect the communities we exist to serve, and to bring value and growth to our customers. We believe we have the ability to grasp this opportunity by financing the transformation to a low-carbon and climate-resilient model.

Our vision is to help create a vibrant, robust future that opens the door to new skills, ideas and jobs. Providing transition finance solutions, particularly in emerging markets where the opportunity is greatest, is core to our climate strategy.

There is no more significant opportunity to effect these changes than in China.

HSBC CHINA'S CLIMATE STRATEGY

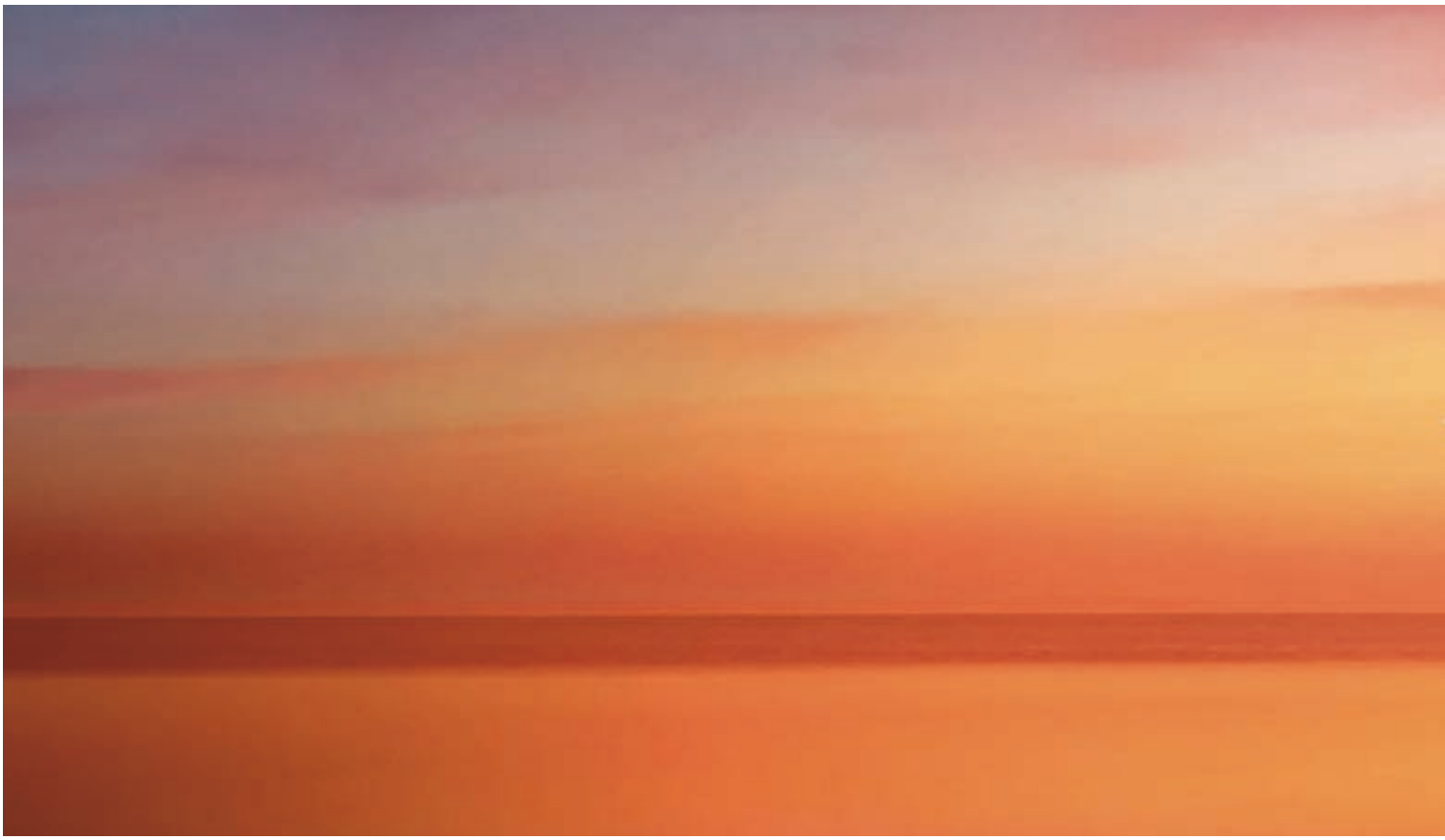
HSBC in China is determined to support our customers in seizing the opportunities and minimising the risks of climate action. We recently enhanced our climate strategy for China in line with the announcements made by the Group in October.

In China, HSBC drives its climate change strategy through a Sustainability Steering Committee, our largest business entity in our China operations and chaired by the CEO of HSBC Bank (China) Ltd. We aspire to be the leading international bank in China supporting the transition to a Net Zero economy, not just by playing our part, but by helping to lead it.

To support the development of China's carbon market HSBC, has this year made an investment of nearly RMB 100 million in cooperation with a number of partners including the World Resources Institute (WRI), the World Wild Fund for Nature (WWF) and Tsinghua University Education Foundation to suport three major areas: energy transition, low-carbon innovation and nature-based solutions.

HSBC Wholesale Banking has also been focusing on exploring new business opportunities with green customers. In cash management, we were the first foreign bank to introduce the concept of 'green deposits' in June 2021. In trade finance, we launched the Sustainable Trade Instrument Product and Sustainable Supply Chain Finance. Our Market and Securities Services developed its ESG bond offering, such as the HBCN ESG Policy Bond to align local issuers with global criteria and link offshore green bond demand to onshore market, and provide Green Structure Deposits. We keep close to the development of the onshore carbon trading market in China.

In retail, the focus is more on thought leadership and the development of new products. Marketing campaigns are arranged to raise awareness and showcase our achievements. An ESG Forum was organised in June 2021 through HSBC Live Streaming to underline our credentials on ESG as a responsible international bank. A campaign was also arranged for retail customers to raise their awareness of sustainable investment through all marketing channels. Thematic funds and impact deposits are available or are planned to be launched in the second half of 2021.



A green structured deposit was launched in November 2020. We are also working collaboratively with China in third markets, and most notably along the Belt and Road.

As a signatory of the Green Investment Principles for the Belt and Road (GIP) which was jointly led by the Green Finance Committee of the China Society for Finance and Banking in China and the City of London's Green Finance Inititiative, we pledge to uphold these principles in our investment and operations. GIP aims to substantially enhance the sustainability of infrastructure and economic development across BRI countries. We continue to build our sustainable investment portfolios to support the GIP. Our aim is to influence the market to develop sustainably through active engagement on ESG issues and for this we have a dedicated Responsible Investment team across developed and emerging markets.

