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AFRY Insights

Energy transition

Winter 2022

Interviews

Lisen Oliw (Norrsken Foundation)
Luca Maria Rossi (Baker Hughes)

Topics

Challenges for fleet electrification
Building resilience in the gas market
Small Modular Reactors on the path to decarbonisation

Imprint

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Editorial

Dear reader,

Resilience, intelligence and excellence are the qualities that have guided us in designing this issue of our magazine in light of the current geopolitical situation. It is not without significance that a lighthouse in stormy water is emblazoned on our cover, because for us it is a symbol of the orientation that we as AFRY Management Consulting also want to give you.

It will not surprise you that Russia's invasion of Ukraine dominates much of our colleagues' analyses, especially with regard to the new, riskier gas market, supply chain challenges and much more. Nevertheless, it is precisely the question around climate change that drives us to take a stand on sustainability issues, as Carlos Perez Linkenheil (p. 20) as well as Helena Mueller (p. 24) do in their articles.

But who can solve the most pressing problems of our time? Entrepreneurs, says the Norrsken Foundation, which partners with AFRY to make a difference to impact startups, and we talked to one of Norrsken's leaders, Lisen Oliw (p. 22). We also spoke to Luca Maria Rossi of Baker Hughes, with whom we not only discussed the ambitious net zero commitment of the company, but also asked how Baker Hughes is taking its customers on this journey (p. 28).

Last but not least, this edition features writers from AFRY's engineering and digital business areas (p.10, 30, 32), reflecting the broad significance of the energy transition topic and the importance of collaborating across interconnected expertise areas to achieve the best outcomes.

As always, your feedback and comments are welcome, so that we can improve our next issue. We remain curious and make it our mission to bring you new ideas, perspectives and insights in order to support you for what is coming next.

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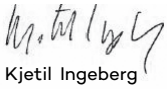
Kjetil Ingeberg

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Going all electric

Key challenges for fleet electrification

EV Fleet Market Overview
We are at the beginning of a mobility revolution, and fleets are a crucial part of this transition. The exponential growth of EVs is no secret. For instance, 63 million fleet vehicles in Europe make up 20% of all vehicles. More than 40% of all vehicle miles travelled and 50% of all emissions from road transportation are represented by this. By 2030, there will be 73 million fleet vehicles in the EU, including both electric vehicles (EVs) and vehicles powered by internal combustion engines (ICE). If we focus on only the electrified segment of fleet vehicles, an anticipated 24-fold increase will bring actual numbers in Europe to 10.5 million by 2030, up from 420,000 vehicles today .

By the year 2040, 15 million EVs are expected to be a part of corporate fleets in the US. The rapid expansion of EV fleets is advantageous because it significantly improves the environment. Nearly 25% of all greenhouse gas emissions in Europe and 23% in the US are attributed to road transport. Reaching national greenhouse gas targets will be significantly aided by replacing ICE vehicles with zero-emission vehicles. Government policies are encouraging EV fleet conversions since there is so much to gain from doing so. These policies include both laws that demand progress and incentives like tax breaks and subsidies. However, there are a lot more reasons for electrifying fleets.

Fleet operators can reduce TCO for corporate owned or leased vehicles, avoid "pollution penalties," increase employee convenience, and advance a corporate social responsibility policy to reduce carbon emissions and become more of a "green" brand.

As always, change involves challenges with impacts proportional to the size of the change itself. Fleet operators face at least three predominant challenges when contemplating the transition to electric vehicles:

1. the inevitable complexity of understanding and planning for a new fuel source.
2. market barriers, noticeable in the significant upfront additional capital needed to purchase and deploy the electric vehicles and associated charging infrastructure.
3. operational challenges to progressively transition the fleet while ensuring its smooth and robust daily service.

1. The Ecosystem
Fleet electrification entails more than just replacing a fossil-fuelled vehicle with an electric car. Operators must carefully consider and plan the integration and coordination of numerous components in order to achieve a successful transition to a zero-emissions fleet:

- Electric vehicles that can accommodate their needs for mobility
- Charging stations
- Monitoring and fleet management software
- Provision of renewable or clean energy
- Grid and utility infrastructure
- Training and education

The market for electric vehicles is still somewhat fragmented; fleet operators considering a switch to electric vehicles may need to collaborate with a number of vendors and suppliers, each with their own unique offerings,

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to evaluate and choose the technology options that best suit their transportation requirements in this complex, constantly shifting ecosystem.

2. Upfront costs
To make the switch to electric vehicles, a non-trivial financial expenditure is needed upfront to pay for the incrementally higher cost of electric vehicles compared to fossil-fuel vehicles, the cost of charging stations, and any necessary changes to the electric grid for the energy supply. There are currently a number of funding alternatives available from the EU, state, and municipal governments, as well as utilities, to subsidise both the electric vehicles and related infrastructure for charging them.

However, it might be difficult for fleet operators to discover the best financing choice and to put in a strong application. Additionally, a variety of innovative ownership-and-operation business models are emerging as the market for e-mobility solutions grows. These methods are designed to reduce the upfront cost by making it a recurrent annualised charge that fleet operators can pay over time while still saving money on fuel and maintenance. These cutting-edge business concepts include "energy-as-a-service" (a fleet operator owns the vehicles, while a third party controls the infrastructure for charging and energy), "mobility-as-a-service," and others. Several of these financing approaches are being supplied by new companies and have not yet been shown to be efficient on a wide scale, despite their enormous potential.

3. Operations
The implementation of a fleet electrification project might take months or even years, possibly disrupting the entire transportation network. Large MHDV (Medium and Heavy Duty Vehicles) fleets may experience the shift in stages. Some vehicles and routes might be fully electrified and in use, while others might still be in the planning stages or be undergoing installation.

The fleet operations can be difficult when both conventional and electric vehicles are in use every day; it implies to put in place and managing different processes for refueling and recharging, maintenance planning, repairing operations among others. Additionally, even though electric vehicles are typically simpler to maintain and drive, maintaining the electric fleet efficiently might call for specialised training for both staff and drivers. Sometimes, workforce training and development are neglected, which leads to operational inefficiencies.

Conclusions
Fleet electrification is in progress due to rising EV usage and anticipated financial and environmental benefits. Both the public and private sectors are moving toward electrifying their fleets. Environmental methods to cut emissions become a source of resilience and a competitive advantage as the severity of the climate crisis increases. However, in order to reduce emissions to a manageable level, it is necessary to be able to transition from a theoretical acceptance of the goals to specific, actionable plans for getting there. Even while the solutions aren't always straightforward, they are currently accessible to businesses with the drive to get going and the know-how to succeed.

Risk aversion

Building resilience in the new, riskier gas market

Nord Stream 1 exists because of Russia's difficult relationship with an independent Ukraine. Russia was reliant on Ukraine to transit its gas to Europe; and between 2006 and 2009 Gazprom and Ukrtransgaz were in dispute over transit fees. The political desire to bypass the problem of being beholden to Ukraine, led Russia to build two expensive subsea pipes directly to Germany. By itself these two subsea pipes (Nord Stream 1) could only divert about half of the gas flowing via Ukraine, so for total independence in its gas export capability, Russia planned and built a second Nord Stream.

Investors in Nord Stream 2 had to abandon the project following sanctions from the US, which foresaw an over-reliance on Russian gas; and the project was finally completed by Gazprom alone.

Before invading Ukraine, the Kremlin exerted as much pressure as contractually possible – through creating 'artificial scarcity' and pushing up prices – to encourage Germany and the EU to commission Nord Stream 2. On this occasion though, they did not oblige, and Russia has been left without the export flexibility it desired.

This has not stopped gas providing arguably the most effective lever the Kremlin can pull to exert political pressure on Europe. Very few commentators would disagree that the Kremlin has abandoned contractual obligations, and Gazprom's standing as a reliable supplier, in favour of furthering its wartime objectives, completely changing the risk landscape for European energy.

So Europe is looking to build its way back to energy security, and in the gas market this means more LNG re-gasification capacity and maximising local reliable gas supplies, mainly from Norway. The bubble chart shows the relative security of supply position of a sample of European countries; illustrating the importance of indigenous production, pipelines from the North Sea and access to the global LNG market. Italy and Spain have access to pipeline supplies from North Africa, which arguably makes them more secure than illustrated here, although these routes have been subject to disputes and interruptions in recent times.

The positions of Slovakia and Czechia are identical to Hungary, as would be Poland's if it had not been an early mover to diversify away from Russian gas; and, Poland also

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has the contracts in place to secure itself with US and Qatar for LNG, and for Norwegian gas via the new Baltic Pipe. Hungary has also taken a different political stance to the rest of the EU and stands out as a lone EU member state that has done a deal this August to contract further gas supplies from Gazprom.

The EU would like to see all its states reduce their overall gas demand which is an effective method for reducing the risks from a volatile gas market. However, finding alternative fuels to gas can be very challenging and the transition will take time; so in the meantime companies, governments and regulators are trying to better understand the risks from the global gas market and how best to mitigate against them.

Security of supply analysis normally relies on two factors: the magnitude of a risk and the probability of it occurring. Historically the risk of total interruption of Russian gas was quantified as having a huge magnitude but this was always combined with an extremely low probability. The risk of an interruption to gas transiting Ukraine was considered quite likely, but this was considered greatly mitigated once Nord Stream 1 existed.

These assumptions are clearly no longer any good – Nord Stream 1 has been sabotaged and is unlikely to ever restart, allowing Gazprom to call force majeure on many of its contracts.

In future, stakeholders in the gas market need to assess their risks by keeping a keen eye on where the next threat to gas supplies is likely to arise. The global gas market is connected by LNG, which travels by ship, and this means governments trying to protect their gas supplies need to monitor world events – including, weather and warfare. A long history of reliability is not a reason to discount risks along the supply chain from a particular supplier. Some examples of risks from the LNG market are as follows:

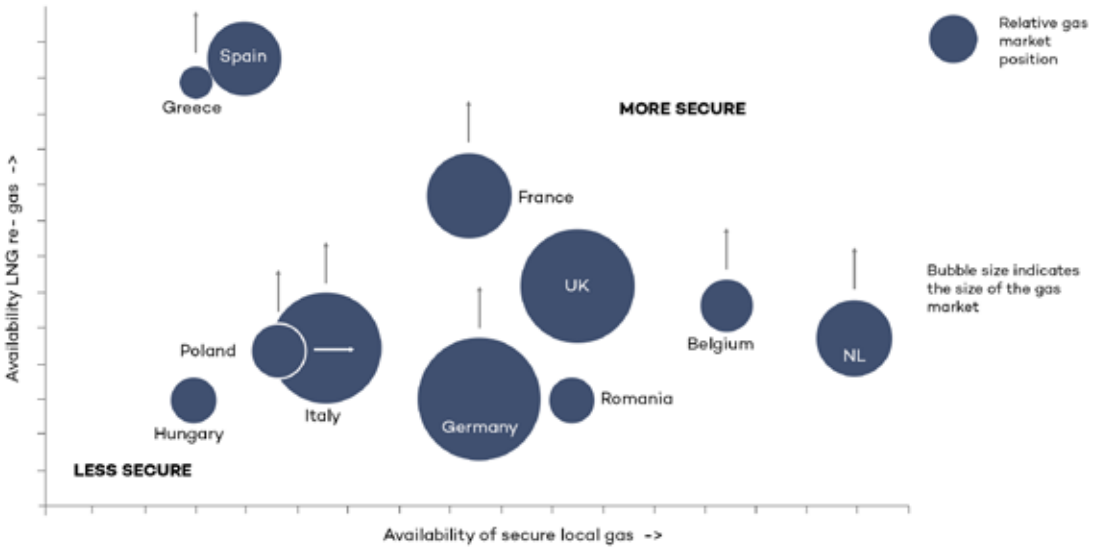
- Qatar has been a reliable LNG supplier, with enormous LNG production capacity, but on route for Europe its ships must pass through the Straits of Hormuz (between Iran and UAE) and the Suez canal – both of which have been liable to political and physical constraints.

