

Ethical CORPORATION MAGAZINE

DIGGING DEEP WITH
BLOCKCHAIN

HIGH HOPES FOR
HYDROGEN TO
DECARBONISE
TRANSPORT

A photograph of a man with a muscular build, wearing a blue tank top, a brown cap, and khaki pants, digging in a trench with a blue shovel. The background is a clear blue sky and a large mound of brown earth.

HARD TRUTHS ABOUT THE GREEN ECONOMY

The race to clean up mineral supply chains

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WELCOME TO THE NOVEMBER 2019 ISSUE

This month, we are taking a deep dive into efforts to clean up the production of the minerals that are critical to the energy transition. As Martin Wright reports, the collapse of the tailings dam at Vale’s mine in Brumadinho, Brazil, in January this year was only the most spectacular recent example of the environmental and human rights toll of mining, a sector that is becoming increasingly important due to the rapid rise in adoption of renewable energy and electric cars. He charts progress by the industry itself and the increasing pressure being brought by investors.

One of the most crucial issues is tackling the significant human rights and environmental risks of the small-scale artisanal mining sector, particularly in cobalt. Catherine Early reports on how blockchain is being trialled by companies, including IBM, to bring the necessary transparency that could keep 150 million artisanal miners in global supply chains.

With the EU targeting a third of cars being electric by 2030, one of its poorest member-states, Portugal, sees a bright future in exploiting the mineral critical for batteries. But as Oliver Balch reports from Porto, the “new gold” could turn to dust if local opposition is not assuaged.

Our other briefing this month highlights progress in overcoming some of the biggest challenges on the road to more sustainable transport. With the IPCC warning against growing crops for fuel, alternatives to kerosene >

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are nowhere near the 31bn litres needed by 2030. Angeli Mehta reports on the companies, including LanzaTech and SkyNRG, that are producing the next generation of bioenergy.

She also highlights the growing calls to tax aviation in Europe, where the “flight-shame” movement is expanding, but not fast enough to curb galloping demand.

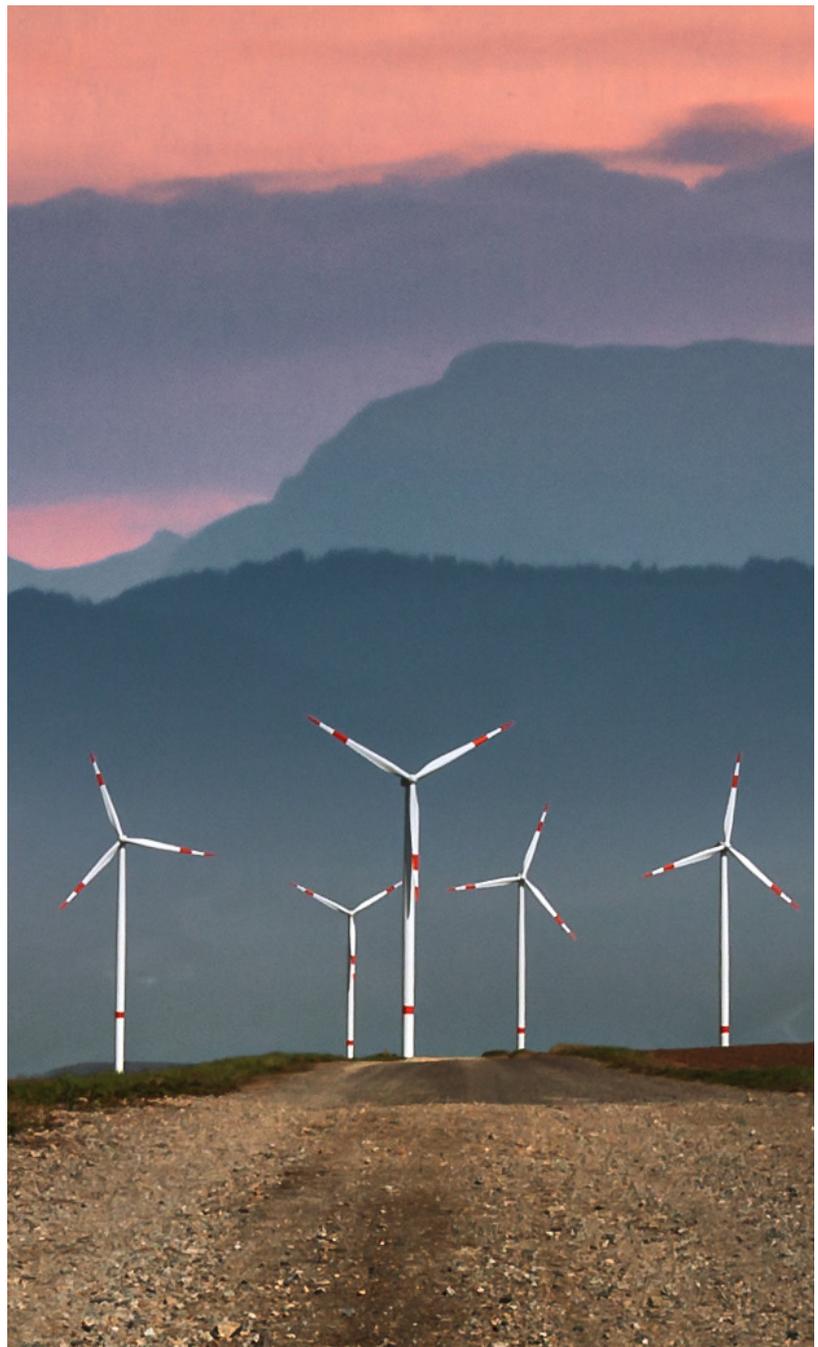
Mehta also looks at prospects for decarbonising road transport using hydrogen, as the first hydrogen powered trains take to the rails in Germany, and net-zero emissions targets in UK and France help to drive the regulations and incentives that will be needed to finally take this low-carbon transport technology to scale. She also reports on [digital solutions](#) to make road travel safer and less congested in Africa.

