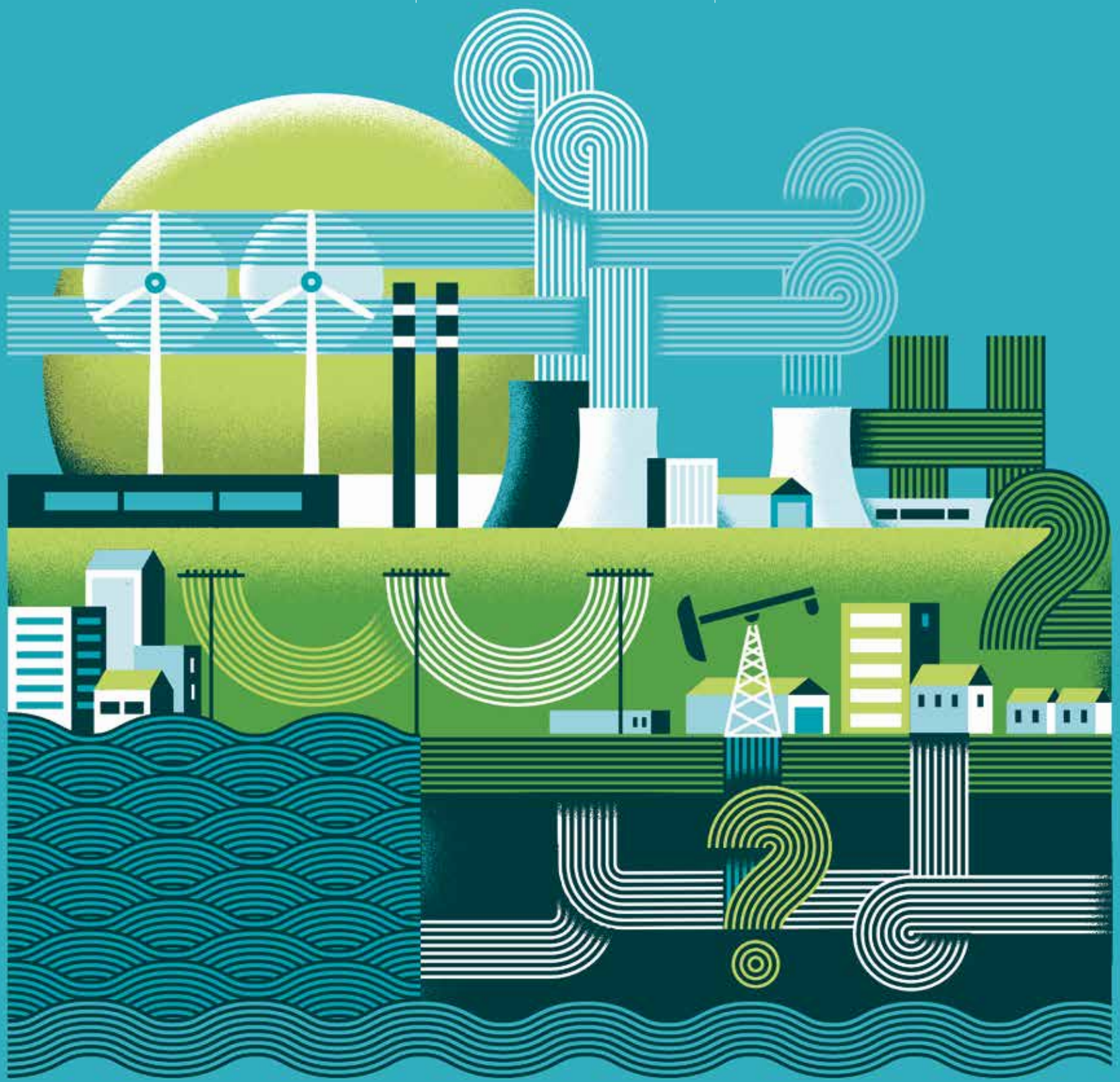
FUTURE OF ENERGY



FUTURE OF ENERGY

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ARTIFICIAL INTELLIGENCE

How AI can alleviate energy poverty

Living in homes without power, with no money to heat or cook, sounds like a Victorian-era social issue, but it's a present-day problem in the UK. Can artificial intelligence help?

Olivia Gagan

Cold winter days are the hardest to endure for people suffering energy poverty. "I was getting lethargic sitting still to keep warm," says one. "Physically, I wasn't even taking a bath. I was saving up the money. Mentally, I was losing my health, cutting down on so many things," says another. "I was holding off with the laundry, even holding off going out looking for a job because you need clean clothes."

These are cries for help from people who have contacted the Fuel Bank Foundation over the past year. The charity provides emergency credit to those struggling to pay their energy bills. Requests for support have increased by 23 per cent since the start of the coronavirus pandemic. Worse still, the foundation says self-disconnection, where households switch off their power supply completely, is a growing problem.

Choosing between heating and eating, or between having power or going into debt, are decisions increasing numbers of people are having to make. It has been a long, tough winter. Unemployment currently stands at 5.1 per cent, the highest level since 2016. And for many of us, as our homes have become our workplace and school, domestic energy consumption has jumped as a result.

Artificial intelligence (AI) innovations and smart technology are typically thought of as preserves of the wealthy. Charities and academics, however, believe they can provide vital solutions to fuel poverty by tracking and managing energy usage, enabling cheaper power consumption and providing short-term solutions when there isn't enough money for the bills.

How? At a community level, installing smart local energy systems can make electricity cheaper by deploying low-carbon, local power. This can cut generation and distribution costs, and deliver the savings back to users.

Within homes, smart prepayment meters can now add instant emergency credit when funds run low, tiding users over until they can afford to top up. In turn, the consumption data smart meters generate can be used to give suppliers insights into their customers' energy usage patterns.

Yet this data has to be used carefully and thoughtfully. People struggling to power their homes can often slip through the net, simply because they don't behave according to what suppliers and the government expect. Applying blanket assumptions about who needs help, and how they can be helped, doesn't work, especially as the pandemic draws more people into fuel poverty.

Andrew Brett Wallis via Gettyimages

Dr Aidan O'Sullivan, associate professor at University College London, where he leads energy and AI research, says the government and suppliers spend money "trying to identify people who should be getting the winter fuel allowance and support for fuel poverty, and still get it quite badly wrong".

"What AI can really help with is correctly identifying the customers who should be receiving support," he says. The signals that suggest a household is starting to struggle with their energy use are complex.

"For example, someone might repeatedly reduce their consumption at the end of the month as they run out of money, which is a subtle signal that can get lost when averaging data," says O'Sullivan.

His work includes building neural networks, which can use signals from smart devices to detect whether a home is falling into fuel poverty. Energy suppliers can then help at-risk customers with targeted interventions, such as giving personalised guidance via an AI agent.

Dr Rose Chard, who leads consumer insights at Energy Systems Catapult, a state-backed not-for-profit which works to accelerate new energy technologies, stresses that fuel poverty is diverse. It affects different people in varied circumstances, which is often overlooked when trying to use technology to solve fuel poverty.

"An elderly woman living on her own, in a property that she owns, on a very low state pension with no mortgage, might be fuel poor. But we also have working families, on zero-hours contracts, living in the private rental sector, who are fuel poor. So there isn't going to be one solution that's going to work for all households," she says.

Someone fit and healthy may enjoy tracking their energy consumption via their smart meter, turning their thermostat down by a couple of degrees and getting cheaper bills as a result. While for others, who are in a damp or draughty home or living with a serious health condition, this could be bad for them. But they may benefit from using a smart system to heat individual rooms in their home to higher temperatures. Therefore, imposing one-size-fits-all AI and smart technology is unlikely to be the answer.

Instead, Chard suggests tech innovators can do better by considering exactly who stands to benefit from the algorithms, products and systems they create right at the start of the research and development process. Actively involving vulnerable householders and wider services, such as the NHS, earlier in research can ensure innovations and support schemes are fit for purpose.

Her team last year successfully trialled provision of "heating on prescription" in combination with smart meters. She says: "We found with smart controls, people were able to heat their home to healthy, warm temperatures in a way they weren't before. And what if a GP or a healthcare visitor could prescribe a warm home for six months at times in your life when you might be most vulnerable to living in a cold home?"