- Less significant to Europe is the Panama canal, which acts as a bottle neck to LNG produced on the East Coast of the US travelling into the Pacific. This route has also been the cause of market disturbances.

- The shipping market itself and the charter rates for LNG carriers and FSRUs (floating storage and regasification units – now so desirable in Europe) are highly volatile. It is not unusual for the charter rates to quadruple within a month or two, and not fall back for several months. The northern hemisphere winter is an exceptionally expensive period this year, in a particularly tight market resulting from the removal of so much Russian gas.

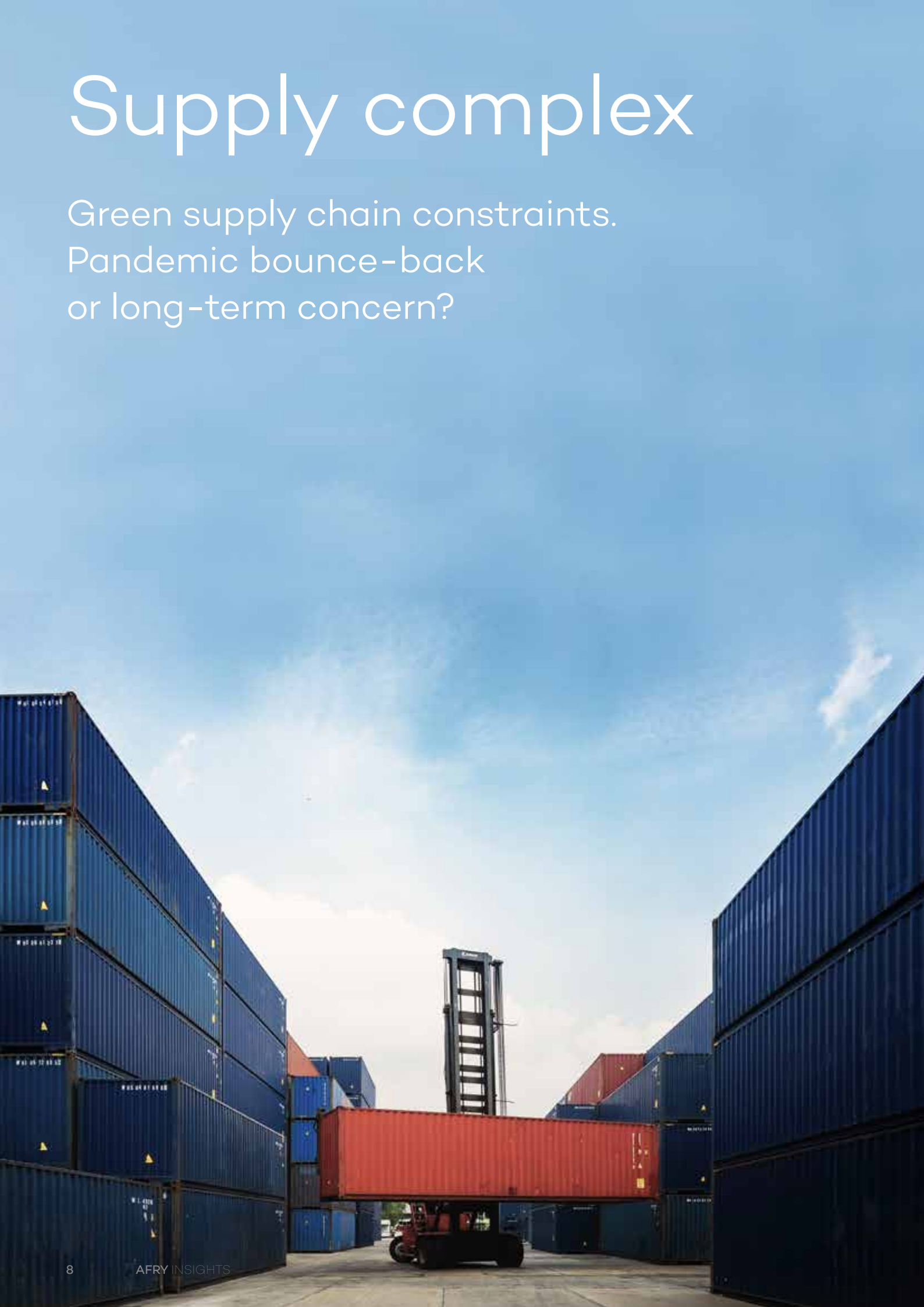
- Another threat could come from LNG demand in other parts of the world – such as Japan and China. The Fukushima disaster in Japan is an example of an unexpected accident leading to high demand for LNG and high prices. China has a huge energy demand and it is hard to predict its preferred source for that energy. Given the sheer scale of China's energy demand and its use of gas in residential heating means the weather in China can have significant impact on global LNG demand.

In future, security of supply analysis should assess mitigations for even seemingly unlikely occurrences and take much closer notice of developing geopolitical situations. Locally sourced energy will be the foundation of secure systems with a diverse range of international sources to spread geopolitical risk. To paraphrase Winston Churchill when he was First Lord of the Admiralty and he was considering the security of oil supplies, "safety and certainty in gas lie in variety and variety alone".



Supply complex

Green supply chain constraints.
Pandemic bounce-back
or long-term concern?



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The effects of Russia's invasion of Ukraine are being felt across the world in terms of growing food and energy insecurity. The interconnected nature of the global gas market through Liquified Natural Gas (LNG) transportation means that when the price goes up in Europe the impacts are felt around the world. And across the world, one response to the crisis is that energy security can be provided through renewable technologies such as wind and solar. We see it in the EU's REPowerEU plan and in Japan's announcements in April (Ukraine war puts Japan's clean energy transition at risk | Financial Times).

At the same time of course gas use will continue and diversification into LNG away from Russian pipeline gas in, e.g. Germany, will bring major investments in fossil fuels in the short-term.

These developments double down on the already large, expected investments in wind, solar, batteries and in hydrogen. In Europe alone, according to AFRY Management Consulting central projections, we can expect increases of 560GW of wind, 670GW of solar, 108GW of batteries and 107GW of electrolysers by 2040. We have seen dramatic falls in the costs of these technologies over the last two decades to take us to a place where, even before the increase in fossil fuels more recently, green electricity was already the cheapest option available.

But as the global economy bounced back from the pandemic, the prices of the minerals and metals required to make these green technologies spiked, with lithium prices, for example, increasing five-fold. Many of these metals and minerals have since reduced in price but remain significantly higher than their prior levels.

In the light of the "weaponisation" of gas by Russia, questions are rightly being asked about where the raw materials for green technology are produced, where the known reserves are located and how we can respond to further supply chain shocks, should they occur.

For wind power, the main concerns are the reliance on rare earth metals, which are mainly produced today in China due to resource location and low processing cost. Copper and zinc are needed in large quantities as well although there is less concern around secure supply of zinc due to its abundance.

China is dominant in the central aspects of the solar PV supply chain – from polysilicon production through to cells, wafers and modules. The raw material silicon itself is relatively abundant.

Lithium, cobalt, nickel and graphite are the key metals and minerals for today's battery production. Lithium is only moderately concentrated in terms of production, but as stated prices have increased dramatically due to a lack of investment in mines in the recent past. Cobalt is produced predominantly in the Democratic Republic of Congo. Globally, around 20% of high-grade nickel, suitable for batteries, is produced in Russia. When it comes to electrolysers, the required metals vary by type of technology but all face different potential future constraints, with nickel and platinum worthy of a particular mention.

There are several different strategic responses that governments and companies can have to concerns over rising prices and availability of key minerals and metals.

1. Diversification of supply – where resources allow, enable an increase in the diversity of production to reduce reliance on potentially unreliable trading partners.

2. Absolute increase in supply levels – work to plan the expansion of facilities with reliable partners. These supply side measures are already overdue. Lead times for new mining facilities are long, at around 10 years on average. Facilitating the development of new mines through fast-tracked permitting and planning will be necessary to avoid the worst increases in price and supply shortages. This will need to be done whilst still maintaining ESG requirements.

3. Diversification in technologies – move to those technologies requiring less scarce metals and minerals through increased R&D funding. As an example, in wind turbine manufacture, moving to a rare-earth-free generator in the drive such as is proposed by GreenSpur. Sodium ion batteries are developing fast which will contain concerns over lithium. Another option considered is moving to the use of more aluminium wiring from copper wiring although this presents its own set of challenges.

4. Enable the re-shoring of production facilities - this is especially needed for solar PV to enable the production of all parts of the supply chain to be carried out locally. Companies involved in the energy transition may consider getting involved further upstream, at least partially, to keep ahead of developments and the competition. Stakes in newer start-up technologies may also pay off.

Many of the locations of the minerals and metals needed for the energy transition are in locations that will be subject to high climate change risk and water stress. This makes it even more imperative that we act quickly. It can be expected that any major transition, such as the one we are embarked upon in energy, will be far from smooth. But with the right foresight, strategy and implementation, the worst of the future disruption can be avoided.