And I report on progress on India’s ambitions to electrify road transport and find that while a market for electric private cars is still some way off, in public transport and shared vehicles such as buses, taxis, motorcycles and rickshaws, the EV revolution is well under way.

Next month, we will be asking whether the Task Force on Climate-related Financial Disclosures recommendations are succeeding in their aim of driving a more low-carbon economy. And we will end 2019 by publishing some of Oliver Balch’s “disruptors” series of interviews with sustainability leaders. ■



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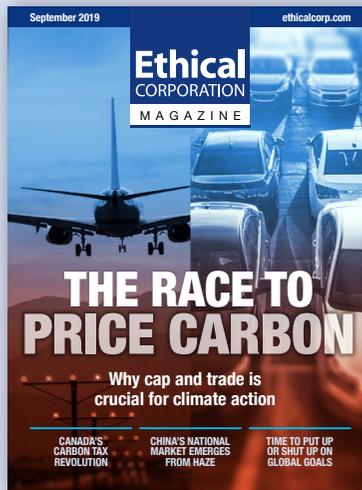
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A DECADE OF ACTION: ETHICAL CORPORATION MAGAZINE IN 2020

Ethical Corporation is in the process of drawing up its editorial calendar for next year, and if you are interested in supporting and/or assisting us to cover particular areas listed below, please do contact sponsorship@ethicalcorp.com



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- ▶ The rise of climate adaption (including water risk and migration crisis)
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Road to the clean economy shrouded in murk

Martin Wright reports on a host of new initiatives to urgently clean up the production of 'energy transition minerals' like lithium, cobalt and copper

 [VIEW ONLINE](#)





WIKIPEDIA

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hen the tailings dam at Vale's mine in Brumadinho, Brazil, [failed in January 2019](#), killing around 250 people, it unleashed a renewed torrent of concern over the human and environmental cost of the world's extractive industry.

And it accelerated efforts to scrutinise and manage a supply chain which, while it may start deep in Brazil, Peru or Congo, often ends up, literally, in our hands – in the text I've just sent to my son, the laptop on which I type these words – and the device on which you're reading them.

Because while the dam collapse may have been the most spectacular recent example of mining going wrong, it's far from the only one. This year alone has seen a flurry of reports of human rights abuses in the extraction of everything from [lithium](#)

The aftermath of the Brumadinho tailings dam collapse in Brazil, which killed 250 people in January 2019.

and [cobalt](#) to copper and gold. The first three are among the so-called "energy transition minerals", seen as vital to the emerging green economy.

There's a searing irony here, and it's one not lost on investors and activists: the powerhouse of a clean, green future is being driven in part by some distinctly dirty and dubious practices. And to add urgency to irony, if that economy is to fulfil its promise and transition us smoothly to a low-carbon future, our need for such materials is set to soar. The World Bank estimates a cool 1000% increase in consumption of key minerals used in energy storage under a 2-degree climate action scenario. The World Economic Forum-led Global Battery Alliance suggests that in the next decade alone, thanks to the rapid rise in adoption of renewable energy and electric cars, demand for lithium and cobalt will balloon by a factor of six and four, respectively.

So it's no surprise that, as reports mushroom of bad practice down and around the mines, investors who take sustainability seriously are getting increasingly anxious. "They realise they're exposed to companies who are dependent on >

extracting resources from some very dodgy places in the world, and they're not always managing that risk properly," says sustainable finance specialist Sasja Beslik, currently managing director of the Zurich-based bank J. Safra Sarasin. "That's making them much more willing to start demanding hard evidence of more responsible practice."

Such evidence isn't easy to come by. Like many of the world's supply chains, the one for transition minerals can be both convoluted and murky, particularly where small-scale, "artisanal" operations are involved. There are an estimated 18,000 tailings dams scattered across the world, and in many cases, their ownership is unclear.