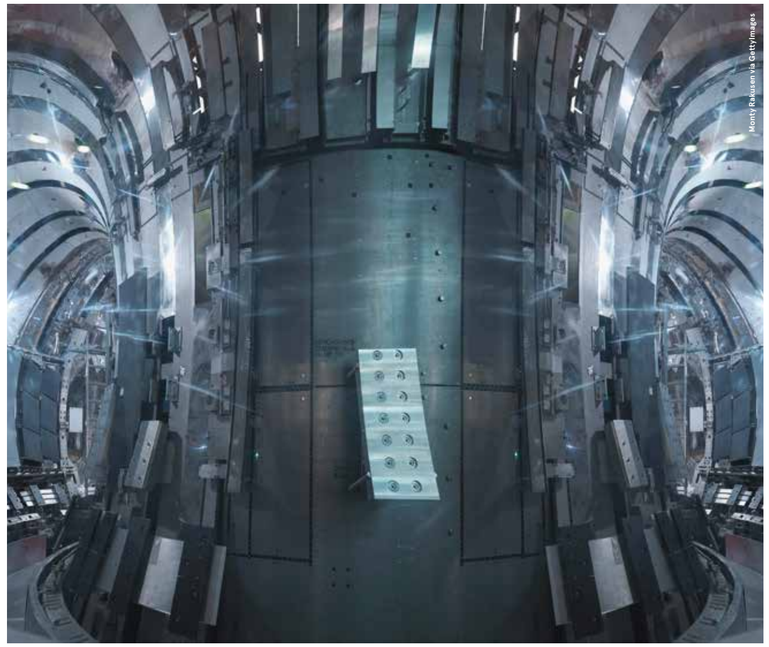
Providing resources to help manage, rather than minimise, energy use is perhaps the most effective application of AI and smart technology for those experiencing fuel poverty. Combining valuable data and technological advances with human sensitivity and insight may be the best way to meet that most basic of needs: keeping warm and dry.

96% of the people who contacted the Fuel Bank Foundation for help in 2020 had to make the choice between topping up their meter or buying food for their family

76% have to ration when using heating and hot water every day or weekly

49% have to choose between having a cooked meal and relying on cold food every day or weekly

Fuel Bank Foundation 2021


Monty Rakusen via Gettyimages

Inside a fusion reactor

NUCLEAR FUSION

Generating power with 'mini suns'

For decades, fusion power has remained a distant dream. Now, though, miniature suns are starting to fire up

Emma Woollacott

It's carbon-free, contributes to a greener future and has effectively inexhaustible fuel from seawater and lithium. So says Professor Ian Chapman, chief executive of the UK Atomic Energy Authority (UKAEA), backing nuclear fusion.

"It's very low land use, so it doesn't take up a lot of space, and it's baseload, so you don't have the intermittency you might with renewables," he enthuses.

Nuclear fusion has long been heralded as the holy grail of power generation. So long, in fact, the industry jokes that success is permanently 30 years away.

Recently, though, all that has started to change. Now, around the world, international collaborations and private companies are making significant progress and claiming we could see the first commercial power stations come into operation by 2040.

Unlike nuclear fission, which generates energy through splitting atoms, fusion involves smashing two atomic nuclei – generally deuterium and tritium, both forms of hydrogen – together under great pressure, in a process that creates a heavier nucleus and releases energy. It's the same process that goes on in the sun.

"And the important thing is that, unlike fission, it doesn't have the same long-lived legacy waste or chain reaction," says Chapman. "You can't have a Chernobyl; it just can't happen."

In the UK, the government is currently looking for a site to trial a prototype fusion energy power plant, with councils and local authorities bidding to play host.

The design for STEP, Spherical Tokamak for Energy Production, should be completed by 2024. It will build on existing UKAEA work with tokamaks, which are compact fusion devices that use magnetic fields to contain plasma and create the high pressures required.

The latest step forward has been the firing up of Mast-U, a new spherical tokamak that includes a new way of exhausting the enormous amounts of waste heat.

"You must have seen videos of eruptions coming out of the sun; solar flares or mass ejections, big spirals of gas, which are thrown out," says Chapman. "Well, we have a miniature sun and, in the same way there are events which happen at the edge where heat is thrown out, so you need to make sure none of that heat damages the wall."

The usual way of dealing with this is to allow the heat to flow to a sacrificial surface that's consumed. However, the new system allows materials to last much longer by channelling the heat over a longer distance.

"By the time the material gets out to the metal at the edge it's a lot cooler, as it's radiated heat along the path," says Chapman. "And that takes the heat flux down from a level that's at the melt limits of the materials that we have, down to a heat flux that's really what would happen in a car engine."

Mast-U was turned on last October and power is now being ramped up. Results should be in by the summer and, if successful, it should cut the heat which hits the wall by 90 per cent.

But STEP is by no means the only fusion project in town. ITER, the International Thermonuclear Experimental Reactor, is a fusion project involving 35 countries. Already three-quarters built, it's due to fire up in 2025.

ITER is all about proof of concept, demonstrating that fusion can take place on a commercial scale. The findings will feed into other national initiatives around the world, including STEP and the power stations that will later be based on it.

"Despite the onset of the pandemic in 2020, the ITER project has managed to stay largely on track," says a spokesperson. "2020 was a decisive year, with the arrival of ITER's massive first-of-a-kind components, for example magnets weighing several hundred tonnes each, from all over the world and the start of machine assembly in mid-year."

Meanwhile, a number of independent companies are working on fusion technologies of their own. One such is First Light Fusion, spun out from the University of Oxford in 2011.

First Light has a different approach to STEP or ITER, using inertial, rather than magnetic, fusion. This involves firing a projectile at around 20 kilometres per second – 50 times faster than a bullet – at a target containing deuterium and tritium. The force generated is powerful enough for fusion to occur.

However, according to co-founder and chief executive Nick Hawker, the company has no plans to move into power generation directly, but instead will sell its targets and technology.

> **Unlike fission, it doesn't have the same long-lived legacy waste or chain reaction**

"We don't think it's credible for a startup to build a power plant," he says. "But we want to produce something that's a physical product, the ultimate espresso capsule, a consumable. Each one is equivalent in energy terms to a barrel of oil."

Chapman welcomes such initiatives, suggesting they all add pieces to the puzzle. "I think it's also a sign that the market has an appetite for fusion and wants to invest, and that's a really good thing," he says.

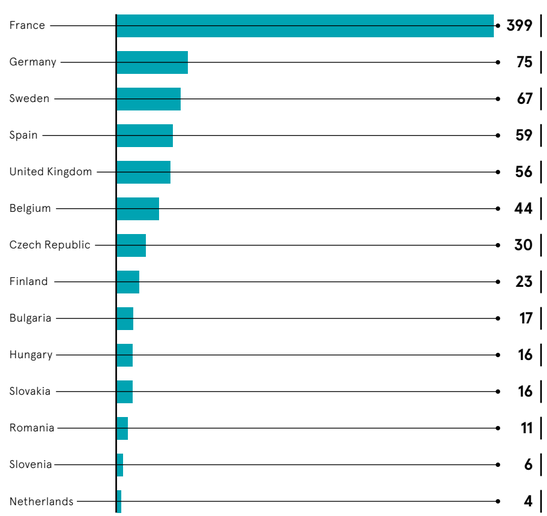
"These private companies are now leveraging money from oil and gas majors and venture capitalists, so that shows the market has an appetite for investment."

In the long term, fusion is unlikely to displace other forms of power generation entirely; in many geographical areas, wind or solar power is a better bet. However, it's widely seen as a potential major player within a portfolio of power generation techniques.

It's also likely to need a fair level of subsidy at first, says Chapman. "To start with, with any disruptive technology, you need some subsidisation to begin with, just as we've seen with offshore wind, which was subsidised 20 years ago," he says. "But now the price has come down and down, and it's cheaper than other energy sources."

WHO IS MAKING THE MOST OF FUSION?

Gross nuclear electricity generation in the European Union (in terawatt hours)



BP 2020

Making vital connections for offshore wind: the key to Europe's carbon-neutral future

Offshore wind power is leading the charge to a new world of sustainable electrification, says **Ragnhild Katteland**, executive vice president of the Subsea and Land Systems Business Group at Nexans

Both the UK and the European Union have pledged to achieve net-zero carbon emissions by 2050. These targets are incredibly ambitious, demanding rapid change and significant investment.

To reach net-zero, Europe's transportation, factories and buildings need to be powered by sustainable electricity. In 2018, the Continent generated an astonishing 2800 tera-watt-hours of power and providing this incredible amount of electricity from solar, wind and hydro will be the defining challenge of the race to net-zero carbon emissions.

One of the key pillars of this effort is offshore wind power, a resource that has gone largely untapped until recently. Further away from land, wind speeds are higher and more predictable, and higher wind speeds produce far more electricity; for instance, a turbine in 24km/h wind generates double the energy of a turbine in 19km/h wind.