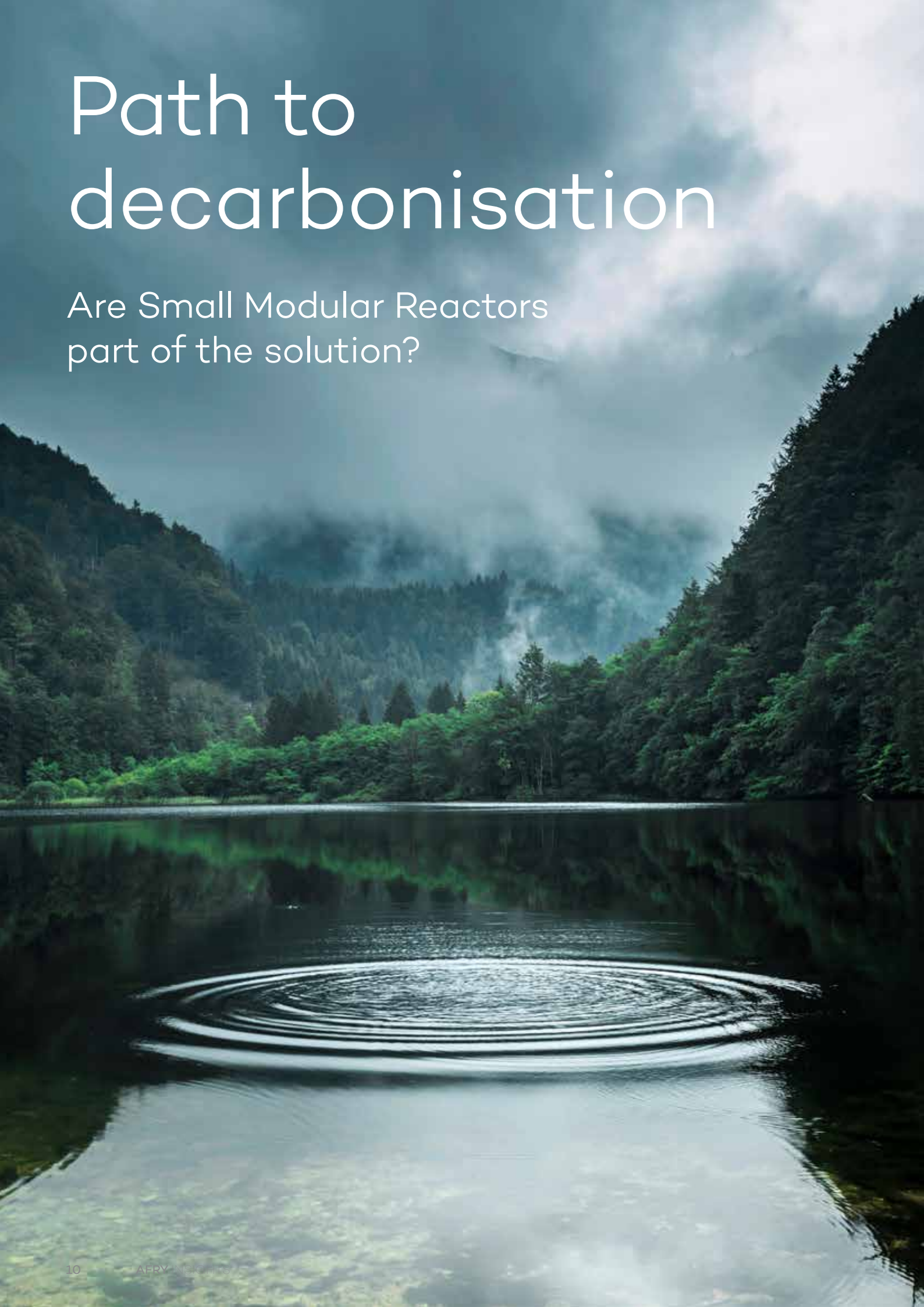
Links:
https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en#repowereu-actions

https://www.greenspur.co.uk

https://ft.com

Path to decarbonisation

Are Small Modular Reactors part of the solution?



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The energy sector is responsible for three-quarters of global emissions therefore 'decarbonising' this segment has become a top priority (20% of energy consumed globally is in the form of electricity – the remaining 80% comes directly from fuels used for heating, transport, industry). The UN targets a 45% reduction in emissions by 2030 and net zero carbon emissions by 2050 to limit rising temperatures, however current projections have emissions increasing 14% by 2030. In addition, the Russia-Ukraine conflict has highlighted the fragility of certain parts of the global energy system and resulted in volatile energy prices. Understandably, when looking for a solution, much focus is on renewables - especially wind and solar - but there are challenges to overcome in order to fully replace fossil fuel power production owing to their intermittent energy output profile depending on prevailing weather conditions. Whilst it is technically possible to overcome this challenge with energy storage and other flexibility measures, a low carbon baseload power will still be required to support a decarbonised grid.

Nuclear energy is the second-largest low-carbon power source, making up 10% of 'green' electricity globally and 40% percent amongst developed nations, however the technology continues to suffer from bad-press, from some quarters, associated with legacy waste, historical accidents involving old designs and concerns over safety.

Conventional (large-scale) nuclear power plants are expensive and time-consuming to build, making financing a challenge – this, along with the concerns and challenges mentioned above are often the reasons why this technology is not more widely deployed.

The nuclear industry has been required to rethink and adapt to the increasing demand for clean energy and to overcome the challenges of its large-scale projects. A new class of reactor is being developed to tackle these issues – the Small Modular Reactor (SMR):

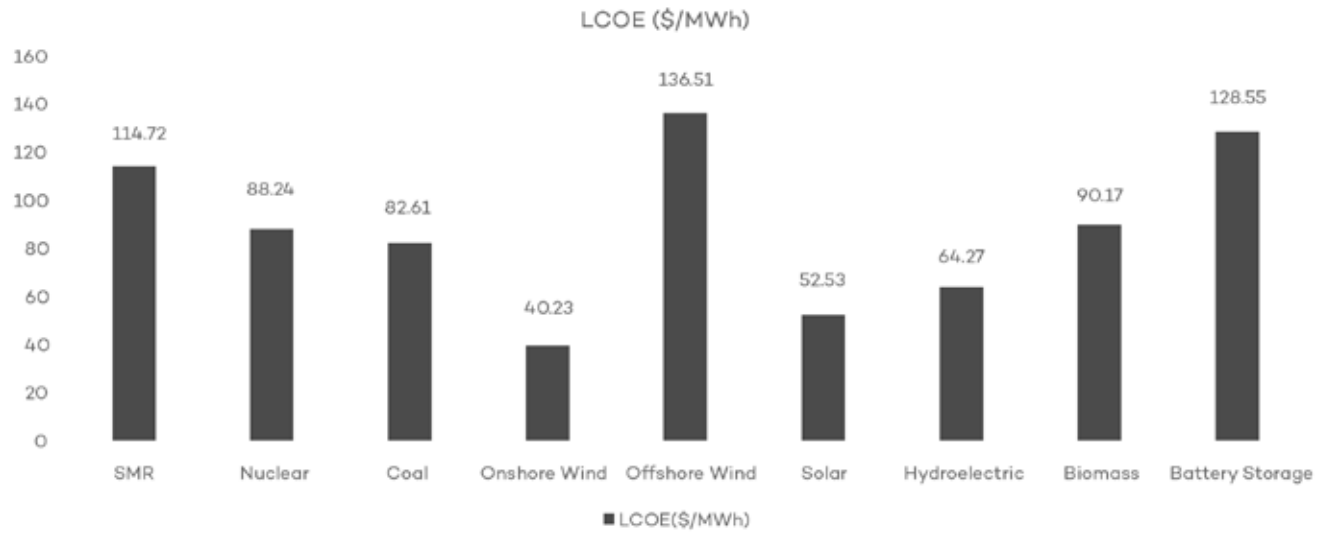
- Small: SMRs are a fraction of the size of a conventional nuclear power reactor (think under one football pitch for the smallest designs and up to 7 football pitches for the largest of the proposed designs), making them versatile for deployment.

- Modular: making it possible for systems and components to be factory-assembled and transported as a unit to a location for installation.

- Reactor: using power-dense fuel to undergo nuclear fission (the splitting of an atom to create energy) to generate energy in the form of electricity or heat.

The smallest SMR "micro-reactors" proposed offer 1MW power whereas larger SMR designs provide up to 440MW, which is approximately one third of a traditional large reactor (An SMR is generally limited to a power output of under 300MW, however some proposed designs exceed this and are still classified as "small"). This variety of designs being developed will provide a flexible solution to decarbonisation across many geographies and market sectors.

As well as providing secure and stable electricity and heat, SMRs can complement the increased deployment of renewable technology. The intermittent nature of wind and solar power requires energy storage solutions or other grid stabilisation and management methods. Nuclear reactors can, within certain limits, match output to demand ("load-following" characteristic) – increasing output during renewable intermittent periods and reducing when renewable production peaks; thus improving the resilience of the overall power system. Depending on the overall plant and auxiliary system design, SMRs can also provide power for hydrogen production and/or desalination which provides additional flexibility and benefit in the drive for wider decarbonisation.



An SMR plant would occupy an area roughly 100 times smaller than a wind or solar farm of the same installed capacity therefore can be located closer to energy demand. This high power-density characteristic of nuclear power can provide particular benefit to remote communities, such as those in Canada and Siberia, who mostly rely on diesel generators for heat and power and where SMRs would help reduce emissions and offer a more economic energy solution. Compact, air-transportable designs fit for this purpose are being developed, with decade-long lifetimes. NASA is even testing a two metre tall SMR for space missions.

Many western vendor programmes have first-of-a-kind units and commercial deployment planned for the late 2020s or early 2030s, however the first commercial SMR is already under construction in China. It should also be noted that SMR type designs are used in military ships and submarines, safely operating under challenging conditions for over 65 years.

There are some challenges still to overcome so the journey from large-scale nuclear to SMRs requires innovative solutions for:

- Construction times for conventional nuclear power plants is on average 7.5 years and total project lifecycles can be over a decade from first concept to commissioning. Delays are notoriously common in large projects and lead to wildly inflated budgets, such as at Hinkley Point C in the United Kingdom – currently delayed by a decade and projected to be £7 billion over budget. SMRs are designed for modular, factory fabrication which eliminates the majority of on-site activity, thus significantly shortening construction times. In addition, the repeatability associated with using the same design for multiple plants reduces risk and minimises delays.

- The 'Levelised Cost Of Energy' (LCOE), usually expressed in $/MWh, is a measure of the average cost to produce energy for a given plant over its lifetime, accounting for all costs. A "one-off" SMR could not match the LCOE of conventional reactors, which follow 'economies of scale' – meaning that bigger reactors are more cost efficient. SMRs instead rely on 'economies of series' whereby costs are driven down by high volume factory production. They could also be built at retired fossil fuel plants to repurpose existing generator and transmission equipment, for further savings, or on decommissioned nuclear sites.

- Safety is always a key priority in any energy project but of particular importance to the nuclear industry. SMRs are able to benefit from passive safety systems which, while also found in modern large-scale reactors, are easier to implement in SMRs because of their size. These are design characteristics and safety systems that do not require external power, monitoring or human intervention to ensure the safe operation and shutdown of the reactor. Some SMR designs rely only on passive safety, eliminating the need for operators. SMRs can also be installed underground, providing additional security against natural disasters and malintent.

- Licensing and regulatory approval of nuclear facilities takes time, however various international initiatives are ongoing to share information between regulators, with the aim of standardising the process where possible. This will facilitate international rollout of designs and increase the benefit from mass modular production.

The innovative SMR designs being proposed, coupled with the knowledge obtained from the last 70 years of nuclear power as well as improved processing and final solutions for nuclear waste, mean nuclear technology can provide a robust contribution to decarbonising the energy and industrial sectors.

With intelligent application and deployment, SMRs can provide low carbon energy as well as support greater and faster rollout of renewable technology in a cost effective manner. So, as various SMR designs are progressed and pass through the required legislative and regulatory processes worldwide, it is now time to rethink and adapt to nuclear being part of the solution.

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We strongly believe that change happens when exceptional people with brave ideas come together.