One initiative that seeks to shed some light on the chain is the Transitional Minerals Tracker, a project of the Business & Human Rights Resource Centre (BHRRC), backed by the Ford Foundation. It covers the six minerals key to the production of solar photovoltaic panels, wind turbines and electric vehicle batteries – namely cobalt, copper, lithium, manganese, nickel and zinc. In each case, it identifies the human rights risks associated with their production, and the leading companies involved in their extraction. Then it tracks whether those companies have human rights policies in place, and pinpoints allegations of abuse against them.

It makes for rather grim reading. Take lithium. Each one of the five largest companies involved in its extraction (Albemarle, Jiangxi Ganfeng, Livent, SOM and Tianqi) have been accused of abuses in their South American operations, while only one (Livent) has a human rights policy. Even where such policies are in place, says the BHRRC's senior researcher, Eniko Horvath, it's no guarantee that



ANATOLIY_GLEB/SHUTTERSTOCK



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abuse won't occur. "All but three of the 23 leading companies in transition minerals have outstanding allegations against them, yet 14 have [decent policies on paper]. It just shows they are not strong enough to deal with the problem on the ground."

A similarly disheartening conclusion comes courtesy of the Responsible Sourcing Network in its latest annual report, [Mining the Disclosures 2019](#). It singled out 27 leading cobalt importers as particularly poor performers when it comes to exercising due diligence in their supply chain, accusing them of complacency and describing their attitude to corporate risk as "deplorable".

Ouch.

To be fair to the industry, it hasn't been idle. The last few years have seen a veritable plethora of schemes aimed at cleaning up the supply chain, such as the Responsible Minerals Initiative, which aims to "help companies make informed choices about responsibly sourced minerals in their supply chains". Its members range from tech giants such as Apple, >

Small-scale artisanal mining operations are more likely to pose supply chain risks.



All but three of the leading companies in transition minerals have outstanding allegations against them



RODRIGO S. COELHO/SHUTTERSTOCK

Facebook and Google, to automakers Renault, Tesla, VW and Volvo, and many more besides.

But the fact that reports of abuses continue to surface suggest there's a long and rocky road ahead to genuinely responsible sourcing. And as demand for transition minerals rockets, that road won't get any smoother.

INVESTOR ENGAGEMENT

So how are investors responding to it all? For the most part, the watchword is “engagement”. In the case of Stephen Barrie at the Church of England Pensions Board, it's even in his job title: deputy director of ethics and engagement. “We're grappling with the fact that these [extractive] industries are hugely important in terms of a transition ... but also have a very high social and environmental impact,” he said. Like many in the sustainable finance world, the Church has decided that [disinvestment is a stick to be wielded only as a last resort](#). Instead, it's marshalling both its moral and financial influence in a drive to improve practice, particularly when it comes to tailings dams.

Like many, the CofE was shocked by the

Protest in Brazil against the Brumadinho mine collapse.

Brumadinho collapse – but sadly not that surprised. “We'd identified tailings dams and joint ventures as a major concern in 2017, and started engaging with the International Council on Mining and Metals [ICMM – a leading industry body] last year. So when the disaster happened, we at least felt we'd done our homework. We waited until the end of the official mourning period in Brazil, then issued a call on behalf of a group of investors saying there had, as a matter of urgency, to be much better standards on tailings management.”

The Church's moral influence may be hard to quantify, but there's no doubting the financial clout such influence can bring to bear. That call has now attracted the support of more than 100 investors, with a combined total of \$12trn assets under management. The result has been the launch of a Global Tailings Review, co-convened with the UN's Principles for Responsible Investment, the UN Environment Programme and – crucially – the ICMM, and led by a group of independent experts. It's early days, admits Barrie, but “our intention is that today's best practice becomes the minimum standard, because these are major dams, which >

AEROVISTA LUCHTFOTOGRAFIE/SHUTTERSTOCK



Tesla is a member of the Responsible Minerals Initiative, which aims to help companies clean up their supply chains.

have serious consequences when they fail – and there are so many around the world.” Once the review’s completed, that standard “will become a requirement for ICMM members”.

The CofE isn’t waiting to act, though. In April, it wrote to all publicly listed extractive companies and asked them to disclose all of their tailings dams, including those run under joint ventures, whether operating or not, and answer 20 questions on each dam, ranging from engineering issues to managerial oversight. It gave them 45 days to respond in the form of a letter signed by the chair or CEO. To date, says Barrie, 68% (by market capitalisation) of the sector has replied, which he regards as “a really good response”. Details of all the disclosures, along with lists of companies that have as yet failed to respond, will be published on the CofE’s Pensions Board website as a very public tool for other investors to use when making funding decisions.