HSBC believes the challenge of climate change and the route to Net Zero is actually also an opportunity which, in the world of finance and banking – and especially in as dynamic a market as China's - is leading to some extraordinarily creative and clever new approaches to how we lend and use our money.

HSBC believes the challenge of climate change and the route to Net Zero is actually also an opportunity which, in the world of finance and banking – and especially in as dynamic a market as China's - is leading to some extraordinarily creative and clever new approaches to how we lend and use our money.

CASE STUDY

Chinese Green Corporates Securing Global Recognition

COMPANY PROFILE

London Stock Exchange

THE LONDON STOCK EXCHANGE

London is home to Europe's largest capital market with a deep pool of liquidity and international investors. We welcome companies from all over the world for initial public offerings (IPOs), listings and follow-on issuances. Furthermore, the capital's world-class financial markets ecosystem of banks and investors allows companies of all sizes to address any type of financing needs – and at speed. Our unique geopolitical position puts us at the heart of global markets, with direct access to US and Chinese investors. London has the most diverse investor base of any major global exchange, providing companies with capital to serve their globally focused business models.

The London Stock Exchange has had a representative office in Beijing since January 2008. The ground-breaking Shanghai-London Stock Connect launched in 2019 to facilitate a new level of capital cooperation between China and the UK.

"Improving the visibility and access to capital for green and sustainable commercial activities worldwide is a key goal of London Stock Exchange. There are many other Chinese companies, which like Yangtze Power, are helping to drive the global green economy. We hope to have the opportunity to partner with these companies and to support their long-term strategic goals."

London Stock Exchange is committed to supporting issuers with access to sustainable finance products and services across a range of asset classes and to supporting investors as they look to optimise their portfolios.

Key components of London Stock Exchange's Sustainable Finance offering for companies are:

SUSTAINABLE BOND MARKET (SBM)

London Stock Exchange's SBM allows issuers of qualifying sustainable debt finance instruments to display bonds on the platform, providing access to the largest, most sophisticated and long-term oriented investor base for sustainable debt finance. To date, more than 318 bonds have been admitted, raising USD 130.5bn, from issuers in 30 countries and bonds in 18 currencies.

GREEN ECONOMY MARK

London Stock Exchange's Green Economy Mark recognises London-listed companies and funds with 50% or more of their revenues derived from products and services that contribute to the global green economy. It helps to increase the visibility of London-listed companies and funds that are contributing to achieving positive environmental objectives. More than 100 companies and funds with a combined market cap of USD 140bn have received the Mark since its launch in 2019.

LONDON STOCK EXCHANGE AND YANGTZE POWER

One of the companies London Stock Exchange has worked with in China is Yangtze Power Co Ltd.

The announcement by President Xi Jinping that China will become a Net Zero emitter of carbon by 2060 has set the stage for a profound transformation of the country's energy system. China's Yangtze Power Co Ltd. is at the heart of that transformation. Founded in November 2002 and headquartered in Beijing, Yangtze Power looked to London to help finance its low-carbon growth – and is leveraging the Green Economy Mark. It is the first Chinese issuer to receive the London Stock Exchange's Green Economy Mark.

Yangtze Power has large ambitions. The USD 60bn-plus company operates 45.5 gigawatts (GW) of hydropower plants – equivalent to almost half of the UK's entire generating capacity. It plans to expand this by 26GW in the near future, meaning that it will need to raise significant capital.

As part of its plans, in September 2020, Yangtze Power became the third Chinese company to list on London Stock Exchange's innovative Shanghai-London Stock Connect, which was launched in partnership with the Shanghai Stock Exchange. The company raised USD 1.83bn through an offering of Global Depositary Receipts (GDRs).

Crucially, Yangtze Power received the Green Economy Mark at admission to Stock Connect, certifying that the company generates more than 50% of its revenues from green products or services, according to FTSE Russell's Green Revenues Data Model.

"The GDR issuance of Yangtze Power is not only beneficial for our overseas business expansion and capital structure optimisation, it also helps us get access to overseas equity financing, integrate with international capital markets and further develop our international strategies," said Yangtze Power Chairman Lei Mingshan.

"We are also proud that our commitment and contributions to generating sustainable energy has been recognised by being provided with the Green Economy Mark," he added.

Yangtze Power's Stock Connect listing will help it to access global investors and its Green Economy Mark helps showcase its green economy credentials to interested investors.

London Stock Exchange is committed to working with companies like Yangtze Power, who are part of the Green Economy and helping to deliver solutions to support Net Zero targets.

HIGHLIGHTING GREEN ECONOMY COMPANIES

中国长江电力股份有限公司
China Yangtze Power Co., Ltd.

London Stock Exchange's Green Economy Mark identifies listed companies and funds contributing to the global green economy by addressing key environmental objectives such as climate mitigation and adaptation, waste and pollution reduction, and transitioning to a circular economy.

Research on our latest cohort of Green Economy Mark holders shows:

- **105 issuers have been recognised with London Stock Exchange's Green Economy Mark**
- **USD 215bn combined market capitalisation**
- **74 corporates and 31 closed-end funds**
- **Uptick in international constituents and regional representation**
- **Data shows members of the cohort remained resilient amidst COVID-19 market uncertainty**

Training China's Leaders in Green Disclosure

COMPANY PROFILE

LUJIAZUI FINANCIAL CITY GREEN FINANCE DEVELOPMENT CENTRE

Established in 2019, the Lujiazui Financial City Green Finance Development Centre (GFDC) is an independent legal entity that is supervised by Shanghai Lujiazui Financial City Authority.

The GFDC is committed to promoting exchanges and cooperation between the financial industry and green-related real industries, exploring the innovative development of green financial products and businesses, promoting industry capacity-building and international cooperation, and jointly leading the green financial development vision from blueprint to practice.

To date, the GFDC has worked closely with key partners in promoting green finance and ESG Investment in China via various projects. GFDC has built strategic collaborations with relevant stakeholders in the UK, France, Luxemburg and the Financial Centres for Sustainability (FC4S) Network.

As a bridge between the local and international financial industry, GFDC is committed to promoting green finance as well as ESG development and helping Shanghai to build an international green financial centre.