AFRY Management Consulting works globally to address challenges and opportunities in the energy, bioindustry, infrastructure, industrial and future mobility sectors through:

- Strategic advice
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Asia adapting

Buzzing motorbikes, towering megacities, abundant street food, ancient temples, warm rain – there's no place like Asia. But in the world of energy, Asia is not always so unique. As elsewhere in the world, energy costs have skyrocketed, driven by global forces, with growing pressure to decarbonise and rigid regulations that can limit options.

Businesses and public entities are developing resilience to these challenges by developing new options to meet their energy and sustainability needs. A standard approach is via new physical energy infrastructure. Typical contemporary examples include businesses installing solar rooftop panels (and do not forget energy efficiency!) and utilities expanding grid capacity to support growth in renewables. More innovative examples include the planned "SunCable" transmission line that would create a massive interconnection between Australia and Singapore, expanding the options for both countries (and Indonesia along the way).

Another approach to enhancing resilience is via novel commercial and regulatory mechanisms, whether with regard to existing or new infrastructure. For example, the availability of onsite PPAs and/or net-metering policies make solar rooftop systems more attractive and achievable for end consumers. Implementing novel commercial arrangements (enabled by regulations) in transmission lines can similarly open new opportunities, such as the new PPA enabling power transactions between Laos and Singapore via an existing transmission path through Thailand and Malaysia.

One development with potential to dramatically shift the energy landscape in Asia – as it has also begun to do in other regions of the world – combines physical, commercial, and regulatory angles. A corporate PPA (CPPA) between a generator and an end-use consumer, enabled either directly or indirectly by the local utility and T&D system, is a commercial arrangement that – when enabled by local regulations – can facilitate the physical development of new renewables plants.

Box 1: Taiwan - Asian CPPA trailblazer continuing to present CPPA opportunities

Taiwan was among the first jurisdictions in Asia to allow RE plants to sign PPAs directly with non-utility offtakers. An early attention-grabber was TSMC's agreement with Ørsted's 920-MW Greater Changhua 2b & 4 offshore wind farms.

CPPAs continue to be available in Taiwan and are underpinning some of Taiwan's most recent offshore wind developments. AFRY expects a substantial portion of Taiwan's planned 15 GW of offshore wind in 2026-2035 to be supported by CPPAs.

CPPAs as win-win-win

The availability of CPPAs can benefit the entire electricity value chain. End consumers get a new option to reduce or stabilise energy costs and meet carbon reduction goals (see Box 1).

Developers gain another source of offtake. And governments gain a tool for enabling renewable energy development without needing to foot the bill. Increasingly around the world, corporations are using CPPAs to "green" their electricity supply and their supply chain, while simultaneously providing new renewables plants the revenue certainty to support their financing and construction.

		CPPA availability[1]	Comments
East Asia	Japan		– With the new Feed-in Premium (FiP) (Apr 2022), one option for renewables to earn revenue is via bilateral contracts (CPPAs) with retailers – Renewable Energy Certificates (in Japan called "NFC"s) of Non-FiT (including FiP) renewables can be purchased only through a retailer. To buy NFCs only, the options are non-FiT-NFCs through a retailer via a virtual PPA contract, or FiT-NFCs in auctions
	S. Korea		– Third-party PPA through KEPCO has been available since 2021 but few contracts signed; direct PPA to start Sep 2022 – Main barrier cited for low interest is the high cost of associated transaction and wheeling fees
	Taiwan		– CPPAs available with clear rules; participants include high profile off-takers such as TSMC (see Box 1) – Mandatory bundled REC purchase is also introduced for large industrial customers
Southeast Asia	Indonesia		– Regulatory changes now allow limited third-party retail participation within commercial and industrial estates – Subsidies for commercial and industrial customers challenge any value proposition for CPPAs
	Malaysia		– Permitting CPPAs had been proposed as part of enabling retail full competition by 2029, but this is now in doubt – A recently established green certificate market allows prospective off-takers to access emissions abatement
	Philippines		– Competitive retail market allows end-users with >500 kW demand to enter into PPAs through suppliers – Green-energy option programme in 2022 enabled >100 KW end-users to procure renewables through suppliers
	Singapore		– Corporate PPAs available as a bundled electricity and REC product, but must be purchased through a retailer – Due to very limited renewable potential in Singapore; the long-term demand for CPPAs is likely to well exceed supply
	Thailand		– Currently no opportunity for purchasing energy directly from renewable sites; however, "green tariff" essentially enabling this is being contemplated – Only Private PPA model: owners of solar rooftop projects can supply electricity to facility where project is located ('behind-the-meter')
	Vietnam		– A 1-GW pilot scheme ("DPPA") is being rolled out, executed via CfD contract – The limit on capacity is due to EVN's concern on current grid stability

[1] As of Sept 2022


Relatively strong and accessible enabling scheme(s)


Relatively weak or inaccessible enabling scheme(s)


Scheme(s) paused or actively in development

Rapid growth ahead

CPPA availability in Asia has generally lagged relative to other regions such as Europe and the US. However, CPPAs are already available in some jurisdictions in Asia, and enabling programs and regulations are being developed in others.

In Taiwan, Japan, and South Korea, it is already possible to execute a CPPA in at least some form – although the requirements and mechanics are substantially different in each case. Vietnam is actively developing a CPPA program (called "Direct" PPA), with a 1-GW pilot expected to be launched in the coming months.

A summary of CPPA availability across selected countries in Asia is presented in Box 2. AFRY expects CPPAs to become increasingly available in Asia as regulatory and commercial constructs become tested and increasingly standardised.

New considerations for end consumers

The essential benefits of CPPAs for end consumers are clear: a potential electricity source that is cheaper, more stable, and cleaner. However, realising the benefits requires levelling up in some key areas.

– Procurement teams.
For many end consumers, and especially in many Asian countries where retail service is provided by integrated utilities, electricity procurement is limited to paying monthly electricity bills from the local electric utility. Soliciting CPPA bids, evaluating offers, and negotiating contracts in the context of electricity purchasing requires additional levels of expertise and sophistication.

– Energy economics and regulatory evolution.
Particularly when evaluating offers, it is critical to understand how retail tariffs and relevant fees such as "wheeling fees" will evolve – and possibly interact with the CPPA – in the future.

New considerations for developers
While CPPAs present developers with additional and potentially more-lucrative offtake options, maximising benefits from this new route to market similarly requires some additional capabilities.

- Marketing and sales.
  Finding a CPPA offtaker will require outreach to multiple candidates; and developing mutual trust will be particularly important when striking a deal with a newly available type of agreement.

- Assessing creditworthiness.
  The creditworthiness of the local utility offtaker can often be assumed to be strong, but now the creditworthiness of each potential CPPA offtaker must be vetted.

- Ensure product sufficiency.
  Depending on the local regulations, in particular settlement granularity, it may be necessary to consider the details of how a plant's output will meet the offtaker's need. For a CPPA between a solar plant and an industrial factory, does it matter when the solar plant is (or is not) generating electricity?

Seizing the opportunity
In this era of rising, volatile energy prices and increasing pressure to decarbonise, corporations and states are looking for new options to secure clean, low cost electricity. While regulations can sometimes interfere with these goals, other regulations, critically those enabling CPPAs, can create new options and bring benefits to much of the electricity value chain. Realising these benefits requires doing some things differently or in more sophisticated ways. Those who successfully navigate these requirements can position themselves well in the energy world of today and tomorrow.

AFRY Management Consulting is pleased to be serving our clients in Asia from our offices in Bangkok, Beijing, Hanoi, Jakarta, Manila, Pune and Shanghai.

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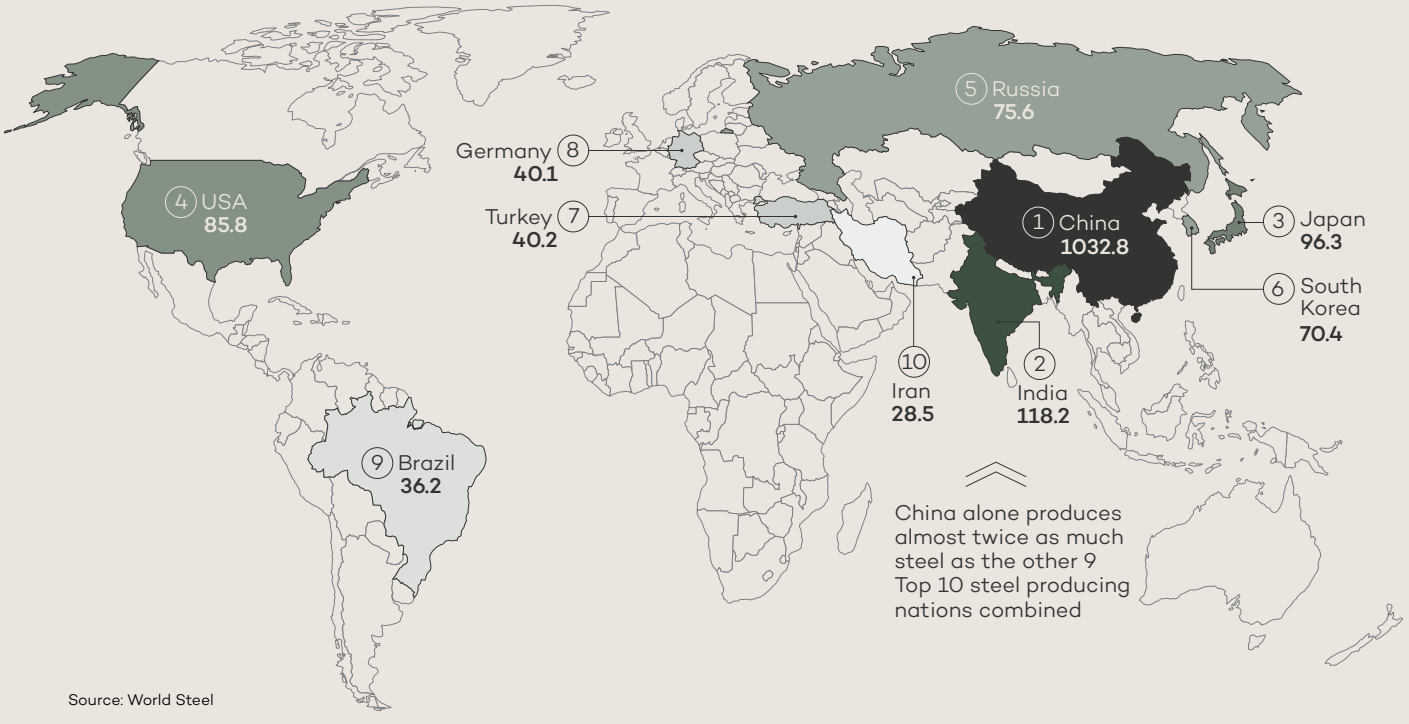
The green steel revolution.

Source: WRI 2022

Leading global crude steel production.