The Church of England is far from the only investor getting stuck into the transition minerals issue. Spurred by an [Amnesty International report](#) into working conditions in cobalt mines in the Democratic Republic of the Congo (DRC), the UN’s Principles for Responsible Investment network targeted the cobalt supply chain. Specifically, it asked leading auto and electronics companies where they source their cobalt.

Initial responses varied. “Some of the more advanced ones had started to treat cobalt as a conflict mineral, and begun to carry out the same due diligence efforts they did with tin, tantalum, tungsten and gold”, says the PRI in its report



Some of the more advanced companies say they have started treating cobalt as a conflict mineral

Drilling down into the cobalt supply chain. But other responses stretched credulity, with some “claiming to rely on cobalt not sourced from the DRC. Given the amount of cobalt used in the companies’ products not only were these claims very unlikely, but they also failed to provide proof to back them up,” the report says.

Amnesty followed up with further research to allow investors to make a like-for-like comparison of companies. Some emerged with credit. These included household names such as Apple, praised for having 100% of the smelters in its chain audited by third parties, and BMW, for publishing the full list of smelters and refiners its suppliers use, and the countries of origin from which it sources. Samsung, too, drew praise for insisting on third-party audits.

Such engagement with the wealthier end of the supply chain, rather than producers further upstream, could exert considerable leverage. After all, the same tech and auto giants that are keen to trumpet their net-zero ambitions will hardly welcome exposure to allegations of human rights abuses. Hence, perhaps, Amnesty’s ethical >

battery campaign, launched in March 2019, challenging the leading carmakers to produce the world's first completely ethical EV battery within five years' time.

REGULATION

As well as the carrot of investor support, of course, there's the stick of the law. Regulations such as the Dodd-Frank Act in the US, and the EU's forthcoming Conflict Minerals Regulation (covering tin, tantalum, tungsten and gold), can help concentrate minds around the boardroom table. But as Beslik says, "they can only really have an impact if there's true transparency in the supply chain". And as a rule, the more disparate and fragmented the chain, the tougher it is to manage, let alone police. Barrie acknowledges that investor pressure stands a much greater chance of success with larger operators (rather than the artisanal sector since these, by definition, are entities that can attract direct investment).

So is such pressure having an effect? Yes, says Terry Heymann, CFO of the World Gold Council, which represents large-scale mining companies. It's recently launched a set of Responsible Gold Mining Principles (RGMP), "in large part as a response to growing investor interest... We're already seeing investors pulling back capital [from dubious operators], insurance providers taking a second look and customers increasing their scrutiny."

The principles, announced in September this year, cover issues from labour conditions to environmental impact. They were drawn up after two years of consultation with more than 200 experts and organisations, ranging from industry bodies to civil society, including NGOs that have been quite [critical of the sector](#), such as Global Witness and Earthworks.

There will be a three-year implementation period, after which council members will be expected to conform to the principles as a condition of business, says Heymann. Their greatest impact, he



ULULA

Social enterprise Ulula has customised apps that allow miners to report issues via text or voice message.

suggests, will be on the "investment community and customers, saying 'we're not going to provide you with capital or buy your products unless you conform'. And that would be a good place to get to."

All such initiatives, of course, rely on transparency, and that means on-the-ground assurance. Quite how thorough that can be is a debatable point. The RGMP lay great stress on third-party assurance, although when I ask Heymann if this would include unannounced spot-checks, he demurs. "It's possible that these may happen down the road, but for now, the whole area of non-financial assurance is still developing."

Whether assurance can really be thorough without such uninvited swoops is a moot point, of course, although as technical solutions such as sensors, apps, and monitoring by drones and satellites improve so does the potential for more thorough scrutiny.

The Church of England's Stephen Barrie cites a project run by Fundación Chile, which monitors tailings dams using a mix of ground sensors and insights from local people, with the data uploaded to a website open to all.

As mobile phones become commonplace even in remote areas, the opportunity to enable mine workers and their surrounding communities report issues via secure apps is growing. Ulula, a Toronto-based social enterprise that harnesses technology to help organisations monitor human rights in >



The newly launched Responsible Gold Mining Principles cover issues from labour conditions to environmental impact



PIXFICTION/SHUTTERSTOCK

their supply chains, has customised apps but also allows people to report issues via text or voice message, ensuring that a lack of access to the latest technology is no barrier.

Mobile phones can help ensure artisanal miners get the best price for their product, by providing them with the latest market information, and allowing them to seek alternative buyers who might offer them a better deal. Mobiles can also provide SMS warnings of unstable mine shafts, or the dangers of chemical processing, as well as links to the nearest health centres in case of emergency. And, of course, they can help miners band together to negotiate better terms. (See [Can high-tech solutions work for artisanal mining?](#))

Ultimately, the sheer weight of demand for the minerals needed to drive the green transition should unleash greater research and development investments in both demand-reduction and alternative materials. There are promising signs here, such as the integration of EV batteries in the power grid to curb overall electricity demand, and improvements in the recycling and repurposing of both batteries and wider IT tech in general. There

The World Gold Council has launched a set of Responsible Gold Mining Principles largely in response to growing investor pressure.

is even the more distant prospect of some of the more awkward raw materials, including cobalt and lithium, being reduced or replaced with the advent of technologies such as sodium-ion.