In March 2021, the project initiated by Lujiazui Financial City Green Financial Development Centre and CDP was successfully selected by UK PACT as one of the five projects it supports in China. Environmental disclosure is at the heart of this project. The project aims to accelerate China's environmental improvement, low-carbon transition, and the carbon neutral target. The project consists of research reports, technical training to regulators and financial institutions, as well as seminars.

There have been three main challenges to overcome during this project involving the development of environmental disclosure in China. Firstly, there are various regulatory departments involved with different standards. Secondly, relevant regulations are still being established, enterprises and financial institutions are lacking

fundamental knowledge. Thirdly, the transparency and accountability of ESG data needs to be improved. Meanwhile, COVID-19 has also meant that engaging with regulators and companies for on-site training and meetings has been full of uncertainty.

The GFDC and CDP continue to follow the latest regulations to help financial institutions and businesses understand their carbon emissions and environmental impact, identify climate-related risks, and successfully disclose environmental information with the goal of achieving Net Zero emissions targets. By sharing international and in particular, UK-based examples of good practice, the project will lead to potential business opportunities between the UK and China: supporting the two countries to tackle climate change and their respective commitments to The Paris Agreement.

One part of our project, which was successfully held in Shanghai in September 2021, was the ESG Information Disclosure Policy and Practice Seminar. The seminar invited relevant regulators, financial institutions, industry representatives and third-party professional service parties to discuss ESG information disclosure policy and practice, especially in environment (E) information disclosure and carbon emissions target management. Through exchange and discussions, the seminar supported financial institutions in building ESG investment capacity, and helped enterprises improve the quality of information disclosure and achievement of Net Zero targets. More than 50 representatives responsible for ESG matters - from domestic and foreign financial institutions and enterprises actively participated. CDP and Carbon Trust shared their carbon reduction targets and implementation paths, which received a warm response, promoting several potential UK-China business collaborations.

The project will continue to focus on environmental information disclosure, through various types of activities, including comparative analysis of environmental information disclosure policies, dialogues with regulators, financial institutions, enterprises, and technical support. GFDC aims to support China to further establish environmental information disclosure regulations, achieving its carbon neutrality goal, and fighting climate change together with the international community.

CASE STUDY

How ESG Principles can Prepare Corporate Culture for Net Zero

COMPANY PROFILE

abrdn

At abrdn, we empower our clients to plan, save and invest for their futures.

Through the expertise, insight and innovation of our team, we aim to help clients create more ways for money to make an impact. We set our sights on giving them more confidence to achieve their goals, and more clarity about what they need next. And we focus on delivering outcomes that are more than just financial – by investing sustainably to build a better world.

abrdn is a global business, with clients in 80 countries. We manage and administer GBP 535 billion of assets on their behalf and we have over 1 million shareholders.

> "There's growing appreciation among Chinese companies of the value that ESG policies can bring. From abrdn's perspective, the pathway to a Net Zero future is intertwined with investors embodying ESG principles."
>
> DAVID SMITH
> SENIOR INVESTMENT DIRECTOR FOR ASIAN EQUITIES, abrdn

In abrdn's experience as an investor, the company has found that there is a growing appreciation globally, including among Chinese companies, of the value that environmental, social and governance (ESG) policies can bring.

abrdn believes selecting firms with strong ESG standards in its portfolios improves the chance of avoiding loss-making corporate failures and scandals, while also viewing it as a way to generate alpha – or above-market returns – by investing in positive change at companies. Ultimately, abrdn is confident that progressive ESG policies will drive company returns and share prices over the long run, all while doing good for the future.

To break the acronym down, the 'E' of ESG relates to how companies interact with the environment – what they consume, discharge, dig up or leave behind. The 'S' deals with the way they interact with employees, government, society and vendors; and the 'G' refers to the governance of a company, or how well it is managed.

We know energy use is changing the world over. Understanding who the winners and losers will be in the global transition to renewable energy is terrifically important for abrdn as investors, and central to ESG considerations.

A common perception about China is that its companies retain a rudimentary understanding of ESG, with low levels of transparency and disclosure. While this may have been true in the past, today we're seeing a growing appreciation of the value that attention to ESG factors can bring in China.

Many Chinese firms now outline their thinking on sustainability, their aspirations to reduce their carbon footprint and the frameworks they have in pace to negate ESG-related risks.

Maintaining a steady drumbeat of education and engagement is key for investors such as abrdn playing a role in devising solutions in climate action.

From abrdn's perspective, the pathway to a Net Zero future is intertwined with investors embodying ESG principles.

While China's securities regulator is drawing up new guidelines to improve the quality of disclosures, abrdn continue to be encouraged by the steps Chinese businesses are taking themselves to set new standards for ESG domestically. One such group, Contemporary Amperex Technology Co. (CATL), is core to China's push to achieve Net Zero carbon emissions by 2060. It is a global frontrunner in the manufacture of rechargeable lithium-ion batteries, which will power the shift to the electrification of road transport. Aligned to United Nations' goals on sustainable energy and climate change, CATL strives to emulate the quality of global peers such as LG Chemical and Samsung SDI.

Nari Technology is another pioneer at the heart of China's energy reform. As the nation's leading provider of secondary power equipment, its hardware and especially software will facilitate the transition of China's fossil fuel-powered grid to renewable energy. abrdn view Nari as more of a solutions provider than an equipment manufacturer, ensuring that China's energy supply is fit for the future. Nari also being aligned to United Nations' Sustainable Development Goals on energy efficiency and affordable energy is another good signal that the move toward Net Zero is underway.

CASE STUDY

Funding the Green Transition

COMPANY PROFILE

CITY OF LONDON CORPORATION

The City of London Corporation is the municipal governing body of the City of London. It supports and promotes the City and the UK as a leading international financial centre through a wide range of activities, including strategic engagement with key overseas markets such as China.

The City of London Corporation set up offices in Beijing and Shanghai over a decade ago. Since the establishment of these offices, The City of London Corporation's China programme has continued to go from strength to strength.

The Lord Mayor of the City of London and our Chair of Policy and Resources Committee are the two senior figures of our China programme, and are supported by a team in China and London.

The UK-China Green Finance Taskforce, co-established by the City of London Corporation and China Green Finance Committee, as part of the outcome from the 2017 UK-China Economic and Financial Dialogue, spearheaded UK-China collaboration in green finance over the past 5 years and continue to serve as a key platform for leading industry and policy experts to develop market-led solutions to help scale up green finance in both countries as well as globally.

Alderman William Russell, the 692nd Lord Mayor of the City of London and Dr Ma Jun, Chair of China Green Finance Committee are the co-chairs of the Taskforce.