In 2021, global crude steel production reached **1951 million tonnes (Mt)**. Here are the top ten largest steel producing nations in the world:



Source: World Steel

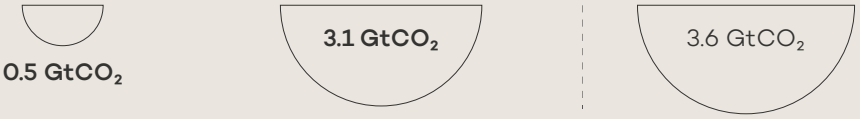
All over the world, steel is mainly produced using two methods:

Electric arc furnace (EAF)
Utilising scrap

Blast furnace basic oxygen furnace (BF-BOF) production
Utilising coke, scrap and iron ore

Global Steel Industry CO_2 Emissions

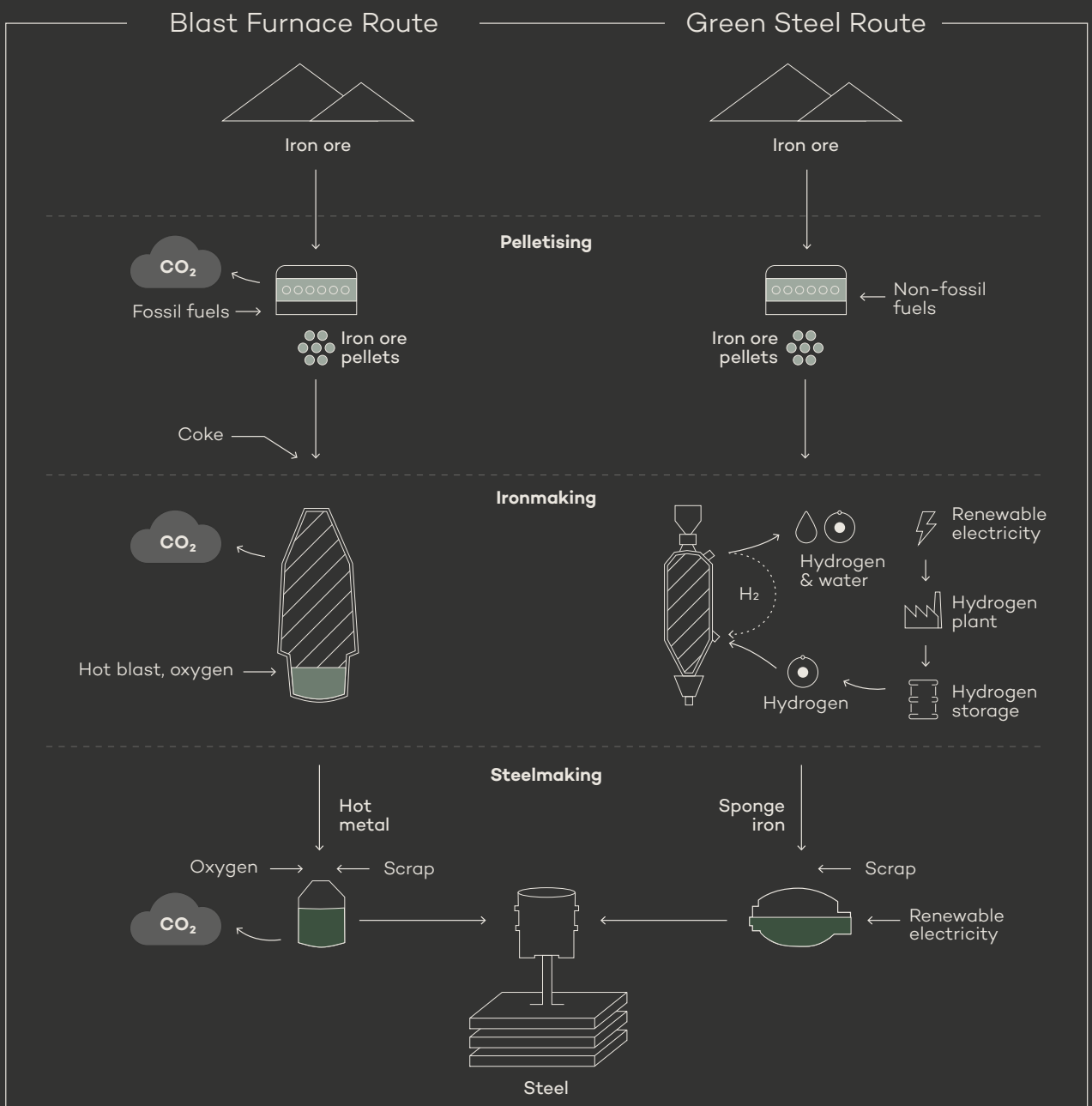
CO_2 EMISSIONS BY METHOD (2019)



One way for the steel industry to decarbonise is through the replacement of fossil fuels in the process.

Decarbonising steel

Traditionally, steel is made from iron ore with coke - a fossil fuel - in a blast-furnace at high temperatures. Decarbonising steel requires new methods of production. Conversely, green steel uses **green hydrogen that is produced from renewable energy and water.**



By adopting new processes to produce steel, fossil fuels can be removed from the process and significantly reduce CO_2 emissions.

Energy Capacity and Green Hydrogen Required for Steel Production

	ANNUAL STEEL PRODUCTION	= GREEN HYDROGEN REQUIRED	+ ELECTROLYSER CAPACITY REQUIRED (GW)	+ RENEWABLES CAPACITY REQUIRED (GW)	EQUIVALENT RES CAPACITY (2021)
Base reference	1 MT	50,000 T	0.56	0.7	
Global	1951 MT	97,550,000 T	1,097	1,371	45%

Source: AFRY Analysis, IRENA

On the fast track

Are current events accelerating the energy transition towards net zero?

The current invasion of Ukraine by Russia has clearly shown Europe the shortcomings of the last few years, during which the strong dependence on gas imports from Russia was not taken into account. As a result, current EU policy makers are envisaging a strong acceleration of the energy transition, with a view to reduce dependency on fossil imports by significantly increasing renewable capacities.

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Even elsewhere in the world the current high gas prices push policy makers towards technologies not impacted by the fossil fuel price increases. The other side of the story is the expectation that power generation by coal-fired power plants will reach record highs by the end of this year, which will cause very high emissions overall. While economics for renewables have significantly increased amid current high power prices, as the willingness to pay for clean energy has never been higher on the corporate side, the expected strong acceleration in the short term is currently slowed down by supply chain issues and lacking work force.

Short term drawbacks
The rebound in demand after Covid and the steep increase in prices for natural gas led to the expectation that global coal deployment in 2022 will in all likelihood match the annual record set in 2013, and that coal demand will increase even further next year to a new all time high. This is bad news for the planet and leads to a significant setback in progress towards the goal of climate neutrality. Emissions have to be seen as cumulative and not year by year, unfortunately, making the need to decrease future emissions even more inevitable. This remains a risk at least in the short- to mid-term as the renewables sector fights with supply chain issues and potential work force shortages. This is currently leading to a delay in expansion of renewables due to unavailability of parts as well as increased costs.

Improved regulations
Over the past months, policy makers have picked up the pace with multiple initiatives being promoted, such as the proposed Inflation Reduction Act in the US, the Energy Security Strategy in the UK and the EEG 2023 in Germany. The latter is targeting an increase in today's RES capacities in Germany by a total of 230 GW by 2030 and 480 GW by 2040, mainly driven by solar, quintupling todays capacities.

The European Commission has also not missed out on the recent developments by publishing RePowerEU, which forms the latest EU energy strategy with the overall target to reduce dependency on Russian gas and increase the rate of clean energy expansion. The main pillars of the strategy are decreasing approval times for clean energy projects to one year, while quintupling the rate of investment in clean energy by 2030 aims to more than triple the installed base of clean power by 2030.

This means that the pace of new RES installation is set to be significantly accelerated across Europe, but only if national targets are adjusted to implement the EU goals.

Improved market conditions
In general, the economics of renewables have drastically improved over the last few months with record high power prices allowing renewables traders to negotiate higher PPA rates or sell power at record high prices through the energy exchanges. Due to the current European power market design, technologies such as renewables and nuclear that are not impacted by current rising fuel prices are set to earn record windfall profits. As it is unclear when power prices will normalise again, bringing the asset online as soon as possible is one of the highest priorities for the players in the market in order to have strong negotiation power to reflect current high prices in the long term PPA price.

From the perspective of corporates, the current alternative is to buy power from the exchange, which shows prices that are currently up by around 700% compared to a normal year. For example, the German 2023 contract was traded at around EUR 50 / MWh in the beginning of 2021 and is currently traded at over EUR 370 / MWh. It is in the interest of the corporates to be able to stretch these costs over a longer period of time. AFRY's PPA benchmark therefore currently shows 10-year PPA prices to be traded south of EUR 100 / MWh, leading to a current win-win situation for both sides: for RES developers and operators, who can secure financing due to long term commitments with very high IRR expectations, while corporates are able to spread out their costs over a longer period of time. This is reflected in this year's CPPAs closed deals numbers, which have been the highest across the past years while utility PPAs are on decline.

What will be the back up technology?
An energy system with a high share of renewables will need a tonne of flexibility on both sides, demand and generation. While demand side flexibility is due to come significantly from sector coupling, generation flexibility has become a mystery amid recent developments. Before Russia's invasion, most countries planned to increase their gas-fired capacities in order to secure enough flexibility to ensure supply security even in hours when the sun is not shining and the wind is not blowing. The question is now: Who is currently still investing in gas-fired power plants? The answer is predictably that it is not happening much. Currently roughly 10GW of new gas-fired power plants are planned, with AFRY's Central Scenario showing the need for around 55GW of additional gas capacity by 2030. What can fill the gap if this target is not met? Well, it is likely that planned coal phase outs, most prominently by Germany, will not be solvable. The only suitable long term solution seems to be hydrogen fired power plants. To improve this, the EU plans to invest around EUR 200 million in hydrogen projects. However policy makers will need to act swiftly as this is quite an infrastructural task.

There is light at the end of the tunnel
There is hope that once the supply chain issues are resolved, there will be no obstacles to a strong expansion of clean energy projects. Popular acceptance of renewable energies has never been higher, as current high energy bills make it painfully clear to everyone that relying heavily on fossils exposes the power sector to extreme price shocks. Even with power prices reverting back to a more normal level, the need for clean energy through PPAs will remain high as the fear of potential future price shocks will further increase demand for long term price certainty amongst corporates. This, combined with strong regulatory support, will hopefully be enough to make up for the increased emissions that seem inevitable over the next few years.

Interview
Lisen Oliw
Managing Director Nordics,
Norrsken Foundation

Masterminds

What if the world's biggest problems could be solved by entrepreneurs, by individuals and their ideas? Wouldn't it make sense to support them? The Norrsken Foundation does just that and, with the help of AFRY, supports entrepreneurs whose business ideas can change our world for the better. Lisen Oliw, Managing Director Nordics, explains how this works in concrete terms and why the foundation is now opening its third hub in Barcelona after Stockholm and Kigali.

AFRY Insights: Many people have an idea of how a foundation works, but maybe you could first explain about Norrsken goals and how exactly you work.