Such investments are, by their nature, riskier and longer-term. But it's there, perhaps, that the greatest rewards lie – not just financial, but for people and the planet, too. ■



Martin Wright (@martinfutures) is a writer, adviser and public speaker specialising in environmental solutions and sustainable futures. He is a former director of Forum for the Future.



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Can high-tech solutions work for artisanal mining?

With 150 million people dependent on small-scale mining, companies including IBM are trialling technologies like blockchain to keep them in supply chains despite the perceived high risks. [Catherine Early](#) reports

 [VIEW ONLINE](#)





AMNESTY INTERNATIONAL

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igh-profile human rights scandals in the sourcing of cobalt have sent companies that use the metal in lithium batteries scrambling for initiatives to clean up their supply chains. (See [Road to the clean economy shrouded in murk](#))

Campaign groups and others working with artisanal miners welcome these efforts, but worry that new regulations in the EU and US, coupled with the increased pressure on companies to take more responsibility for their supply chains, could have unintended consequences.

Some 40 million people in 80 countries make a living from artisanal mining, while an estimated 150 million are indirectly dependent on it. The fear is that if companies believe it is too risky to use

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The Clean Cobalt Framework contains a commitment not to use cobalt from artisanal mines

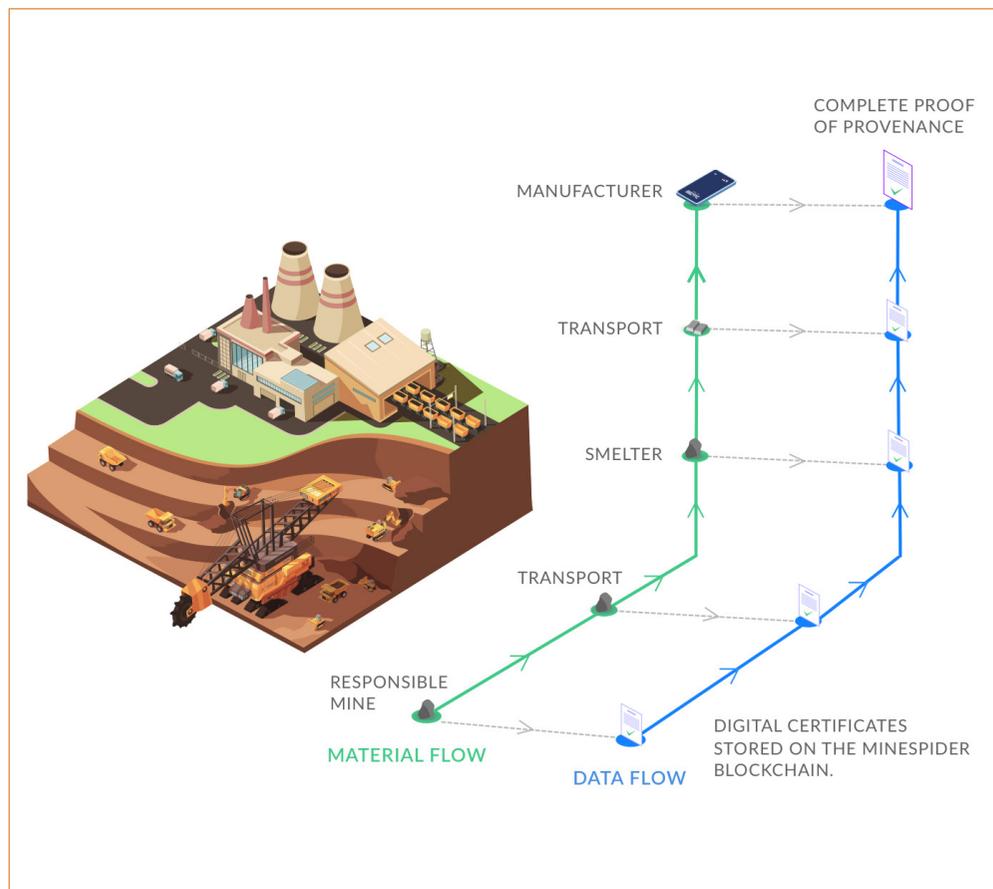
artisanal mining in their supply chains, they could abandon the sector altogether.

Such concerns are not unfounded. At the end of last year, mine operator Eurasian Resources Group (ERG), which extracts and processes minerals including iron ore, copper and cobalt, announced a [Clean Cobalt Framework](#) as part of a plan to increase cobalt production four-fold.