The Taskforce's work focuses on:

1. DATA AND INFORMATION DISCLOSURE

- In December 2017, China and the UK agreed to launch a joint TCFD pilot programme, in which 10 leading financial institutions would adopt TCFD recommendations and curate the practical lessons they learned for subsequent adopters.
- Currently, 13 Chinese and UK financial institutions have joined the pilot and received comprehensive guidance from the People's Bank of China and the Bank of England. The Industrial and Commercial Bank of China (ICBC) and Principles for Responsible Investment (PRI) represent each side respectively serving as co-chairs of the pilot steering committee.

2. GREEN BELT AND ROAD

- At the Second Belt and Road Forum for International Cooperation held in Beijing in 2019, the Taskforce announced the formation of the Secretariat for the Green Investment Principles for the Belt and Road (GIP), and the first list of signatories.
- Today, the GIP signatories stands at 40, whose overall assets mount to over USD 48 trillion worldwide.
- The goal of the GIP is to encourage and assist signatories to better integrate environmental considerations into the decision-making and implementation processes of their investments in the region.

3. ESG AND SUSTAINABLE INVESTING

- Established in 2021, the ESG Leaders Forum (ELF) is a practitioner-led initiative to further embed ESG integration into the UK and Chinese investment community and to promote the best practice that can be replicated in both markets.
- The ELF seeks to establish a mutually-recognised engagement framework, equip institutional investors with knowledge, tools and motivation to deal with ESG risks, and facilitate relevant participants (including regulators, investment institutions, research institutions and service providers) to conduct capacity building in order to mainstream ESG investing.

Through a series of capacity building and thought leadership programmes, the UK-China Green Finance Taskforce has equipped UK and Chinese financial institutions with knowledge on adopting green and sustainable finance in their business. In particular the Taskforce's work has helped participating financial firms in the UK and in China in their efforts to advance green and sustainable data and information disclosure, a key step on their path to contribute to Net Zero.

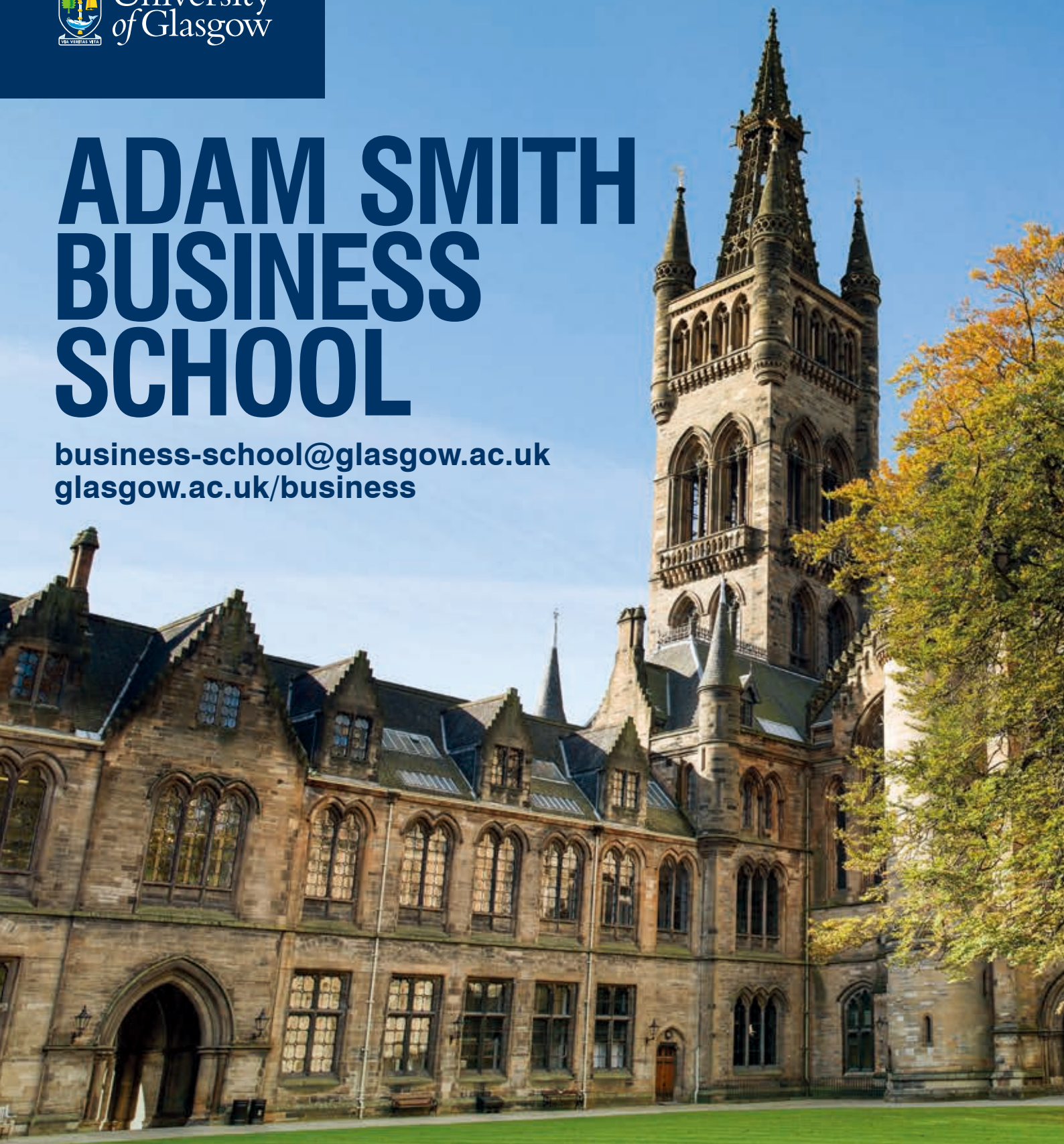
Looking ahead, the Taskforce's work will continue focusing on capacity building to help financial services firms in the UK and in China to ensure that environmental consciousness, climate resilience, and social inclusiveness are built into their business, so that they can contribute to the Net Zero goals in respective markets.