Lisen Oliw: Norrsken Foundation is in the business of proving that impact and profit can go hand in hand. In other words, that it's possible to build successful, fast-growing and profitable companies, whilst also making the world a better place. The idea is very simple, but to me it's mind blowing. These two objectives did not always seem compatible in the past, and a lot of people still question whether they are. However, since Norrsken was founded six years ago by Niklas Adalberth, previously one of the co-founders of Klarna, a lot of things have changed. There is a common understanding today that we need innovative solutions to solve some of the great challenges we face as

a planet - climate change and the green energy transition are probably the two most obvious examples. At Norrsken, we simply believe that entrepreneurs represent our best bet at achieving that.

Why do you at the Foundation see entrepreneurs as key to solving the most urgent problems of our time?

I think it's very simple. It's because we are in a hurry. We don't have time for lengthy decision-making processes or political initiatives that cannot stand alone or scale. Entrepreneurs are by their very nature fast-moving and adaptable - it's exactly what we need in order to keep pace. Here it's important to bear in mind that most member companies at Norrsken House in Stockholm are still very young. Their teams are an average of three to six people strong, and as an early-stage startup, life can be hard. That's where Norrsken comes in.

Take for example Plexigrid, who are reinventing the energy grid, or Flower, who are using AI to make electricity available when needed or Rebase, who are creating energy models to optimise distributed energy systems.

The Foundation built its first base in Stockholm and its second in Kigali. Why did you choose these two locations in particular to build Norrsken House impact hubs?

Stockholm was a natural starting point for us - that's where most of the team is from and it was Niklas' home town. In addition, we've had tremendous support from the city, and recently Stockholm has started to emerge as somewhat of a global hub for impact entrepreneurship. It makes perfect sense for us as a base for our operations.

Kigali, on the other hand, was a strategic decision. East Africa is on the rise and the region's economy is growing very fast. Most of the macro trends are clearly pointing in the same direction - Africa is on the cusp of a digital transformation, very similar to what most countries in the west have already experienced, and just like in the US, Europe and Asia most innovations will likely be driven by entrepreneurs.

Kigali is well positioned to grow into an important hub for the region: the city has a young and fast-growing population, it is comparatively stable, has a very business-friendly climate and a well-developed infrastructure. That makes it easy for foreign investors to make Rwanda their first point of entry into Africa. If we at Norrsken can repeat what we have managed to do in Stockholm, to simply support entrepreneurship and grow the startup ecosystem, we believe this can be very impactful, because it has the potential to drive massive, sustainable economic growth across the entire region. This, coupled with the hope that we may inspire entrepreneurship at large in east Africa, has the potential to positively impact the lives of millions of people.

Norrsken recently opened its third location, in Barcelona. Congratulations on the opening and why Barcelona?

Barcelona has a small but rapidly developing startup ecosystem. It's also a very desirable city to live and work from. It's not one of the leading startup hubs in Europe yet, but we think it's very well positioned to grow into one. We want to help enable that journey, and at the same time try to shift the focus more towards impact entrepreneurship. Coupled with the fact that we found a great local partner in Thomas Meyer, founder of Desigual, and an absolutely stunning beachfront property to work with, it seemed like too good of an opportunity to pass up. Our vision for Barcelona goes way beyond the south of Spain, however. We want Norrsken House in Barcelona to become Europe's biggest hub for impact and tech, and act as an epicenter for impact entrepreneurs and investors from across Europe.

The Elevate initiative is one of the many interfaces that links Norrsken with AFRY. What is important to you about the initiative and why are partner companies so important to you?

The idea with Elevate is to build an advisory matching platform, in some ways similar to a dating app, where start-ups can connect with those wishing to contribute pro bono advice and support. This is only made possible thanks to the willingness of you at AFRY, as well as our three other partners, to provide expert advice and support for the founders on the platform.

It's not about lengthy commitments, for your employees it's usually just one hour of their time. But just one hour spent with an experienced subject-matter expert can be enormously valuable. Regardless of whether the topics discussed are emissions outside the company's own value chain like for our house member Gokind or a comparison of the Swedish and Finnish logistics markets for Creative Optimization. One hour spent with an AFRY expert can really help level up the business cases of our members. And that's incredible to see.

Decade of action

Climate risks can no longer be ignored. The latest report from the UN's Intergovernmental Panel on Climate Change issued a strong warning that current action is causing irreversible damage, and that significant investments are needed to mitigate the crisis. This stresses the need for urgent technological and financial reform, as well as business re-engineering.

A global net zero scenario would require transformational changes across all business sectors, the energy ecosystem and the global economy.

Emission reductions and the transformation of current energy systems require annual investments in the magnitude of 1 to 1.5% of global GDP annually. The IPCC, in its 1.5°C Report, estimates that by 2035, 2.5% of the global GDP will have to be devoted annually to sustainable energy related investments, of which more than a third will constitute additional net investment needs.

Therefore, business must reduce greenhouse gas (GHG) emissions wherever possible. Part of the global challenge is defining responsibility for the generation of GHGs. The level of influence and control each company has over emissions through the value chain is divided into three scopes.

While we have long seen a wide range of concrete actions in business for owned and controllable emissions (known as Scope 1 & 2 emissions), less attention has been paid to reducing the so called Scope 3 emissions along the whole value chain. Despite the challenges of addressing indirect emissions, Scope 3 does not only have a huge potential to prevent the worst impacts of climate change, but it can also lead to substantial business benefits, new partnerships, innovations and revenue growth.

Transformational change needed

Together, energy generation and use account for about 75% of global GHG emissions, including both the sectors' own emissions (Scope 1 & 2) and downstream in the value chain (Scope 3).
However, the direct responsibility – as reflected in Scope 1 & 2 reporting – accounts for a relatively low share of 1/3 of total emissions.

Hence, most businesses do not have insight into the magnitude and nature of their Scope 3 emissions. Governments have a key role to play in implementing standards, regulations and incentives to support decarbonisation of Scope 3 emissions. This is happening both in the US and the EU. In parallel, companies working to reduce Scope 3 emissions can mitigate risks within their value chains, unlock new innovations and collaborations, and respond to mounting pressure from investors, customers, and civil society.

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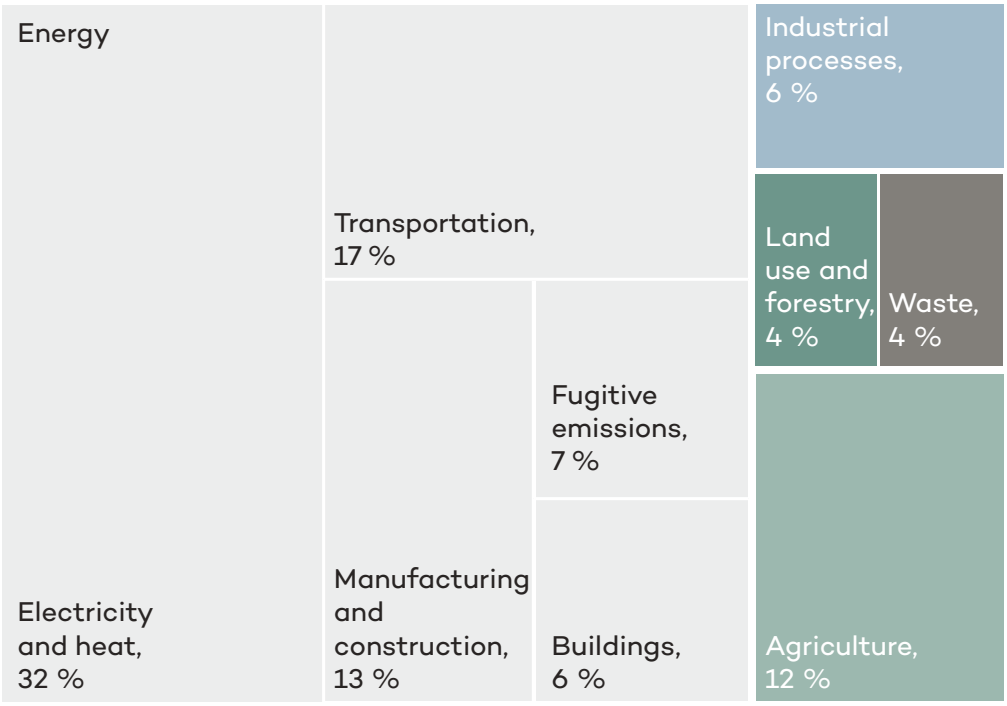
Key areas of action
Companies that are successful in building new coalitions and partnerships, with a shared ambition to reduce emissions, reinvent business models and innovate new products and services, will be better positioned to capture future growth.

Efforts on multiple fronts can create a virtuous cycle where every company actively works to reduce emissions in their value chain while simultaneously benefitting from the efforts of other companies. This also creates more robust data to base targets and performance tracking on and helps to create new innovative solutions built upon a value chain system's perspective.

Business model innovation
Companies can shift to or create new innovative business models to substantially reduce their Scope 3 emissions. Reconsidering what the company can offer and how it can be offered at a systematic level, can help it meet marketplace demands and generate revenue in new ways while reducing emissions across the value chain.

Supply Chain	Business operations	Customer usage
Scope 3 - upstream emissions	**Scope 1 & 2 – inside company**	**Scope 3 – downstream activities**
Transportation / freight	Own vehicles and fleet	Transportation / freight
Business travel Production of goods and services	Buildings - consumption of fossil fuel and electricity	Customer travel Use of sold products and services
Capital assets (buildings, vehicles, computers etc)		End-of-life of sold products and waste produced

Global CO_2 emissions by sector



Emissions performance can also be assigned a monetary value by putting an internal price on carbon that covers Scope 3 emissions. A carbon price can also be used to collect fees that can then be reinvested in new low carbon activities, products and services. A price on carbon can cover both upstream and downstream emissions. It can also financially quantify the environmental performance of products or services relative to those of a company's competitors.

According to CDP, in 2017 nearly 1,400 companies were already factoring an internal carbon price into their business plans. This includes over 100 Fortune 500 companies with annual revenues of approximately USD 7 trillion.

Circular business models
Creating successful and profitable business models that reduce the promotion of unnecessary consumerism, and decrease material demand, are much needed. Product service systems, for example, provide services as well as products for collaborative consumption with the intention of reducing environmental impact.

Redefining the way we think about product ownership by sharing eliminates the aforementioned emissions associated with new products. Belongings can remain idle for long periods of time, e.g. the average European car is in use only for 2% of its lifetime.

New technologies as change enablers
"Fourth Wave" technologies such as data analytics, smart sensors and blockchain will help companies manage their Scope 3 impacts by offering powerful insight into complex global value chains and will help reduce emissions in new ways. These technologies are playing an increasingly important role in business innovation, and business executives agree that implementing new technologies will not only improve their company's environmental footprint, but also its bottom line.

From product to service
Among the most powerful tools for a company to mitigate its Scope 3 emissions is to focus on lowering lifecycle GHG emissions already during the design of products and services. The design process can play a crucial role in defining the range of reductions in GHG intensity that can be achieved.

If a product is designed to be manufactured using a specific material, the possibilities to lower embodied GHG emissions and processing emissions, the range of options for upstream and downstream logistics, the optimum possible use phase efficiency, and the feasible end of life treatments are all invariably determined by the design choice.