The framework contains an explicit commitment not to use cobalt from artisanal mines. ERG stated that the sector accounts for 20-25% of global cobalt production, but that it was concerned about child labour and human rights issues associated with >

“

Due diligence isn't about avoiding risk, but identifying and addressing it, and being transparent about that



MINESPIDER

it, and that it needed to support its customers in responsible sourcing of the metal.

Lauren Armistead, business and human rights researcher and campaigner at Amnesty International, says: “Due diligence isn't about avoiding risk, it's about identifying risk and addressing it, and being transparent about that. Then all the actors in a supply chain can work together on the issue.”

Nathan Williams, founder and chief executive of Minespider, a blockchain protocol for responsible mineral sourcing, agrees that artisanal mining has been made “an easy scapegoat”. “There are legitimate problems, but they are used to distract from the problems that large-scale mines have,” he says.

“If the answer that the industry comes up with is that mining should go to be a ‘large-scale player only’ model, then we have to ask what else can these people do, and how can they feed themselves. That's not an easy answer,” Williams says.

However, he adds that in order to de-stigmatise artisanal mining, the sector needs to be formalised, and that means a company buying downstream needs to be able to verify that a mineral came from artisanal mining, and knows the conditions under which it was produced.

Minespider's blockchain technology is being piloted in Peru and Europe.

BLOCKCHAIN AS A SOLUTION

One possible solution is blockchain, which can provide an immutable record of information, such as what mine the mineral came from, whether it has a licence from the government, the quantity of the mineral sold, and at what price.

Initiatives so far have tended to focus on large-scale industrial mining, but some companies are now beginning to explore how to use the technology with artisanal miners. This is more challenging due to lack of access to technology and incentives for people to use it, but proponents admit that although difficult, it is not impossible.

Germany-based Minespider is one of these. It has open-source, public blockchain technology that is being piloted in Peru and Europe, so far just with large-scale mining companies. But it has always intended to expand use to the artisanal mining sector, Williams says. The technology is ready; it just needs agreement from government bodies, businesses and development agencies, and the company is working on this, he says.

In a [whitepaper](#) explaining how blockchain could be used to make mineral sourcing more responsible, Minespider suggests ways that the artisanal sector could be involved. These include >



DENNIS VAN DE WATER/SHUTTERSTOCK

IBM's Responsible Sourcing Blockchain Network is looking to expand into the artisanal mining community

developing an easier to use version of its specialised online application, and working with its partners to establish a comprehensive programme of training, microfinance and savings, as well as health and education services to incentivise people to participate in a traceability programme.

“You can't just send blockchain into rural Africa and expect artisanal miners to use it, there needs to be some kind of onboarding” Williams says.

IBM is also considering how to use its blockchain technology in the artisanal mining sector. In January this year, it established a consortium called the Responsible Sourcing Blockchain Network (RSBN), which includes automotive manufacturers Ford, Volvo and Volkswagen Group.

This has been successfully piloted on a cobalt supply chain from the Democratic Republic of the Congo via China and South Korea to the US, and is ready to be rolled out, according to Sai Yadati, who leads IBM's blockchain work with industrial sectors.

“Now that we know it works, we are looking into expanding the technology to the artisanal