> "The UK-China Green Finance Taskforce is a long-standing partnership between the City of London Corporation and China's Green Finance Committee of the China Society for Finance and Banking. It will continue to serve as an important platform to drive green finance growth in the UK and China, as well as globally."
>
> ALDERMAN WILLIAM RUSSELL,
> 692ND LORD MAYOR OF
> THE CITY OF LONDON

University of Glasgow

ADAM SMITH BUSINESS SCHOOL

business-school@glasgow.ac.uk
glasgow.ac.uk/business



AACSB ACCREDITED
ASSOCIATION OF MBAS ACCREDITED
EQUIS ACCREDITED
Athena SWAN Bronze Award GENDER CHARTER
PRME an initiative of the United Nations Global Compact

CHAPTER

05 Nature

BROUGHT TO YOU BY

University of Glasgow
Adam Smith Business School

On Biodiversity and Business: Five Steps for Nature Based Solutions

BY PROFESSOR JOHN CRAWFORD

> "The solution starts with understanding and accepting a simple truth: our economies are embedded within Nature, not external to it."
>
> SIR PARTHA DASGUPTA
> THE ECONOMICS OF BIODIVERSITY, LONDON, HM TREASURY 2021

INTRODUCTION

The recent Global Risks Reports from the World Economic Forum (WEF) are consistent in highlighting climate change and environmental degradation as amongst the highest and most impactful risks that the global economy faces. More significantly, these reports emphasise the hyper-connectivity of the global risk landscape. This means that not only are climate and environment amongst the most urgent and impactful risks to the economy, in the words of the 19th Century Scottish naturalist John Muir, these risks are 'hitched to everything else in the Universe'. This complexity is bound up in what Klaus Schwab (Founder of the WEF) refers to as the underlying dimensions of the economic risk landscape in the 21st century: multiplicity, interconnectivity, and pace[1]. Mastering these complexities is the foremost challenge for business and will require partnership to replace competition as the operating paradigm. Conventional models of growth through competitive advantage no longer make sense when companies are scrabbling simply to remain relevant to a new generation of consumers that is increasingly anxious about the future of their planet[1].

Given these challenges, what might be the new operating paradigm for companies? It is no longer enough to be 'seen to be green'. Consumers will demand action from corporates and verifiable outcomes that are easy to act on. The answer lies in corporates' capacity and capability to 'master the complexities' referred to by Klaus Schwab, quoted above. Many recognise the need for joined-up business solutions that minimise unintended outcomes, often called 'systems approaches'. However, the consequences of hyperconnectivity for the business world is often not fully grasped. This is most obvious in the approach of businesses and governments to the climate and environmental emergency.

Firstly, we take a closer look at the quote at the top – what does it mean for businesses and the economy to be embedded within Nature? Next, we talk about how businesses need to collaborate to co-create Nature-based solutions that stretch across the value chain. Finally, we note that the opportunity to reflect and theorise is gone and that we know how to get started. We provide some recommendations on how to start impacting now, and how to get better at it over time.

A THEORY OF EVERYTHING ELSE

What does it mean for our economy to be embedded in Nature and what are the consequences for businesses and Nature-based solutions?

The Invisible Hand of the free market is a greatly misused and abused concept introduced by Adam Smith in his *An Inquiry into the Nature and Causes of the Wealth of Nations*, arguably the most important substantive proposition in all of economics[3]. Although elaborated beyond Smith's original concept, it is taken to mean that in a free-market economy the outcome will be somehow 'optimised' through competition. Many parallels are drawn between this property of economies and the concept of Darwinian evolution – somehow 'less fit' species/organisations become extinct and that the ecosystem/economy is more optimal as a result? In fact, both

interpretations are wrong, and we now know that economies and ecologies are innovation processes that are powered by sharing.

Kaufmann introduces the Theory of the Adjacent Possible[4] to show how sharing of genes and innovations can lead to a hyperbolic explosion of innovation processes in evolution and in economies. The significance is the prediction that such processes generate an infinite number of possibilities in a finite time and explains the hockey-stick behaviour (long periods of slow growth followed by a rapid uptick) in both the number of species on Earth over time and in the number of innovations (products) in the global economy.

Returning now to the quote at the top of this introduction, we might begin to understand what it means for business to be embedded in Nature. The difference between Nature and economies is that Nature tempers hyperbolic growth using natural selection based on competition for finite natural resources to limit the total biomass. The only meaningful constraint on growth in our economic system is whether something can be sold for more money than it takes to make and sell it. By placing an appropriate economic value on natural resources, innovations that have a large environmental cost will become extinct compared to those that don't.

In both economies and ecologies, the number of possible innovations far exceeds the number that are realised – the rate of innovation is not what limits growth. What ultimately limits growth is whether innovations in the past reduce the potential for innovation in the future. In nature it doesn't, but the climate and environmental crisis is proof that innovation in our economy does and has.

The future of the economy depends on us developing the means to make such innovations extinct and amplifying those that do not. But it also depends on innovations that remove the existing constraints that have been built up over time. Outcomes that do both things are what we call Nature-based solutions.

WHOLE VALUE-CHAIN SOLUTIONS

The interconnectedness and multiplicity of the global economic risk landscape means that we cannot treat risks in isolation. From a business perspective, the challenge is to predict how each part of your business, and the businesses it connects to, needs to change to maximise both profitability and nature-positive outcomes. This cannot be achieved by working with the parts in isolation and a whole value-chain approach is required. The inherent complexities of taking such an approach are a barrier to adoption.

The Arbikie Distillery case study shows the benefits that can accrue when these challenges are overcome and provides an example of delivering nature-based solutions by taking a whole value-chain approach. Since some two-thirds of the emissions in the food system come from outside the farm gate, the IPCC Special Report on Food Security[5] notes that maximal reductions in the environmental footprint of the food system can only be achieved by coordinating the interventions in production at one side of the food system with changes in consumption at the other, and by eliminating wasteful practices in between. This requires cooperation between many interconnected global, national and regional businesses, between those businesses and farmers, and between business, farming and policy. This case study shows it is not only possible, but that the business becomes stronger as a result.

[1] http://reports.weforum.org/global-risks-2012/
[2] https://www.thelancet.com/journals/lanchi/article/PIIS2352-4642(21)00001-8/fulltext
[3] George J. Stigler (1976). "The Successes and Failures of Professor Smith," Journal of Political
[4] Economy, 84(6), p. 1202 (pp. 1199–1213).
[5] Entropy 2019, 21, 864; doi:10.3390/e21090864
https://www.ipcc.ch/srccl/chapter/chapter-5/

The advantage of digital technology for ESG is that data can be secured using e.g. blockchain from source to stakeholder, allowing for a transparent and secure auditing of impact.