Combined with more accurate weather forecasting and remote, data-based power management, offshore wind has the potential to generate a significant proportion of Europe's energy.

Currently, Germany and the UK lead the way in offshore wind power. Over half of the world's total offshore wind power is generated by these two countries. However, to meet the ambitious net-zero carbon goals, Germany, the UK and the rest of Europe must greatly increase their number of offshore wind turbines.

Fortunately, technological improvements have made offshore wind farms increasingly viable. The EU recently announced plans to increase the amount of power it generates through offshore wind by 25 times by 2050. It currently produces 12 gigawatts (GW) and aims to increase this to 60GW by 2030. The UK currently generates 10GW from offshore wind and the government has increased its 2030 generation goals from 30 to 40GW.

Outside Europe, other nations are also investing heavily in offshore wind. Over the next decade, China intends to build 50GW of offshore wind capacity and India plans to build 30GW. The International Energy Agency estimates that, by 2030, the industry in the United States will grow by 13 per cent and continue to add 20GW of capacity every year. Globally, experts estimate offshore wind will provide 200GW of clean power in the next decade alone.

These worldwide goals are driven by technological improvements. Larger turbines are currently coming online which can each generate 15 megawatts, enough power to support 20,000 homes, and offshore wind farms are becoming more efficient. A better understanding of turbine behaviour in rough seas also means turbines can be built further out, where winds are far stronger.

10%

of electricity used in the UK is already generated by offshore wind

Source: https://www.renewableuk.com/page/WindEnergy

30GW

To meet growing demand, the UK will add 30 GW in offshore wind generation capacity by 2030

Source: https://www.gov.uk/government/news/new-plans-to-make-uk-world-leader-in-green-energy

> **Each new gigawatt of offshore wind power requires up to €250 million in terms of power cables, and we are proud to provide them**

Another important development comes in the form of floating offshore wind farms. Currently, most wind turbines are fixed to the seabed. But this becomes impractical at water depths greater than 60 metres. Yet some 80 per cent of the world's wind potential is found in waters deeper than 60 metres. To reach this potential, we must use turbines mounted on floating platforms moored to the seabed

The coming decade's ambitious offshore projects will be the most complex, risky and demanding efforts to date. Nexans can deliver on these demands with the breadth of capability, deep expertise and excellence in execution.

As electrification specialists, Nexans enables the offshore wind industry to electrify the future by harnessing the power of wind. We already produce every type of subsea and land cables that connect turbines to grids and we are the number-one supplier of the subsea high-voltage export cables that bring the power onshore. And we expertly install them to ensure project success.

Each new gigawatt of offshore wind power requires up to €250 million in terms of the inter-array cables and export cables, and we are proud to provide them. We have already delivered cables to ten offshore wind projects in the UK and, inside the wind turbines themselves, we offer plug-and-play harnesses that are driving the cost of new turbines down. This year we will launch the CLV Nexans Aurora, the world's most advanced cable-lay-ing ship, and approximately half the new installations in Europe will use Nexans products.

The future is bright for offshore wind power. Further optimisations of hardware, control software and cable infrastructure are underway that will bring installation and operating costs even lower, making off-shore wind an undeniable option. At the same time, the supply chain is ramping up to support the coming decade's projects.

At Nexans, we are leading the charge to the new world of electrification – safer, sustainable, renewable, decarbonised and accessible to everyone, connecting us all to new opportunities, technologies and behaviours that will build a better future.

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Q&A

Laying out the future of sustainable energy

Climate expert, author and brother of the World Wide Web inventor, **Professor Mike Berners-Lee** shares his vision of how the UK can help drive a green future

Richard Pallardy

Mike Berners-Lee is intent on getting the world off fossil fuels and onto a more sustainable trajectory. Leveraging his years of experience advising industry leaders on carbon management, the professor at Lancaster University's Institute for Social Futures advocates an approach that gives equal weight to individual action and collective responsibility. In his view, we must pursue a global, top-to-bottom shift that emphasises decarbonisation in every sphere. He puts his *cri de cœur* on paper in the updated edition of *There Is No Planet B*, published in January. The book catalogues a wide range of environmental threats and proposes an abundance of innovative solutions. Here, he explains the unique circumstances faced by the UK in making the shift to sustainable energy, how local energy production can help and what we should be thinking about as the 2021 United Nations Climate Change Conference approaches.

Q What do you view as the major energy problems facing the world?

A The human energy supply has been growing for millennia and is continuing to grow rapidly. For the last few centuries, we've been getting most of our energy from fossil fuel which, of course, has turned out to be hugely dangerous. It has created a climate emergency. We need to get off fossil fuels at high speed. We need to ramp up our renewable energy production like crazy. The good news is it's technically possible. We also need to transform how we use energy to adapt ourselves to the new energy forms. Most of that turns out to be really doable. However, just transitioning energy supply to renewables will get us nowhere. If we carry on growing our energy supply at the current rate, it will mean we've doubled it by 2050. If we were to replace today's energy supply with renewables, but double our energy usage, then we'd still be taking just as much fossil fuel out of the ground as we are now. The more energy we use, the harder we make it for ourselves to transition.

> **We've gone into a world in which the resources we use are so removed from their production. We're detached. That leads to thoughtless, mindless consumption**

Q How do those problems play out in the UK specifically? Are there any we should be more or less worried about?

A This whole thing is a global issue. We need to make sure all the energy required gets to everywhere that needs it. Different countries are using dramatically different amounts of energy. Different countries also have totally different capacities to generate renewable energy. There is a colossal solar panel opportunity at the global level. This is especially true for sun-drenched countries like the United States or Australia or most African countries. If you're a country like the UK, the question is a little bit different. We're a small, crowded island without much sunlight. In Australia or America, all you have to do is put up the solar panels and maybe a few wind turbines. The sunlight will basically do it for you. In the UK, you have a really complex energy mix: a bit of solar panels, a bit of offshore wind, a bit of onshore wind, a bit of tidal, a bit of hydro, maybe a bit of biofuel, maybe a bit of nuclear. It's a much more complicated equation.

Q How much of the responsibility for mitigating climate change lies with individuals and how much with governments? Are individual efforts worth much without government intervention?

A Individual actions make government action possible. All these things work together. We need big systemic change. People are going to transform how they're living. Businesses are going to transform how they operate, and the goods and services they provide. And governments are going to incentivise. All these components are going to come together. In the UK over the last couple of years, we've had a lot of people taking to the streets insisting on action. That has opened up political space, which has enabled our government to feel brave enough to increase its carbon targets to net zero by 2050. That isn't enough, but it's a step in the right direction.

Q What are some of the problems faced in making renewable energy sustainable, both in terms of infrastructure and actual harvesting?

A First of all, we have to generate the energy. At the global level, the big deal is just putting solar panels out. For the UK, it's a more interesting mix. Then you have to get it to where it's needed. So that's a transmission issue. But you use a lot of raw materials. Renewable electricity is dependent on the weather and the time of day. So that gives you huge storage issues. You can store some of it with batteries. But you have to be able to store enough so the whole country can have its electricity supply right through the night in winter. It has to be really cheap. Then there's the question of how you store energy in a lightweight enough form that you can put it into an aeroplane and put it in the sky. But there are emerging technologies. Using ammonia as a storage material, we might be able to get across the Atlantic with a passenger flight.

Colin McPherson/Corbis via Getty Images

Q Is the decentralisation of energy the right way to go? Do we want more local production?

A When local energy production can be done, it does have some advantages. It creates a sense of local independence, which is really good. You don't have to transport the energy. The biggest difference it makes is we've gone into a world in which the resources we use are so removed from their production. We're detached. That leads to thoughtless, mindless consumption. It's the same with our energy. I have some solar panels on the roof of my house. That's actually a great reminder that this energy actually comes from somewhere. If I want to use more energy, I better put more solar panels on my roof. We have such rubbish sunlight in the UK and yet solar panels have taken off. That's partly because we had these feed-in tariffs [that incentivise renewable production]. That's really stimulated the market. Now the feed-in tariffs have been taken away. If you want more solar panels on your roof, you don't get the same government support. But the prices have come down to the point that you don't really quite need it anymore. They're becoming cheaper and easier to make all the time.

> **As we come out of the pandemic, we have a chance to do that with a deep green lens on and, in doing so, make lives better for everybody**

Q Are there any misconceptions about renewables and decarbonisation that particularly bother you?