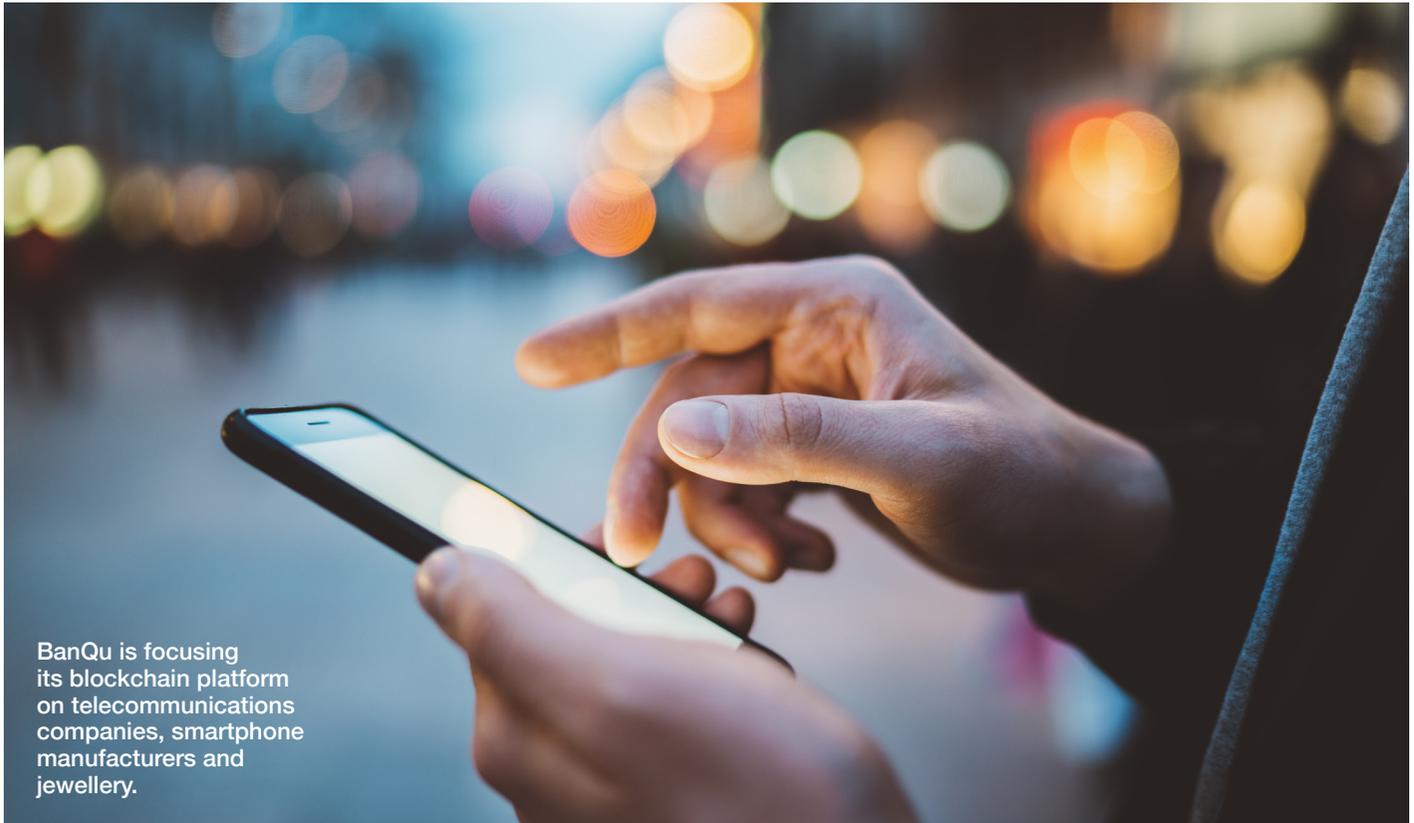
Around 40 million people make a living from artisanal mining, and an estimated 150 million are indirectly dependent on it.

mining community,” he says. Responsible sourcing technology specialist RCS Global Group is also involved with the project. The company already has a strong focus on the artisanal sector through its data-driven mine-site monitoring tools, Better Sourcing and Better Mining.

Nicholas Garrett, the company's chief executive, says that it is straightforward technology-wise to link the blockchain to its existing tools. Yadati agrees, and says the harder part will be incentivising miners to use the technology, and making it easy for them to do so.

Yadati is vague about the solution to this, but says all partners in the consortium are working on it, and Félix Tshisekedi, president of the Democratic Republic of the Congo (DRC), has said he supports the idea.

One company that claims to have a solution for using blockchain with artisanal mining communities is BanQu, which has been operating a blockchain platform based on SMS technology in the [agricultural sector](#) for three or four years. Its >



BanQu is focusing its blockchain platform on telecommunications companies, smartphone manufacturers and jewellery.

IMYANIS/SHUTTERSTOCK

founder and chief executive Ashish Gadnis says the technology has to be kept simple as many people in developing countries do not have smartphones.

“A lot of the large global brands in the tech sector will try to make it complex, that you can’t just bring blockchain to artisanal miners. But the blockchain part is irrelevant: the question is ‘can you give the miner the ability to prove their existence in the supply chain?’ That’s the biggest missing link in mining and farming,” he says.

Information is added to the blockchain by the buyer, while the miner will receive a SMS message through the BanQu system confirming data such as the quantity sold and the price. This SMS is also stored on the blockchain, so it would be obvious to the end-user of the mineral if the buyer had not paid the correct amount to the miner as the data would not match, Gadnis explains. The miner then has a record of the fact that he is part of a legitimate global supply chain, which is very valuable in a sector with a lot of migration, he says.

BanQu is focussing on major telecommunications companies, battery and smart phone manufacturers, and jewellery. It is hoping to announce the first roll out of the technology in two or more of these sectors by the end of the year, sourcing from a handful of cobalt mines in the DRC, Zambia or Madagascar, and precious metal or gemstone mines



The Responsible Business Alliance is trying to address challenges in bringing blockchain to small-scale operators

in Botswana, Peru or Colombia, Gadnis says.

Despite the progress made by these companies, challenges remain in bringing blockchain to the artisanal mining sector. The Responsible Business Alliance is trying to address these through its Responsible Minerals Initiative, and published [guidelines specifically on blockchain](#) in December last year.

The guidelines promote the adoption of a common set of definitions and concepts in the application of blockchain solutions in mineral supply chains, and consensus on what data should be included at each stage of the blockchain, so that systems are consistent and comparable.

They state that the blockchain should be designed so that small-scale operators have the necessary technical skills, are able to upload data with low or no internet connection, can access devices that >



Blockchain can highlight where there are ESG issues, but it isn't a silver bullet in countries with weak governance

support the app, can afford any fees, and have power to charge devices.