MEASUREMENT, REPORTING, AND VERIFICATION

Assets in sustainable investment products are anticipated to exceed those in conventional funds by 2025[6]. This means that access to capital will come with an increasing requirement to demonstrate positive environmental, social and governance (ESG) outcomes. ESG has the potential to transform the rate of investment in nature-based solutions, but this depends crucially on transparent and reliable measurement and verification of impacts.

There are now almost four times the number of connected digital devices in the world than there are people[7]. Technology offers the potential to measure almost anything, almost everywhere and so provides a source of pervasive data that is needed to optimise value chains for ESG. The advantage of digital technology for ESG is that data can be secured using e.g. blockchain from source to stakeholder, allowing for a transparent and secure auditing of impact.

Carbon offsetting through reforestation and prevention of deforestation is now monitored using satellite technology. We can not only ensure that forests that are supposed to be there, actually are there, but also calculate the total carbon accruing each year. Other kinds of nature-based solutions are harder to monitor, and biodiversity is one of the hardest. The Huawei case study demonstrates the potential of connected acoustic sensors for quantifying biodiversity. In particular, it highlights the potential for technology to provide the scalable MRV for biodiversity that is required to deliver the level of impact needed across the wide diversity of environments required.

Data that feeds into MRV is only useful if proper standards and regulation are in place. This is an urgent need in the case of Nature-based solutions where data related to e.g. soil carbon and biodiversity are not subject to internationally-recognised standards. There are lessons to be learned from other sectors, and particularly from engineering. This is especially relevant given that more people now live in urban compared with rural environments, and the role of cities in delivering nature-positive outcomes is critical. The BRE case study, which follows in this report, showcases the importance of building standards in ensuring that the built environment delivers nature positive outcomes, and can-in principle-benefit from ESG-related finance. It provides a set of guiding principles that can be followed in nature-based solutions to ensure that measures of impact can be trusted.

[6] https://www.ft.com/content/5cd6e923-81e0-4557-8cff-a02fb5e01d42
[7] https://techjury.net/blog/how-many-iot-devices-are-there/#gref

FIVE STEPS THAT ENABLE NATURE-BASED SOLUTIONS

This introduction and set of case studies highlight the need to embrace complexities of an interconnected global economic risk landscape and illustrate approaches that do that. In particular, it highlights the importance of top-down regulation combined with sharing and cooperative behaviour in boosting innovation and embedding the global economy in Nature. It shows how this can be exemplified in whole value-chain approaches, and how reliable MRV is a key to boosting the investment that is needed. Based on that, the following offers a set of steps that are necessary to enable nature-based solutions that impact positively on both climate and biodiversity.

STEP 1. ADOPT LOCAL VALUES AND SET DESIRED OUTCOMES

Everything follows from a list of local (i.e. regional) values and target outcomes including acceptable trade-offs, and so this list is the starting point and a critical part of the concept of nature-based solutions. Local values and desired outcomes should be consistent with the global SDGs and although the list can evolve, the initial choice can limit future options and, therefore, requires careful thought.

STEP 2. IDENTIFY THE SYSTEM

The system comprises all the connected businesses and natural processes that impact on the target outcomes, along with the interactions between them. Intrinsic uncertainties and ignorance mean we need to simultaneously embrace a range of different hypotheses about the links between cause (practices) and effect (outcomes) that constitute the systems map of the solution being sought. Each set of hypotheses will have a related level of confidence based on its consistency with available data and these should be considered when designing interventions based on the full range of hypotheses.

STEP 3. ADOPT A MULTISCALE APPROACH

Nature-based solutions must connect to the relevant local and global businesses, to local supply chains and infrastructure, and to local and global policies to maximise their impact. This requires careful coordination of top-down and bottom-up governance. Top-down includes establishing a set of international standards for data and measuring outcomes; transparent regulation to ensure these standards; and the establishment of international scientific collaboration. Bottom-up includes identifying local values and priority outcomes; establishing stakeholder trust; scientific input; and securing a digital infrastructure for measurement, reporting and verification.

STEP 4. SECURE A DIGITAL INFRASTRUCTURE

Nature-based solutions depend on MRV and so are contingent on a digital infrastructure that enables data collection and flow across the value chain; supports inputs from sensor networks that provide the pervasive data needed; and which brings information to all stakeholders. As part of the top-down and bottom-up approach, the local data infrastructure must be compatible with a global infrastructure.

STEP 5. ESTABLISH AN OPEN INNOVATION ECOSYSTEM

Nature-based solutions at any location should link to the wider global solution base to ensure benchmarking of outcomes, appropriate sharing of what works, and combining of innovation. Approaches should be co-created by all stakeholders to maximise the impact of the outcomes and to pool associated risks. This requires governance structures that enable inputs from local and global businesses; local and national policy makers; NGOs, and local and global science.

CASE STUDY

Climate Positive Gin Distilled with Hydrogen Power

COMPANY PROFILE

ARBIKIE DISTILLERY

Arbikie Distillery was founded by the Stirling brothers in 2014 on Scotland's sunny east coast. Arbikie is a unique, field-to-bottle distillery in that we grow, distil, mature and bottle at our Farm Distillery following a single-estate ethos. Arbikie distils a family of luxury, sustainable spirits that includes Kirsty's Gin, winner of Gold at the World Spirit Awards, AK's Gin, the winner of the World Martini Championship, and Highland Rye, the world's only Rye Scotch Whisky rated "9 out of 10" and "absolutely superb" by Forbes Magazine.

When the Stirling brothers set up Arbikie Distillery on their family farm in 2014 their plan was to combine the best of farming and traditional distilling with innovation. Arbikie aims to be one of the world's most sustainable distilleries and Arbikie's six-year sustainable journey, so far, has been one of ongoing collaboration with partners, including the James Hutton Institute and Abertay University. Arbikie are a rare, field-to-bottle distiller as they grow what they need to distil on their own farms, whether that be barley, wheat, potatoes, peas and chillies, or botanicals like juniper, coriander, lemongrass and limes. They have pioneered field-to-bottle distilling across a range of spirits, including gin and whisky, as this fits with the company's circular economy approach to minimising environmental impact.

Arbikie is working on plans to power their distillery with hydrogen as part of the UK Government Green Distilleries Competition, where Arbikie won and entered into Phase 1 (Analysis) alongside 14 other UK Distilleries and are confident of entering Phase 2 (Demonstration) of the competition. Arbikie has also adopted regenerative farming practices, minimising farm chemical inputs and are reviving heritage barley varieties; this not only increases crop diversity on the farm, but promotes regional differences in the flavour of the whisky too.