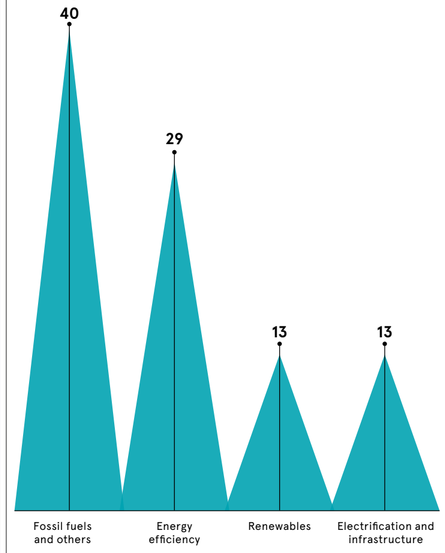
A If renewables are no more than the growth rate in the energy supply, they will do zero. Most people think efficiency will lead to a reduction in energy use. It doesn't. When we get more efficient in our use of anything at all, what happens is that our use of that thing goes up even more than the efficiency improvement. That means the total inputs go up, not down. This is known as the Jevons paradox. William Stanley Jevons noticed that as the UK got more efficient in its use of coal, that was stimulating greater demand for coal, not less. We see it everywhere. Efficiency improvements on their own don't help us. They only help us when we constrain the inputs.

Q How is the UK doing in terms of addressing the energy crisis?

A We are doing OK by the standards of most countries in the world. Aiming toward net-zero carbon emissions by 2050 is better than most, but it's really not enough. We have an opportunity to show some real leadership. And if we had some imagination, we could really do that. As we come out of the pandemic, we have a chance to do that with a deep green lens on and in doing so make lives better for everybody. As we go into hosting the 2021 United Nations Climate Change Conference, we have a chance to go in there with a real seriousness and a coherence in our position. We need to demonstrate integrity. We're on the verge of looking incredibly stupid in opening up a big coal mine on the west coast of Cumbria right as we go into these talks. I really hope we can rise to the challenge.

HOW UN NATIONS ARE SPENDING TO TACKLE CLIMATE CHANGE

The value of investment under the Planned Energy Scenario in accordance with the Paris Agreement between 2016 and 2050 (in trillion US dollars)



IRENA 2020

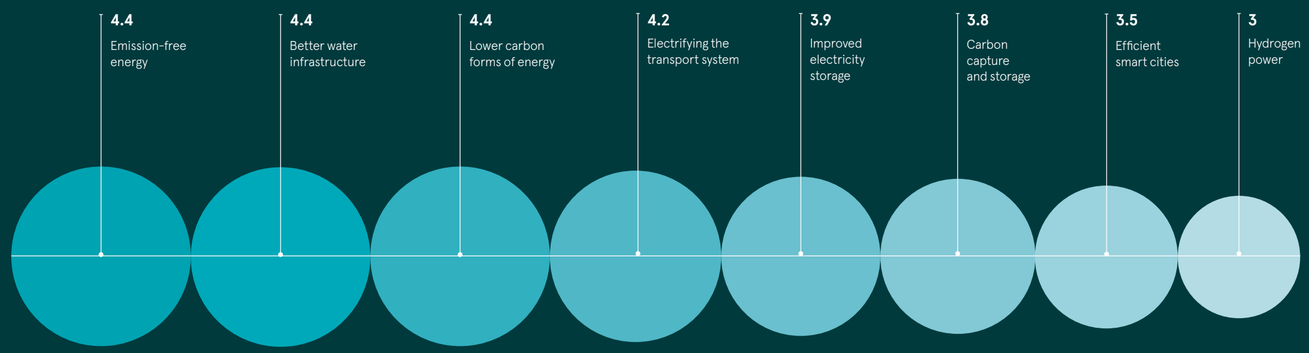
HARNESSING HYDROGEN'S POWER

As the world continues to lessen its reliance on fossil fuels and strives to find renewable alternatives, one source of energy is rising through the ranks. Hydrogen power can provide safe, low-carbon fuel for a range of industries and is becoming an increasingly attractive option

HYDROGEN NOT CURRENTLY TOP OF GREEN INVESTOR LISTS

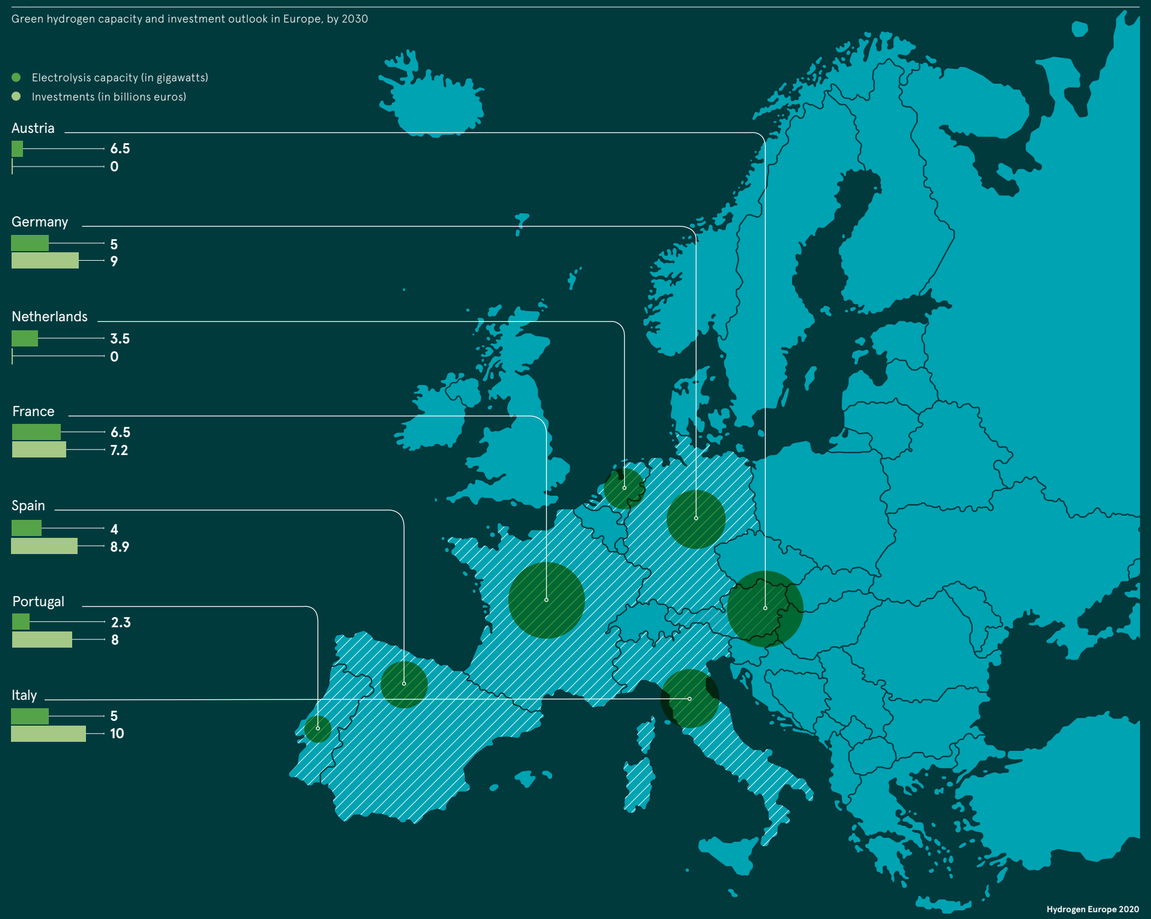
The most attractive forms of sustainable infrastructure among ESG investors worldwide, by importance score out of 9

HSBC 2020



SO, WHO'S MAKING HYDROGEN A TOP PRIORITY?

Green hydrogen capacity and investment outlook in Europe, by 2030

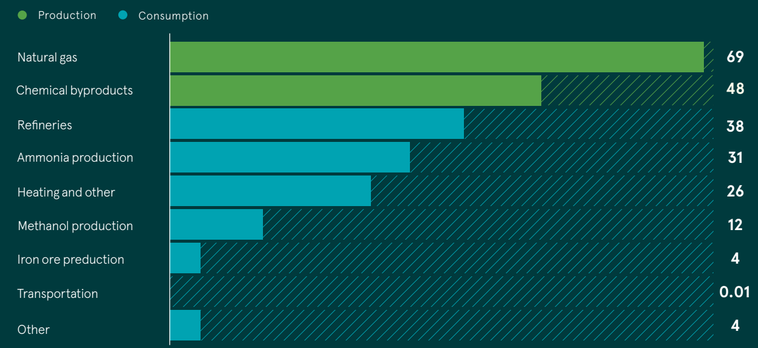


Hydrogen Europe 2020

HOW ARE THEY PRODUCING IT AND WHAT ARE THEY USING IT FOR?