A circular economy approach can achieve large improvements in environmental performance by redesigning systems and business models to simultaneously reduce upstream and downstream emissions. According to Material Economics estimates, a circular economy could reduce up to 3.6 billion tonnes CO_2 in heavy industry per year globally.

Engagement
An important lever for reducing downstream emissions is customer engagement. There are several different approaches a company may take to deliver such an intervention. Successful businesses partner up with clients and are working together to reduce emissions through innovation of new products and services. Engaging consumers and helping them understand how to reduce energy usage and individual carbon footprints are also becoming more frequent.

Many businesses invest in low-carbon projects and companies as well as in resilient development, such as transformational, interconnected technologies and solutions to support their pathway to net zero; renewable energy, carbon storage/CCS, clean hydrogen and battery storage.

The challenge ahead
The world's population is estimated to reach 10 billion by 2050. 68% are expected to live in urban areas, and the growing population will expect to see improved standards of living. It is not difficult to understand that a larger and more affluent population will want to consume more, putting increasing pressure on scarce resources like land, water and energy.

COP27, the annual UN climate conference, is taking place in Sharm el-Sheikh, Egypt on 6-18 November 2022. The conference represents what is likely to be the final opportunity to take global collective action on the climate crisis and achieve net zero emissions across the economy, in line with the Paris Agreement.

To mitigate and adapt to climate change, and provide livable conditions for the global population, governments and companies must lead the way. Reducing Scope 3 emissions and partnering up with both suppliers and customers is critical activity for all businesses leaders who aim at managing responsibly and at the same time create societal value.

Now is the time to act.

Interview
Luca Maria Rossi,
Vice President,
New Frontiers
at Baker Hughes

Intelligent investment

When it comes to discovering and expanding boundaries at Baker Hughes, Luca Maria Rossi is a change agent at the company. A conversation about investing and accelerating the commercialisation of breakthrough decarbonisation technologies.

The current geopolitical situation is claiming lives daily and keeping the world on tenterhooks. From an economic point of view, the energy sector is the main focus in the midst of a crisis whose extent and duration are not yet foreseeable. How does this situation affect Baker Hughes and how are you dealing with it?

Luca Maria Rossi: The global energy sector is changing faster than ever before. At Baker Hughes, our goal is to strike a balance between energy security, sustainability and affordable energy. We're improving our core competitiveness while simultaneously venturing into new territories to create a more diversified portfolio that can span across industrial businesses.

My team here at New Frontiers within Baker Hughes is the group venturing into those new territories, making strategic bets on early-stage companies with innovative

technologies that can be scaled across a variety of sectors. We make equity investments in a range of clean technology start-ups and companies offering hardware, software, and services targeting climate technology solutions, industrial asset management, geothermal and other clean technologies.

One example is through our investment in Mosaic Materials' Direct Air Capture (DAC) technology that features high-capacity and high-selectivity for capturing CO2 in a proprietary metal-organic framework (MOF). This is really interesting technology, as it enables decarbonisation beyond the energy sector into adjacent industries. The importance of solving for such interdependencies between industries has become even more apparent in the current global situation.

Baker Hughes has already made its Net Zero Commitment in 2019 and announced an objective to halve its greenhouse gas emissions by 2030 and to be carbon neutral by 2050. How is this sustainability thinking reflected in your daily work and how will you ensure the success of your sustainability strategy by 2030 and 2050?

Baker Hughes is one of the leaders in sustainability reporting in the energy sector. Our roadmap to reduce our Scope 1 and 2 emissions from our operations to net zero by 2050 will be realised through reduction of operational energy use, increasing the proportion of renewable energy used, and by increasing electrification of our vehicle fleet, and we're well positioned to achieve these goals. We've expanded our Scope 3 emissions reporting to understand the full lifecycle emissions of our company. Of the 15 categories that fall under Scope 3 GHG protocol, we measure and report 11 of them.

Our company strategy is underpinned by our sustainability framework, and in line with this our Board's oversight responsibilities require ongoing, in-depth consideration of economic, social, and environmental risks and opportunities. For our investment in Ekona Power, which produces a solid carbon by-product, we implemented extensive reviews for the health, safety and environmental impacts to the market. Similarly, the New Frontiers team includes an ESG review for all our investments to help ensure they will be sustainable into the future.

How is Baker Hughes helping clients and companies achieve their net zero emissions goals?

In the short term, regular engagement with key stakeholders is crucial to shaping the direction and priorities that will help our customers achieve their net zero emissions goals. We gain insights from peers, customers, governments and academia to help inform our work. We've established knowledge sharing networks for more informed and effective decision making and strategic planning and we've done a tremendous amount of work to ensure our partner organisations are aligned with our corporate purpose in net zero goals.

We're investing in technologies that help our existing oil and gas customers manage their emissions and explore further development in CCUS and geothermal technologies. We'll also leverage Baker Hughes' global manufacturing and supply chains that are already making great strides in decarbonising their footprint. Influencing an even broader set of ecosystem partners and customers only further develops our efforts.

What sectors are you are focussing your effort on in order to identify the technology that will drive the energy transition globally and what key technology developments have you identified in the energy space?

The New Frontiers team is looking at innovative technologies that will continue to mature independently while supporting Baker Hughes' core business offering and customer base. As of today, our focus areas are around CCUS, Hydrogen, Energy Storage and the emerging areas that will help us accelerate our offering. For CCUS, our focus is on improving the economic viability of projects at scale and applying our core technologies across other industrial sectors.

We're also looking at emerging areas we aren't currently operating in where we know our global size can help scale up the technologies faster. We've recently invested in Silbat, a long duration energy storage solution that is for power but also for industrial heat applications. We're also looking at more localised solutions like our investment in Exergo, which is a heating solution provider. And finally, Levidian, a graphene production technology for specialty products and bulk construction materials.

The main topics of the current magazine are resilience, intelligence and excellence. How do you ensure these qualities in your company and how do you promote them among your customers?

The team here at New Frontiers believes that changes in regulatory environments driven by climate change will create long term and material advantages for efficient clean energy businesses. We believe these regulatory changes will create massive opportunities at scale in the climate technology sectors enabled by digital offerings that drive asset performance. To accelerate the growth of these technologies, our portfolio companies are given a platform to independently grow, with access to world-class resources and expertise.

But even with the backing of a huge energy technology conglomerate such as Baker Hughes that has industry experts around the world, we're still fully aware this is a changing landscape and success won't come overnight. Our teams need to remain agile and resilient through the process. With every investment, we're learning something new from our portfolio companies and they are learning from us. The mutual exchange of knowledge and expertise is something we hope to continue to build on in years to come.

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Innovation is key

Is the shift from plentifulness to limited resources opening the door for circular economy?

The energy crisis and the endangerment of the supply of critical raw materials caused by Russia's invasion of Ukraine has radically opened our eyes to the fact that our wellbeing can no longer be based on fossil fuels and overconsumption. Have we finally, truly started the journey towards a society that operates within the limits of the Earth's carrying capacity?

In 2022, Earth Overshoot Day was on the 28th of July, the date by which we had already used all the biological resources that Earth regenerates during the entire year. Thus, we need not only behavioural changes but also sustainable solutions and new innovations throughout the whole value network to accelerate the transition to sustainable consumption.

The world is suffering simultaneously from the climate crisis, dwindling of natural resources, pollution, and biodiversity loss. The transition to a more sustainable society is complex, and, for example, carbon dioxide emissions are proportionately connected to material usage: 70% of all global greenhouse gas emissions are related to material handling and use, while 50% of total greenhouse gas emissions and 90% of biodiversity loss and water stress are due to the extraction and processing of resources. These interlinked threats mean both risks and opportunities to businesses. Companies need to radically transform the use of raw materials to be able to cut emissions and stay competitive at the same time.

As global supply chains are broken, there are raw-material shortages and the prices of materials and their transportation costs have become increasingly higher. Businesses are forced to look for opportunities closer to home. The increasing need for sustainable business operations in all industries has also been accelerated by the tightening regulatory and stakeholder demand. For example, the European Union's regulations and policies play a remarkable role for unifying the legislation and creating common actions and guidelines (such as The European Green deal, EU Taxonomy, Plastics Strategy, Textiles Strategy, Industrial Strategy, Zero pollution action plan, and The Waste Framework Directive).

During the pandemic and the war, consumers also experienced in concrete terms what it means when global supply chains no longer work as they used to, and what the future could hold for us with limited goods and services.

Holistic mindset required
More and more holistic thinking is taking place and innovative solutions are emerging, but there is no silver bullet to solve these complex matters in a simple way. In our current linear economic model we mine raw materials that we process into a products, which are thrown into landfill. The problems in the linear economy and production models have been widely identified, but there are a lot of challenges in changing the existing practices towards a more sustainable way of operating. However, the pressing global challenges are driving us to find alternative solutions, and challenging traditional way of thinking.

Circular economy is a crucial way to tackle the raw material crisis. It is based on three principles:

- Eliminate waste and pollution,
- Circulate products and materials (at their highest value), and
- Regenerate nature.

Reducing our reliance on scarce resources increases our economic resilience, and building a circular economy can offer a $4.5 trillion economic opportunity by avoiding waste, making businesses more efficient, and creating new employment opportunities. Circular economy has gained widespread visibility and attention around the world, however its implementation still requires new practices such as new business models, industrial ecosystems, and new types of raw materials, among others.
Circular business models can contribute to product life extension (through eco design, design for disassembly, repair, maintenance, upgrading, resale or remanufacturing), product as a service (client pays for service, function, performance or result), sharing platforms (leasing, sharing, swapping and reusing), resource recovery (upcycling or recycling of resources) and circular supplies (using recycled / renewable raw materials or energy, redesigning products and supporting operations).

An industrial ecosystem or a circular ecosystem is a network of companies or players from diverse sectors that cooperate and share synergies e.g. for an effort to promote the valorisation of waste, improvement of resource efficiency or reduction of environmental impact. New biobased or recycled materials are needed to replace synthetic, unsustainable materials, or to generate new functional, added value products for the needs of a growing global population.

Solving the crisis with innovation
Pioneering companies and practitioners are already offering alternative solutions and materials, and new game changing innovations are constantly being developed in almost all industrial sectors.

The textile industry, a good example of a systemic challenge, is estimated to produce 10% of global greenhouse gas emissions, but also to have a massive impact on the use of water, on spreading microplastics in the water, and sending textile waste to landfills. There are companies such as Infinited Fiber, which is working on recapturing the value contained in waste by regenerating it as a new and versatile textile fibre. Its technology turns cellulose based raw materials, like cotton rich textile waste, into a premium quality regenerated textile fiber.