Arbikie has used science to unlock distilling conundrums such as with Master Distiller, Kirsty Black, distilling the world's first climate-positive spirits as part of her PhD. Nadar Gin was launched in 2020 following years of endeavour by Kirsty with partners, James Hutton & Abertay. Distilled from peas, Nadar is carbon-negative, avoiding the release of 1.54Kg of CO_2 into the atmosphere through avoidance of fertiliser

"Arbikie is focused on becoming one of the world's most sustainable distilleries, and as both farmers and distillers we are in an ideal position to grow & distil our field-to-bottle gin, vodka and whiskies. Sustainable products are undoubtedly the future, especially in this year of the UN's COP26 and they will be the major economic driving force in the years to come across the world. We are fortunate to have such a wonderful environment on Scotland's east coast from which we can grow and distil the highest quality of barley, peas and rye, and we're proud to play a part at the vanguard of what is becoming a global sustainable spirits movement."

IAIN STIRLING
OWNER, ARBIKIE DISTILLERY

use and imported soy animal feed. To determine this number Kirsty worked with Trinity College, Dublin and Bangor University to complete a life cycle analysis, a technique that quantifies the environmental impact of a product.

Arbikie has a clear mission to become the global leader in a new category of single-estate, sustainable spirits. The company was not satisfied with simply being carbon-neutral, so they focused on distilling the world's first climate-positive spirits. Arbikie achieved that goal with the launch of their climate positive, Nàdar Gin in early 2020 which is already having a positive impact in the distilling industry with the potential for the gin industry to switch from distilling with wheat to distilling with peas: dramatically reducing the product's environmental impact.

The emergence of sustainable spirits has also seen the global Hospitality Industry start to create Sustainable Cocktail Menus, and has created a huge growth in sustainable spirits being bought online, with huge e-commerce growth, particularly during lockdowns.Arbikie is in the process of launching its family of sustainable spirits in China with distribution partners and is looking forward to working with global clients, like Aman Resorts and Marriott International to introduce sustainable spirits and sustainable cocktails to discerning drinkers in the Chinese market. Arbikie is also confident of entering Phase 2 of the Green Distilleries competition, the company worked with Locogen and Logan Energy in the analysis for Phase 1, and looks forward to continuing to work with them in the demonstration/implementation of hydrogen power for their Distillery in Phase 2.

CASE STUDY

UK Green Building Standards Supporting China's Construction Industry

COMPANY PROFILE

BRE CHINA

BRE (Building Research Establishment) was founded in 1921, it is a world leading multi-disciplinary building science centre with a mission to improve buildings and infrastructure, through research and knowledge generation. We use cutting-edge research to develop a range of products, services, standards and qualifications that bring about positive change in the built environment.

> "This successful case can not only accelerate the pace of Net Zero carbon in the construction industry, but also help industry personnel understand how to carry out low-carbon work in the planning, design and even purchasing end of the construction sector. This is conducive to the sustainable development of the whole industry."

GARY ZHAO
GENERAL MANAGER OF BRE CHINA

BREEAM is the world's foremost and most widely applied environmental assessment method and rating system for buildings, with close to 600,000 buildings with certified BREEAM assessment ratings and over 2,310,000 registered for assessment since it was first launched by BRE in 1990. As a globally recognised third-party certification, BREEAM not only encourages and supports the sustainable improvement of buildings, but also helps investors understand their asset conditions and improve the resilience of assets in a more convenient and effective way. At present, BREEAM certification has been applied to thousands of assets in several countries to benchmark, improve and certify its performance, and to demonstrate to the public the high standard of environmental and social governance (ESG) of its enterprises.

IKEA JING'AN STORE

At IKEA, durability is an integral part of the company's ethos, with the organisation setting this at the heart of employee's daily work. IKEA's sustainability strategy - People & Planet Positive - champions the organisation's desire to have a positive impact on the environment and people.

IKEA decided to use the BREEAM sustainable building certification to help advance the company's efforts in championing sustainability. In this case, the IKEA Group set the following goals for the project:

- Achieve VERY GOOD certification
- Reduce carbon emissions
- Improve the efficiency of materials, water and energy

The project adopts the following technologies to achieve energy-saving and low-carbon operations and maintenance, while reducing the carbon emissions of the whole life cycle of the project as much as possible in relation to the building materials used:

- Adapted to local climate conditions, the need for heating is minimised with a performant building fabric and insulation system, analysed by energy modelling tools, which lowers energy consumption - thus reducing: the CO_2 emissions of the building's operations
- Energy-efficient LEDs provide all lighting with an adapted control
- In terms of choice of materials, materials from a responsible source (FSC-timber) or products with lower environmental impact are encouraged and implemented, robust materials are chosen for their durability
- Life Cycle Cost analysis takes place at conception design stage
- Sustainable Procurement Programme
- Site visit regularly to ensure construction and installations are in line with the targeted BREEAM Standards

The construction industry currently accounts for nearly 30% of China's carbon emissions. Since 2016, the state has also begun to conduct national audit and verification of carbon emissions from public buildings. The construction industry will also be included in the national carbon emission trading system in the near future. Therefore, the low-carbon achievements of this project can be introduced and applied by other similar projects. This successful case can not only accelerate the pace of Net Zero carbon in the construction industry, but also help industry personnel understand how to carry out low-carbon work ranging from construction planning and design to purchasing, which is conducive to the sustainable development of the construction industry.

CASE STUDY

Technology Serving to Protect the Red Squirrel

COMPANY PROFILE

HUAWEI - RAINFOREST CONNECTION (RFCx)

Rainforest Connection (RFCx) is a global conservation charity which operates projects in countries all over the world, from Brazil and Romania to Indonesia and Cameroon: protecting the local environment from illegal deforestation and poaching.

By working with Huawei, RFCx are able to collect the world's largest library of acoustic data, and through an extensive monitoring system using old handsets deployed deep in the world's rainforests, they can detect threatening noises, like chainsaws and trucks.

RFCx is currently using this to protect 2,500 square kilometres of land: the equivalent of 350,000 football pitches.

In places such as South America, RFCx use a combination of recycled Huawei phones, cloud storage for the large amount of data collected and artificial intelligence to analyse the audio data collected, and in doing so create an alert system which notifies rangers in real time and prevents further damage to rainforests.

This acoustic monitoring is catching loggers and environmental vandals in the act, and stopping them from wreaking more damage on the planet's ecosystem.