Hydrogen production and consumption worldwide in 2019 *(in million metric tons)*

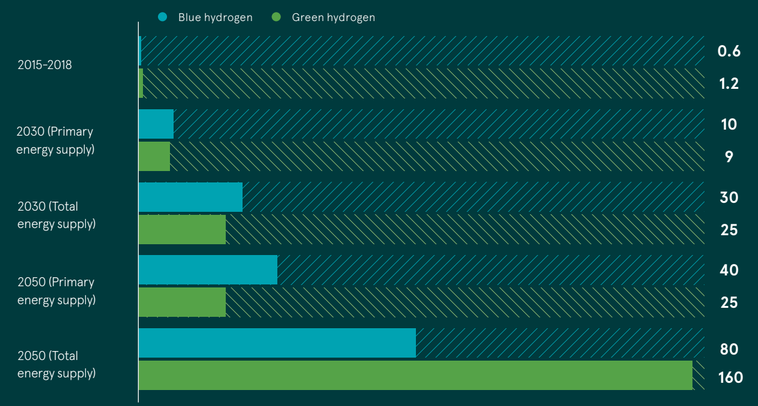
Fraunhofer ISE 2020



GROWING DEMAND FOR BOTH TYPES OF HYDROGEN

Global hydrogen production outlook. Blue hydrogen is formed when natural gas is split into hydrogen and CO2. The CO2 is captured and then stored, mitigating the environmental impact. Green hydrogen is produced by splitting water, producing only hydrogen and oxygen, meaning there is no negative impact at all

IRENA 2020



WHERE WILL HYDROGEN GENERATE THE MOST VALUE?

Forecast market potential of hydrogen in the EU in 2020 *(in billion euros per day)*

WirtschaftsWoche and BCG 2020

CARBON PRICING

Making the polluters pay

With carbon pricing alone no longer seen as enough to meet the targets of the Paris Climate Agreement, what other options are open to businesses set on cutting their emissions?

Mark Hillsdon

With its taxes, tariffs and trading schemes, the world of carbon pricing is complicated. Its aim, however, is clear: to encourage organisations to clean up their act or pay for the pollution they cause.

Carbon pricing falls into three broad areas, starting with the carbon tax, which has traditionally proved unpopular with both businesses and governments that have levied it.

More common nowadays are emissions trading schemes, when governments cap the total level of emissions allowed over a given period, with companies required to buy permits to cover the greenhouse gases they emit. As a market-based system, the faster emissions drop, the cheaper permits become, while companies that surpass the cap are taxed and those cutting emissions are allowed to sell unused credits.

However, according to Dr Matt Goodwin, sales director at sustainable fuel company Waste Knot Energy: "Carbon pricing is having an effect, but not at the speed we need it to. Ultimately, using the price of carbon to mitigate climate change is asking the market to sort the problem. That works to an extent, but the market is such a complicated system with so many competing factors that, although we might get there in the end, it's not going to happen at the pace we need it to. We need CO_2 emissions to go into reverse."

A third way of pricing carbon is through the voluntary carbon market, where companies offset their emissions by supporting schemes that fight climate change. Ten years ago, carbon offsetting dropped off the sustainability radar, amid criticism it lacked transparency, led to broken promises and double-counting of credits and, in some cases, actually did more environmental harm than good.

Now back in the mainstream, its champions believe it has a vital role to play in reversing global warming. ClimateCare helps companies to find projects in which they can buy offsets, ranging from major renewable infrastructure, to smaller projects such as supplying remote villages with smokeless fuel.

According to company chief executive Vaughan Lindsay, businesses should follow a hierarchy of action. They need to measure and understand their footprint, before setting about reducing and avoiding what emissions they can by, for instance, switching to a green energy tariff. The final step is to deal with hard-to-get-rid-of residual emissions and this is where offsetting comes in.

"It's about neutralising emissions," he says. "If you can't reduce or avoid them, take responsibility for them by offsetting." This ensures a company's impact on the environment remains zero, regardless of residual emissions, because for every tonne of carbon that isn't avoided, they compensate by funding a project that takes a tonne out.

And while longer term change is crucial, he adds: "Offsetting is the most cost-effective way to take action today."

> **Everybody needs to participate in this industry to reach the goals of the Paris Climate Agreement**

The cost of electricity generation makes up about 40 per cent of an energy bill, with the rest covering charges for network transmission and balancing, and programmes like the climate change levy, which is a tax on non-domestic gas and electricity bills.

"Although not visible on the bill, carbon costs will be factored into the wholesale electricity price," explains Tim Dixon, an energy market analyst at consultants Cornwall Insight.

One way to avoid these taxes is to go off grid and install solar panels or other forms of micro-generation, he explains, although an easier way to make an impact is to move to green energy. "A lot of businesses are looking at ways in which they can be more sustainable, but the options aren't amazingly clear and transparent at the moment," says Dixon.

Take green energy. In the UK, for a supplier to claim a tariff is 100 per cent renewable, they have to back it with renewable energy guarantees of origin, or REGO, certificates. But these certificates were initially sold too cheaply, devaluing the scheme and leaving question marks hanging over the true provenance of some green tariffs, says Dixon. There have since been calls for the scheme to be reformed.

"More businesses are looking at contracting directly with renewable generators, so they know where their electricity is coming from," he says.

A way to do this is through a power purchase agreement (PPA), which gives businesses greater control over the energy prices they pay. PPAs involve directly contributing to a new renewable energy project by agreeing to pay the developer a fixed price for energy when the project comes online. It's a way of eliminating the carbon impact of purchased energy, while also adding green energy to the grid.

A drawback of this type of agreement, however, is it favours large corporations with deep pockets and credit ratings that enable them to commit to long-term projects.

"It's difficult for small companies to get involved because they're so resource intensive," says Dixon. What's needed are more innovative ways to bring companies and suppliers together, he says, such as aggregated PPAs, which involve a coalition of companies sourcing electricity from a single renewables generator.

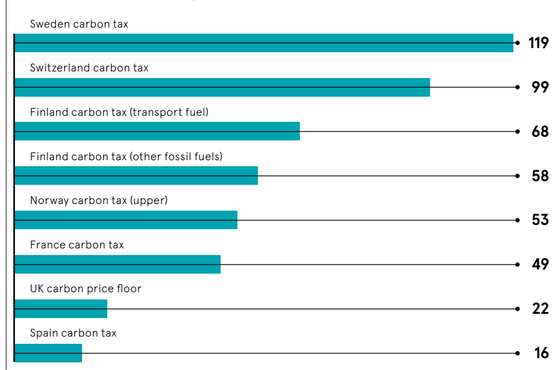
"Everybody needs to participate in this industry to reach the goals of the Paris Climate Agreement," says Zach Starsia, director of accounts at Seattle-based renewable energy platform LevelTen Energy. "We need to mobilise smaller buyers."

LevelTen connects smaller businesses with large clean energy projects that are willing to sell them a small amount of energy. "By pooling their demand, they can act as a single large purchaser, which opens up opportunities that would not have been available had they acted alone," says Starsia.

But whatever direction carbon pricing takes, ClimateCare's Lindsay is adamant that polluters must continue to be made to pay. "The purpose of pricing carbon is to change behaviours," he concludes. "If you pollute something, but you don't have to pay for it and somebody else picks up the bill, you're never going to change."

WHO IS CHARGING POLLUTERS THE MOST?

Eight of Europe's most expensive existing carbon pricing instruments as of April 2020 (in US dollars per metric ton of CO_2-equivalent).



World Bank 2020

OPINION

'We can humanise energy and we must do so urgently'

The brutal shock of coronavirus has had a deeply uneven impact on communities and economies around the world. The world energy industry is no exception.

The crisis has highlighted the importance of energy in all our lives, for homes, health and digital productivity. It has also tested the resilience of grid systems and spurred new investment in deeper decarbonisation of heat and transport sectors.

Access to modern energies is easily taken for granted; affordability, reliability and equity matters are frequently overlooked. Despite free sunshine, household energy debt, fuel poverty and even defaults on mini-grid payments are increasingly evident.

Only the lucky few have abundant energy to light, heat or cool their homes. Hundreds of millions live with zero access to electricity and billions more people lack energy for clean cooking, sanitation and better livelihoods. The gap between those with abundant access and those without enough energy is widening.

Should societies bet on tech-fixes to provide the cure-all? Many green energy solutions are in their infancy and there is little thought about new and different future energy needs. Neither technology promoters nor capital market investors focus on the human pace of the "race to zero". Affordability and energy justice matters are mobilising more people and communities, especially those impacted by transition, to become involved.

Political and policy discussions are starting to touch on the new social energy agenda and it will be important to look beyond peak demand for coal and oil, and address winners and losers, and meet growing demand.