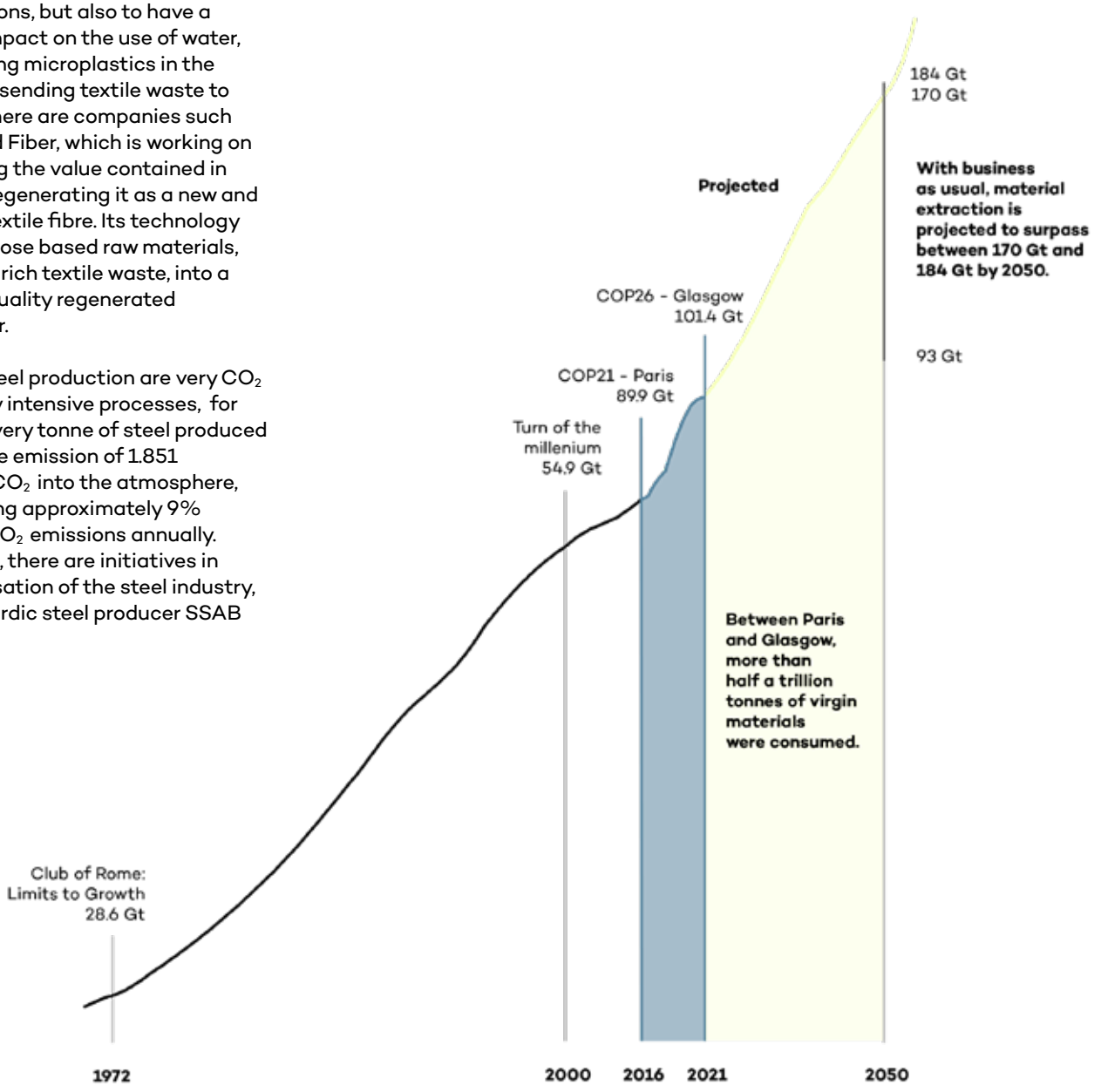
Iron and steel production are very CO_2 and energy intensive processes, for example every tonne of steel produced leads to the emission of 1.851 tonnes of CO_2 into the atmosphere, representing approximately 9% of global CO_2 emissions annually. Due to this, there are initiatives in decarbonisation of the steel industry, and the Nordic steel producer SSAB aims to be the first steel company in the world to bring fossil free steel to the market. In addition, to process development, new renewable materials can be used to replace fossil ones. For example, Modvion is building a wind turbine tower out of wood, rather than metal. By using wood instead of steel, wind turbine towers can boast environmental benefits through a lower carbon manufacturing process. It is estimated that, including sequestration, a timber tower can save about 2,000 tonnes of CO_2 emissions per tower up to the deployment.

The construction sector uses approximately 50% of all extracted raw materials globally and is responsible for over 35% of the EU's total waste generation. In addition, the construction industry was responsible for 36% of the global energy demand and 37% of the global CO_2 emissions in 2020.

Thus, increasing raw material efficiency or using alternative materials could save a vast amount of those emissions. Concrete is being used in almost every construction site in buildings, roads, bridges, and infrastructure. It is causing 8% of CO_2 emissions, mainly due to the use of cement. There are innovations that are already being commercialised, replacing cement with industrial side streams to produce low carbon construction materials (with an 80% smaller carbon footprint compared to cement).

Transitioning to a holistic circular economic model is critical to reduce the environmental impact and to accelerate sustainable business.

The moment for change is now.

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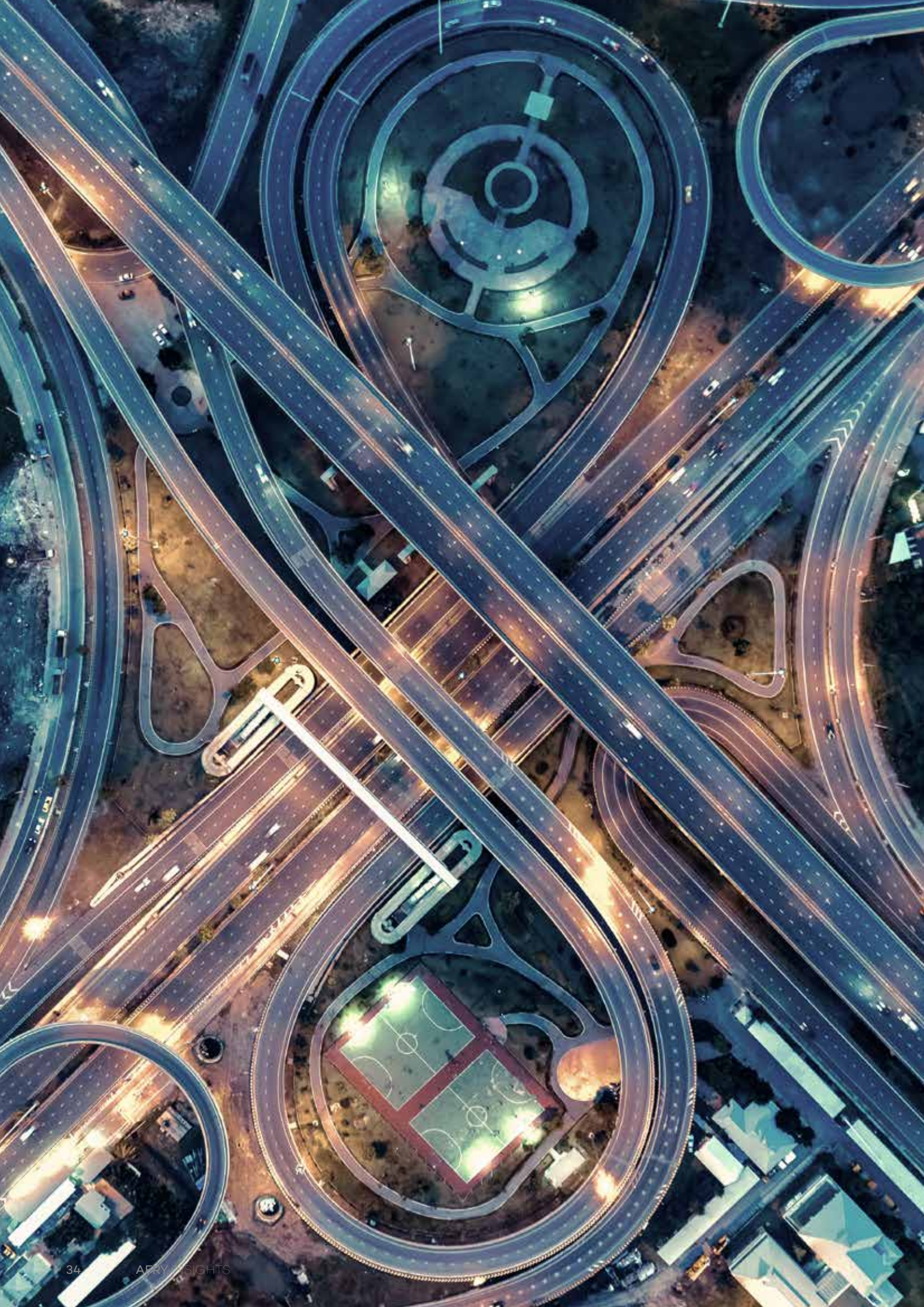

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X marks the spot

Digitalisation of industries has been a topic for over 20 years, yet we are talking about it at an ever increasing rate, as the pace of change in the global energy industry picks up more rapidly than ever before. With digitalisation now at the core of the most complex business challenges, which initiatives make strategic sense and what differentiates them from a set of disconnected individual activities? AFRY X supports its clients as a leading provider of digital solutions across industries with customised solutions for a substantive value-creating change.

Rarely are decisions as momentous as the decision to change. All the more so when it comes to one's own company. A digital transformation, if not always a relaunch, is nevertheless a rebrush of one's own business model. Fortunate are those who can do it of their own free will and not under competitive pressure or to catch up on missed developmental leaps. But fortunate or not, all companies are facing the pressing question of a sustainability transition.

The urgent need for sustainable transition in society is paving the way for rapid digital-driven change. As digital technologies reshape all industries, implications for businesses are broad, and so are the opportunities to make an impact, from AI boosted efficiency to energy as a service. At AFRY X we have brought together our leading digital expertise and key digital technologies in one place to help clients to accelerate their digital transition.

"Digitalisation is the one big enabler in driving the transformation towards a sustainable society. AFRY X is our superpower to rapidly scale our most promising digital offerings to our clients. We will combine deep sectoral knowledge and digital know-how to become an innovative tech company that addresses some of the biggest challenges where digital and domain expertise are prerequisites. We aim to achieve the greatest impact and contribute to sustainability together with our clients." Per Kristian Egseth, EVP and Head of AFRY X.

"Digitalisation is an ongoing evolution that is at different stages in different industries," adds Pernilla Thessén, Head of Strategy and Niche offerings, UX design and analytics, at AFRY X. "We see digitalisation in the Energy sector emerging due to increasing pressure within the sector, and this is logical given the potential of digital transformation within the Energy industry."

Digital transformation is, in a way, a reinvention of the business model. It requires new ways of working, new functions within the company, a new mindset among all employees and, last but not least, large-scale investments to build new capabilities within the company and connect it with the wider ecosystem. AFRY X supports clients in the search for and implementation of customised digital solutions, which, according to Thessén, create more value than off the shelf software. " We see our role at AFRY X in having a solution-oriented outlook based on services that address our clients' needs. The major impact will happen when we focus on partnering with clients to develop packaged service offerings addressing specific challenges. This is where we can solve the real problems out there."

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