The partnership has been such a success globally that Huawei and RFCx are looking at setting up three new sites and are finding new uses for the technology, including the study of endangered species like spider monkeys in Costa Rica.

The technology is making the impossible possible – 200,000 hours of data of animal noises would take a person a lifetime to listen to. But with AI, these data sets are analysed and give nature researchers an accurate map of where various animals are distributed across a region.

APPLYING GLOBAL CONSERVATION INNOVATION TO THE UK

Building on this global partnership, the same technology is being applied to protect an animal closer to home – the UK's much-loved red squirrel which is at risk of extinction unless action is taken.

The introduction of non-native grey squirrels to the UK has seen numbers decline over the last 150 years to dangerously low levels.

Working with the Mammal Society and the University of Bristol, Huawei is looking to set up trials to build up a picture of red squirrel behaviour in the UK.

Using acoustic monitoring as a survey technique, it is hoped the project can provide insight into behavioural patterns which support conservation work and promote UK biodiversity health based on the sounds of nature.

This project will bolster the UK's reputation as a global centre of conservation of animal habitats and underlines the importance of technology as a game-changer in biodiversity protection: combining innovative new methods with the passion and expertise of conservationists on the ground.

Whether it is the spider monkeys of Costa Rica or red squirrels in the UK, technology is proving a force for good, and giving us new tools in the fight to protect the planet.

This is another example of Huawei's commitment to the UK and its collaborations which are helping to push the boundaries of technology for the benefit of everyone.

CASE STUDY

Clear Waters and Green Mountains: Modern Drainage Solutions for Chinese Cities

COMPANY PROFILE

ARUP

ARUP

Arup is an independent firm of designers, engineers and consultants working across every aspect of the built environment. From 90 offices around the globe, more than 16,000 staff members deliver innovative projects worldwide, generating GBP 1.8bn in annual income.

The firm was founded by Ove Arup in 1946 and is renowned for iconic projects ranging from the Sydney Opera House in Australia and the Bird's Nest Stadium in Beijing to the Øresund Bridge between Denmark and Sweden and the Hong Kong-Zhuhai-Macao Bridge.

Arup is owned in Trust for the benefit of its employees with a mission to Shape a Better World.

> "Our sustainable drainage interventions will benefit the economy, public health, liveability, ecology and reduce energy use. We applied local knowledge with international best practice, using a combined local and global multi-disciplinary team, to deliver this solution for Shanghai."

MICHAEL ZHAO
ARUP'S WATER LEADER IN CHINA

Shanghai's success has seen rapid urbanisation and dramatic population growth. However, the pace and scale of urban development also increased the risk of flooding in the city as space that could soak up rainfall was developed for roads, buildings and the other foundations of our modern environment. Less green space in the catchment area led to increased stormwater runoff across the city. This in turn increased the risk of urban flooding and river pollution, exacerbated by the impact of climate change.

The situation prompted Shanghai's city authorities to take decisive action, launching a design competition to look for advanced, yet deliverable, strategies for the densely populated city centre. As a result, Shanghai now has a new Urban Drainage Masterplan developed with the support of Arup in partnership with the Shanghai Urban Construction Design & Research Institute.

The team brought together a wealth of global experience and detailed local knowledge to identify potential solutions that aligned most closely with the specific challenges faced by Shanghai.

By studying relevant cases across the globe, the group challenged the traditional approach of focusing solely on drainage. Instead, they utilised a visionary 'blue, green and grey' design approach that exploited the full scope of the integrated water cycle within the city. So instead of studying the drainage system as a standalone unit, the team could develop solutions that also benefit other aspects of life across greater Shanghai, including ecology, economy and public health.

Machine learning was also deployed to categorise the masterplanning area into different typologies, finally producing a masterplan that can

serve an area covering 640km² and a population of 15 million people. By developing a truly integrated strategy fit for one of the world's megacities, Arup and the Shanghai Urban Construction Design & Research Institute have brought together a scheme that combines climate change adaptation, water sensitive urban design, integrated flood control planning and decentralised infrastructure as key components shaping the city's future.

This means Shanghai will be able to maximise the full potential of current facilities and existing infrastructure before proposing anything new, with an initial focus on improving the management of the existing network.

This approach – combining the green infrastructure of the land, the blue infrastructure of the rivers and the grey infrastructure of channels and drainage networks – will ultimately reduce both costs and carbon by creating a more efficient, integrated network.

As a result, the team can now work closely with the Shanghai authorities to build a city shaped by water and fully integrated with other critical infrastructure, including transportation, water, energy, digital and waste, for urban planning, design and urban redevelopment.

Effective management of the water environment is critical to achieving the United Nations' Sustainable Development Goals (UN SDGs), so this masterplan will not only help the city meet its stormwater improvement target, but also to save costs, build resilience and improve the wellbeing of its people.

CBBC would like to thank all of our sponsors and case study contributors for their support in compiling this report.

Principal Sponsor

Chapter Sponsors

JOIN CBBC TODAY!

China-Britain Business Council
英中贸易协会

The China – Britain Business Council (CBBC) is the UK's national business network for promoting trade and investment with China.

MEMBERSHIP OF CBBC GIVES YOU:

ADVICE

Our experience built over 65 years of supporting thousands of organisations to enter, grow and succeed in China, leaves us expertly positioned to advise you on every step of your China Journey.

ANALYSIS

From bespoke reports and policy updates to market insights across eight core sectors, we provide our members with the tools to help them prepare, plan ahead with confidence, and grow.

ACCESS

Access at the highest levels of influence in the UK and China, and to an unparalleled network of your peers, suppliers, stakeholders and competitors across all sectors. This includes events, roundtables, delegations and VIP visits.

Our diverse membership includes some of the UK's leading companies and universities, many of the most dynamic UK SMEs, and an ever increasing number of Chinese companies exporting to and investing in the UK.

For more information on CBBC membership visit www.cbbc.org/membership

Join CBBC membership today or **get in touch** to discuss your China or UK business needs.

China-Britain Business Council
英中贸易协会

CONTACT

China

Beijing
The British Centre, Room 1001, China Life Tower,
16 Chaoyangmenwai Avenue, Beijing 100020
Tel: +86 (0)10 8525 1111
Fax: +86(0)10 8525 1001
Email: enquiries@cbbc.org

UK

Kings Buildings, 16 Smith Square, London
SW1P 3HQ
Tel: +44 (0)20 7802 2000
Fax: +44 (0)20 7802 2029
Email: enquiries@cbbc.org