We can humanise energy and we must do so urgently. The flows of clean, affordable, reliable and equitable energy are the lifeblood of progress. Securing clean energy and flexible storage for everyone will not be easy. It can be achieved through investment in renewables and other clean energy friends, net-zero emissions heat, power and liquid fuels.

The race to zero ignores this nuance and risks extreme polarisation between green-only energy winners and many more losers. Whose energy decisions are being driven by concerns about the end of this week, the end of the world or both?

The scale and scope of the existing energy system and materiality of the renewable power revolution are not well understood. It is frustrating to be engaged in so many debates which reduce the "tutti fruiti" of modern energies and their uses to the apples or pears of solar and wind power. Not everything can be electrified, yet. Lack of energy literacy, including among some investors, policy-shapers and journalists, is a risk to the future of humanity.

People, new uses and demand dynamics are missing in energy outlooks. We owe it to future generations to maintain a healthy planet. Let us inspire children to keep reaching for the stars. Energies for flying cars, meteorite mining, quantum warp drive engines are exciting possibilities.

Building forward together will involve recovery along multiple pathways and benefits from a new mindset of customer-centricity and demand-driven solutions. There needs to be a safe space for honest discussion of the full costs to society, stranded communities and the "more energy" implications of new human and economic development models. We can offer a safe space, as the world's oldest, neutral and independent world energy organisation, to address these political undiscussable questions.

By the United Nations Climate Change Conference, COP26, in November, the work on new metrics for the "S" in environmental, social and governance, or ESG, reporting by energy investors and firms should be concluding, not starting. And by the end of 2021, we can all share stories of success in humanising energy, which inspire future generations of energy entrepreneurs.

Dr Angela Wilkinson
Secretary general and chief executive
World Energy Council

Commercial feature

Hydrogen roadmap crucial to reaching net-zero

International energy company Uniper calls on UK policy-makers to set out a clear vision that outlines hydrogen's role in meeting the government's net-zero emissions target by 2050

The UK is leading the way globally in laying the foundations for net-zero emissions by 2050, but one crucial driver is still missing: a clear strategy from the government which commits to and outlines the role of hydrogen in getting us there.

Put simply, hydrogen is essential for the decarbonisation of industry, transport, heat and power. We have the technologies and capabilities to unlock hydrogen's potential, policy-makers must first play their part and help to accelerate investment and adoption.

The role of natural gas on any realistic journey to a zero-carbon future cannot be ignored, not least because it produces half the carbon emissions of burning coal. Flexible and cost-effective gas-fired power stations play an important role in continuing to provide reliable energy, meeting demand for power that cannot always be met by the output of weather-dependent wind and solar energy.

In addition to their role in securing the UK's energy supply on the path to net-zero, retaining gas-fired power stations will keep open the cost-effective options to repurpose these plants to run on hydrogen or use carbon capture and storage.

In the next few decades, carbon capture and storage, and hydrogen production, will be pivotal to industrial sectors that find it difficult to reduce their carbon emissions.

At Uniper, we know the power of hydrogen more than anyone. We've already demonstrated this in Germany where we've successfully implemented "power-to-gas" technology using wind power to produce clean hydrogen, which was fed into the gas network for more than seven years.

> **We have the technologies and capabilities to unlock hydrogen's potential, policy-makers must first play their part**

The technologies are market ready and can be used to decarbonise industrial hubs close to our sites strategically located throughout the UK, including the South East, North Wales and the Humber region. But a market framework that encourages long-term investment in new technologies must be there for us to do it.

We welcome the steps the government has already made, including establishing the Hydrogen Advisory Council last year and committing £500 million of investment in hydrogen, with part of the funding set aside to help install 5 gigawatts of low-carbon hydrogen production capacity by the end of the decade. Indeed, in the government's plan for a Green Industrial Revolution, one of the key objectives is to eventually produce enough hydrogen to feed the entire gas network.

To make this a reality, however, the government must set out its strategy, and put forward a clear vision around exactly how hydrogen will be used in the economy and its role in the UK's decarbonisation journey. Who will use it? How will demand be stimulated? And what is required to create a truly end-to-end value chain from producer to end-user?

Meanwhile, we also need to see a clear hydrogen market framework that is technology neutral, brings forward both blue and green hydrogen, and sits alongside incentives to stimulate demand for hydrogen and reward its production. And more progress is needed in the area of regulation and standards, such as requiring boiler manufacturers to supply hydrogen-ready boilers and for uses in the transport sector.

Our commitment to decarbonisation is clear. We have pledged to make our European power generation portfolio carbon-neutral by 2035 and clean hydrogen technologies are a cornerstone of our new strategy. We stand ready to invest significantly to transform our business, enabling a reliable and decarbonised power system, and to help create the UK's emerging hydrogen sector, supporting sustainable economic recovery post-coronavirus and the 2050 net-zero emissions goal.

Indeed, we are already exploring hydrogen projects across the country, working with partners to utilise our expertise and our sites in strategic locations. But such a substantial, long-term commitment can only be confidently set in motion when the government has clearly outlined its position.

For more information please visit www.uniper.energy

uniper

CARBON EMISSIONS

CO_2 good to be true?

Typically perceived as the bogeyman of climate change, CO_2 is now being reconsidered by scientists as the raw material from which to make fuels and even plastics

Josh Sims

Here's a challenge: "If you're a young person and you want to save the planet, while also becoming the richest person on it, then this is the problem to solve. Using captured carbon dioxide, how do you make, say, a fuel?" Posing the question is Dr Stephen Pacala, professor of ecology and evolutionary biology at Princeton University, New Jersey, and chair of the US National Academies panel on CO_2, who adds: "That's the green dream. We just need a lot of inventions to get there."

But, Pacala notes, we're already well into startup territory. Indeed, in some circles, carbon capture and storage (CCS) has been rephrased as CCUS (carbon capture, use and storage). Less the climate change bogeyman, and a waste product to store, some scientists are now seeing CO_2 rather as a raw material to process into something useful.

Aside from any resulting product, a new industry growing out of CO_2 repurposing would also help both to replace those jobs lost in closing down the fossil fuel industry and to mitigate problems in the geological storage of CO_2.

Pacala stresses that "there's a long development road ahead" and CCUS projects are likely to only play a minor role in the wider move towards carbon neutrality, at least in the short term. But, he says, we should embrace "the chance that using carbon could make a noticeable difference".


Andriy Onufriyenko via Gettyimages

1

Making new plastics

"Everyone views CO_2 as a liability and it is. But it could be viewed as a chemical feedstock, as a step to making plastic," says Dr Edward Sargent, professor of electrical and computer engineering at the University of Toronto. "The question for us was: what would it take to do this in a way that's beneficial to the overall CO_2 strategy?"

Sargent has concluded this means viewing the repurposing of CO_2 through a strictly economic lens. Extracting CO_2 from the atmosphere and storing it underground is expensive, which is why CO_2 sequestration, he argues, hasn't taken off as a business.

But since ethylene, a precursor to polyethylene, used in many products from synthetic fabrics to medical devices, is already a $60-billion-a-year market, people will pay for it. It's ethylene which his team has created by using copper as a catalyst to combine the reactants CO_2, water and electricity.

Much of the CO_2 turns into side products like carbonate and the team is currently able to produce 75 per cent pure ethylene. Since the market wants more than 90 per cent pure, Sargent is now using artificial intelligence to accelerate the discovery of a more effective catalyst, possibly a blend of copper and aluminium. He has also scaled up the lab equipment to a "mini-van size" system that increased output by 10,000 times.

"Right now plastics have a big carbon footprint," says Sargent. "But this is a chance to reframe our thinking about them."


Dougal Waters via Gettyimages

2

New routes to battery acid

A catalytic converter developed by chemical and biomolecular engineers Chuan Xia and Haotian Wang at Rice University, Houston, Texas, uses CO_2 as a chemical feedstock to produce high concentrations of formic acid, in a way that is much more purified and so less expensive than other methods to date.

Formic acid is an energy carrier, a fuel cell that can itself generate electricity and carbon dioxide, which can then be grabbed and recycled again. It's also useful as a storage material for excess energy from variable sources, such as wind and solar power, and also for storing hydrogen. It can hold 1,000 times the energy of the same volume of hydrogen gas, which is hard to compress. This is one of the main challenges in the development of hydrogen-powered cars.

The scientists' pioneering converter is based on bismuth and a solid-state electrolyte that's free of the salts that usually then have to be removed in such a process at a great energy cost. The duo say their catalyst can already be produced at the kilogram scale and so is readily scaled up.


Dmitriy Pridannikov / SysEm via Gettyimages

3

Recycling CO_2 into new fuels

"Pulling CO_2 out of the atmosphere and just storing it underground isn't a useful endeavour; it would be far better to do something productive with that CO_2," argues Dr Torben Daeneke, of RMIT University Melbourne's engineering department. "There's a big push in the scientific literature to repurpose CO_2 into something useful, to make, for example, a fuel that can be burnt again and we're one step closer to that."

Daeneke's team has developed a low-temperature, low-pressure liquid metal electrolysis method that efficiently allows CO_2 to be converted from a gas into solid particles of carbon. The catalyst they created has specific surface properties that makes it extremely efficient at conducting electricity while chemically activating the surface. CO_2 is dissolved in an electrolyte liquid with the liquid metal, before a current is passed through it. The process converts the CO_2 into solid flakes of carbon. Before, doing this required extremely high temperatures, making the process unviable on an industrial scale.

He says the resulting flakes are both a more efficient means of storing CO_2 than in its gaseous form, but also they are of a purity that means they could work as an electrode, as part of a super-capacitor or in the production of wonder material graphene.

"I'm optimistic that the process can be scaled up, but driving the reaction is energy intensive and that's where the challenge lies," concedes Daeneke who, in the next year or so, hopes to have completed a microwave oven-style device capable of producing a few kilos of carbon a day. "It may be a question of sitting the process in a location that makes the energy cheaper, in the way the manufacture of aluminium foil is."

OPINION

'Transition to a green economy calls for a workforce with varied skills'

The impetus to tackle climate change and reach net zero is growing. The government's Energy White Paper published at the end of 2020 builds on the grand Ten-Point Plan for a Green Industrial Revolution. Climate change emergencies and net-zero aspirations have been expressed and manufacturers, as well as consumers, are eagerly shifting their focus to electric vehicles and fuel efficiency.

These are all encouraging and welcomed actions, but let's not forget, setting targets and gearing ourselves towards the challenge of meeting net zero is the easy part, putting plans into action will be another story.

A specific set of skills and expertise is required to tackle a challenge of this scale, and it is the responsibility of the government and all organisations to understand the skills and expertise required. Transition to a green economy will not happen if the UK does not deploy the right people with the right skills to reduce greenhouse-gas emissions by 100 per cent, to net zero, by 2050.

In the past, the concept of the energy trilemma and its aim to balance the security of supply, energy affordability and carbon emissions encouraged the development of skills towards the generation of energy and renewable technologies. In essence, skills were developed to satisfy the supply side of the energy market.

Transition to a green economy and reaching net-zero targets calls for a workforce with varied skills and understanding of the supply as well as demand side of energy. That includes not only skills in the renewable and low-carbon energy sector, but also skills enabling organisations to scrutinise their energy consumption, manage it efficiently and reach their carbon credentials in the required timeline.

The combination of technical and operational expertise, and softer skills, such as passion for applying sustainability measures and tackling climate change, will be vital for organisations to shift their net-zero vision into reality.

It is predicted that skills enhancing clean electricity generation, installing energy-efficiency products, providing low-carbon services or manufacturing low-emission vehicles and infrastructure will be critical. And certainly, those skills will be extremely necessary.

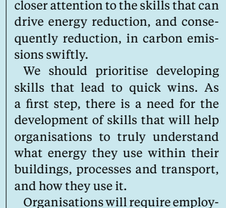
With only ten years left to halve global emissions, governments and businesses have to start paying closer attention to the skills that can drive energy reduction, and consequently reduction, in carbon emissions swiftly.

We should prioritise developing skills that lead to quick wins. As a first step, there is a need for the development of skills that will help organisations to truly understand what energy they use within their buildings, processes and transport, and how they use it.

Organisations will require employees who possess basic energy-management skills and knowledge, and who will help them to scrutinise and understand their energy use, set up proper monitoring and measurement systems, accurately calculate emissions, and comply with mandatory reporting schemes. Also, organisations need employees to eradicate energy waste, improve energy efficiency, switch to renewable energy sources or on-site renewable generation, evaluate fleet fuel efficiency and, most importantly, motivate the entire organisation in adhering to a realistic progression towards net-zero commitments.

It will be an arduous task to develop the green-skills ecosystem that will enable businesses to recruit for the 400,000 jobs that, according to research from Development Economics, will be required in the UK's energy sector by 2050.

Now is the perfect time for organisations and industries to take the lead and control their own destinies of reducing energy costs and emissions. No doubt efforts are already being intensified to boost technical capabilities and skills to embrace the opportunities that decarbonisation and net-zero transition present. ●



Jana Skodlova
Chief executive
Energy Managers Association

Commercial feature

The 'net-zero' dividend

Siemens Energy UK and Ireland vice president **Steve Scrimshaw** says the UK's net-zero by 2050 target will be a shot in the arm for the post-COVID world

The Stone Age did not end for a lack of stone and the Oil Age will end long before the world runs out of oil." These words are attributed to Sheikh Ahmed Zaki Yamani, the Saudi energy minister who helped to direct the 1973 oil embargo and today, as we face the threat of runaway climate change, they seem uncannily prescient.

There is widespread acceptance that the world must quickly wean itself off fossil fuels. HM Treasury, not an institution normally given to hyperbole, warned in December: "Climate change is an existential threat to humanity. Without global action to limit greenhouse-gas emissions, the climate will change catastrophically with almost unimaginable consequences for societies across the world."

A pathway to a zero-carbon world is starting to emerge. The Paris Agreement, adopted by 196 nations at COP21 in 2015, aims to limit global warming to 1.5C, compared with pre-industrial levels. The UK, among others, has set legally binding targets to achieve net-zero emissions by 2050.

The scale of the task ahead is immense. The world burns about 100 million barrels of oil every day. In the UK alone, there are 29 million gas boilers and 40 million petrol and diesel vehicles on the roads. All will need to become zero carbon. The same goes for rail, shipping and aviation. Meanwhile, the clock is ticking: there are less than one billion seconds until 2050.

> The clock is ticking: there are less than one billion seconds until 2050

Despite the enormity of the challenge, it is also a great opportunity. Last October, for example, the UK government increased the country's offshore wind target from 30 to 40 gigawatts (GW), estimating a 60,000 increase in jobs to go with it.

Hydrogen is going to be a big part of the economy going forward. Projections show it is likely to play a larger role as economies turn to low-carbon fuels for transport, power, heating and industry, and will eventually be a key part of the worldwide push for deep decarbonisation.

In a post-COVID environment, where people have lost their jobs, this is a fantastic opportunity to level up imbalances and should be an inspiration for the youth of today.

There is considerable optimism surrounding the developing hydrogen economy. The UK and Scottish governments have each committed to 5GW of low-carbon hydrogen production capacity by 2030, while the European Union's hydrogen strategy sits at the heart of its green deal and COVID recovery plan.

Considerable hurdles remain, however. If it is to fight climate change, the hydrogen will have to be carbon neutral, which means it will be either "green" (in other words, electrolysed from water using renewable energy) or "blue" (produced by reforming natural gas or gasifying coal, but with the CO_2 emissions captured). It will also need to be available at scale and easily and cheaply transported and stored.

Large-scale carbon capture and storage schemes will be an integral part of the blue hydrogen story, but this is a technology still finding its feet and, while the number of applications is growing, many are still at an early stage of development.

Innovation will be an important part of any success story. Siemens Energy and Siemens Gamesa, for instance, have teamed up to integrate electrolysers into offshore wind turbines as a single synchronised system to directly produce green hydrogen.

As with any emerging industry, government support will be crucial. We are advocating for a mechanism to encourage people to invest in these new technologies. Once the policies and the frameworks come out, you will see a huge amount of activity to develop projects.

The government published a *Ten-Point Plan for a Green Industrial Revolution* last November and an *Energy White Paper* the following month. There is no question in my mind that the government gets the message. With COP26 taking place this November in Glasgow, I think we will soon have a clear picture of where we are trying to get to in the 2030s and beyond.

So far, the UK has taken a world-leadership position on the green economy, but speed and scale will be important to maintain this advantage.

For more information please visit www.siemens-energy.com/uk/en/offerings-uk/hydrogen.html

SIEMENS energy

Vithun Khamsong/via Getty Images

NATURAL GAS

Gas as a transition fuel

Natural gas is an easy-to-deploy hydrocarbon producing 50 per cent less emissions than coal, but is transitioning to it really a step in the right direction?

Heidi Vella

As the momentum to heed scientists' warnings that carbon emissions must be halved this decade ramp up, questions are arising about natural gas' place in the energy mix. In particular, whether new investments in the fossil fuel are, in fact, commensurate with the Paris Climate Agreement.

"The net-zero targets mean there isn't time for gas as a bridge fuel; it's easier to replace coal globally with renewables," says Jennifer Cogburn, Gas Americas lead at BloombergNEF. "Gas is now on a similar downward trajectory to coal, just a little bit lagged."

What's more, some are questioning the fuel's stated climate credentials. According to a February briefing from Climate Bonds Initiative, an international NGO, evidence is emerging that the level of greenhouse-gas (GHG) emissions from gas-fired power is much closer to coal. It says previous calculations have not included the supply chain for gas, a significant omission.

At the production level, the high prevalence of leaked methane, a gas more potent than CO_2, is well known in the industry. In January, the International Energy Agency estimated oil and gas operations create just over 5 per cent of global energy-related GHG emissions this way. At International Petroleum Week in February, Maarten Wetselaar, integrated gas and new energies director at Shell, said a failure to tackle this issue could be "existential" for the sector.

> **Let's face it, it's the lesson from COVID isn't it? You listen to the scientists and act early**

Scientists largely agree, gas needs to be phased out of the energy mix by around 2035. Yet, in the UK and European Union, gas-fired power accounts for between 20 and 40 per cent of the energy mix, and in the UK meets around 80 per cent of homes' heating needs. Most coal-fired power plants are expected to be phased out and replaced by gas-fired ones, which have a 25-year lifespan.

However, it is well documented that investors are increasingly becoming nervous about the environmental, social and governance risks of fossil fuels, including gas. Some projects are already being impacted. In February, after legal challenges, energy giant Drax pulled out of a plan to build a large gas-fired power plant in the UK. The company had already sold some of its other gas assets.

Juliet Davenport, founder and chief executive of Good Energy, thinks the move is significant. "The economics for gas power plants are being challenged by drops in load factors due to renewables, in some cases from 80 to 60 per cent," she says.

France's Engie also recently backed out of a reported $7-billion, 20-year contract to import US liquefied natural gas (LNG) due to concerns about associated methane emissions.

However, most analysts see natural gas remaining strong in the market. Wood Mackenzie's latest report says it will be resilient in Europe until 2030. It estimates LNG will account for 27 per cent of the EU's gas supply mix by then, but adds it will face pressure to cut carbon and methane emissions.

"Our research finds overall emissions can be reduced significantly just by switching to gas quicker," says Murray Douglas, research director at Wood Mackenzie. "We're seeing companies take decisions to build new infrastructure, often entirely private investments; there's still a requirement to satisfy gas supply needs. Realistically, we're not going to suddenly halve our gas use in ten or fifteen years; it's going to be slow progress."

He refers to gas projects such as the Baltic Pipe being laid between Denmark and Poland, and a new LNG terminal in the latter.

The risks, however, "are heavily weighted to the downside", he notes. These include, most notably, battery technology, says Rystad Energy's head of gas and power markets, Carlos Torres Diaz.

"Batteries are still in the very early stages and can only provide back-up to the grid for around one to two hours, but if the technology continues to evolve, then this could start displacing some of gas's capacity," he says.

Along with increasing renewables, other technologies could also take capacity away from gas, such as hydrogen and heat pumps for home heating. The UK is targeting 600,000 heat pumps installed every year to 2028, along with phasing out gas boilers by the mid-2030s. How quickly some of these technologies are deployed and commercialised, however, depends largely on how stringent impending policy, including carbon pricing, will be.

"There's a lot of interest in the detail, which is not yet there. How will we move along this [decarbonisation] path? There are questions to be answered about what all the regulations will look like and what impact they'll have," says Gavin Watson, a lawyer at Pillsbury energy practice.

To shore up against these risks, SSE Thermal, a gas asset owner, is actively investing in carbon capture and storage (CCS). The company is currently working to deliver CCS-equipped power stations in the UK that will capture 1.5 million tonnes of CO_2 annually by the mid-2020s.

Wood Mackenzie's Douglas says to secure gas's future beyond 2030, there will need to be "more tangible progress" with CCS, which has been minimal so far.

There are those, however, who continue to argue the shift away from gas should simply happen quicker for the climate's sake.

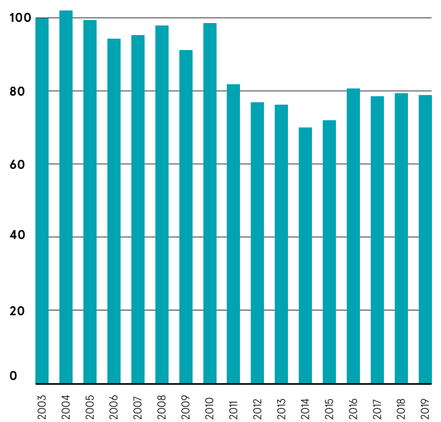
"Let's face it, it's the lesson from COVID isn't it? You listen to the scientists and act early," says Sean Kidney, Climate Bonds Initiative chief executive.

Going forward, use of natural gas, in Europe at least, is likely to decline. According to BloombergNEF, it already peaked in 2019, with demand shifting primarily to Asia, where 47 per cent of energy consumption is met with coal.

But given such pressing climate targets, once coal is gone, Rystad Energy's Torres Diaz says: "Definitely, the next big focus will be gas."

WILL GAS RELIANCE CONTINUE TO DROP? BP 2020

Natural gas consumption in the UK from 2003 to 2019 (in billion cubic metres)



Commercial feature

Agile Octopus customers benefit from times when power is cheaper and greener

Green home heating critical to net-zero ambitions

The UK remains a laggard on clean heat, with most homes still relying on gas. Given the huge challenge to meet carbon targets, are heat pumps the answer?

Decarbonising domestic heating is among the biggest challenges the UK faces in hitting environmental targets. Almost nine in ten British homes still use gas for heating, creating almost a fifth of the UK's carbon emissions.

The government has major plans for carbon elimination. It wants to generate enough offshore wind energy to power all UK homes by 2030, while banning sales of new polluting cars. Two decades later it is targeting net-zero emissions. Many experts believe home heat pumps have a major role to play in success as they are innately efficient and can generate heat from renewable electricity.

"Heat pumps work like an inside-out refrigerator, using electricity to take heat from outside and bring it into homes. The results are like magic: turning every kilowatt-hour powering them into more than 2.5 to 4kWh of heat," says Greg Jackson, chief executive of Octopus Energy, which supplies electricity to two million UK households. "This is over three times the equivalent delivered by gas boilers."

> **There is every reason to think heat pumps will become the preferred heating system by 2030**

Heat pumps are a new technology in the UK, so the current upfront expense remains higher than with a gas boiler. But as with solar panels or electric vehicles, costs would rapidly drop with supportive policies and manufacturing efficiencies. Achieving this requires first lowering green electricity costs to run the pumps, which would stimulate wider usage, and in turn lead to mass production and much lower device prices.

The government believes heat pumps will play a key role in bringing down carbon emissions and is aiming for 600,000 heat pumps to be installed annually by 2028 – and tax reform can help make this a reality. "Green taxes, which include carbon taxes on wholesale costs, should be moved from electricity to gas to fairly reflect its environmental impact and incentivise a consumption change," says Jackson.

Currently, consumers pay heavily for electricity taxes as about 23 per cent of their electricity bills are green charges, even when they use green electricity. The equivalent with polluting gas is only 2 per cent. And given that generation from renewables is continuously becoming cheaper, there is the potential to lower consumer costs even further.

As these changes take place, heat pumps will become cheaper to manufacture. Jackson notes: "In essence they are a fan, a motor and a few pipes with heat-transfer fluid, so as soon as the wider demand emerges, mass production begins and prices will plummet."

Smart tariffs can augment these consumer savings. Most people still buy electricity at a fixed rate, even though it is significantly cheaper outside typical peak times of 4pm to 7pm. "Octopus Energy's smart tariff, called Agile Octopus, ties prices directly to wholesale costs and many customers use it to shift their total consumption away from peak times. This means heat pumps could be used off peak which would greatly lower their running costs," Jackson explains.

Total savings will help drive the necessary environmental change. An Octopus Energy analysis shows that by using electricity off peak, removing green taxes from renewable energy sources and taking advantage of the innate efficiency of heat pumps, costs per unit with a clean heat pump could soon be lower than with a carbon-intensive gas boiler.

"There is every reason to think heat pumps will become the preferred heating system by 2030," says Jackson, whose company is in early pilots to install the devices in a number of UK homes. "Our aim is to help drive the change because of the clear benefits to consumers and to the environment."

To find out more about Octopus Energy's march towards a decarbonised world please visit octopus.energy

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