Michèle Brühlhart, director of innovations at the RBA, says: “This is a standardised approach, but it’s a way of incentivising some of the programmes to consider the more challenging questions around how this technology is applied, so that good models emerge.”

Brühlhart believes that the greatest potential for blockchain in artisanal mining comes from how it is integrated with other technologies, such as mobile money, which enables miners to easily and securely access the funds from the sale of the material they have mined.

The guidelines are currently being revised to include lessons learned so far, she says, adding: “This is a very dynamic field: a year ago we didn’t have the same level of understanding of some of the issues and challenges that we do now as many projects are still in the early stages.”

But Armistead says that blockchain will only really work for artisanal mining in regions where it is regulated, where there are cooperatives through which technical training can be provided. For example, in the DRC many cobalt miners are forced to work in unregulated areas, as there are not sufficient regulated sites compared with the number of people trying to make a living in this way.

“Blockchain can highlight where there are environmental, social and governance issues so that companies can come up with ways of addressing them,” she says. “But it’s not a silver bullet in countries where there is weak governance, institutions and a large unregulated sector.” ■



An artisanal gold miner in Tanzania.

AFRICA924/SHUTTERSTOCK



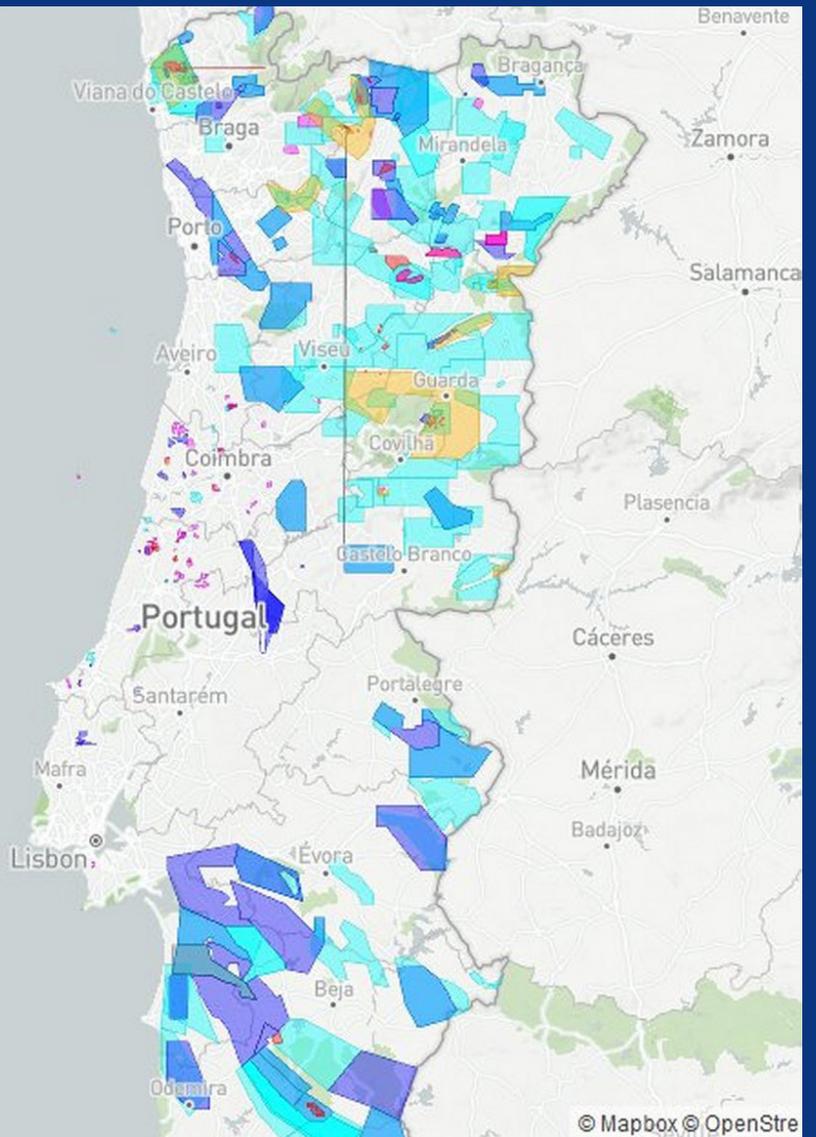
Catherine Early is a freelance journalist specialising in the environment and sustainability. She writes for Business Green, China Dialogue and the ENDS Report among others. She was a finalist in the Guardian’s International Development Journalism competition.



Map showing the areas where requests for mining rights and concessions have been received by the Portuguese government.

With the EU targeting a third of cars being electric by 2030, one of its poorest states sees a bright future in exploiting the mineral critical for batteries. But as [Oliver Balch](#) reports from Porto, the ‘new gold’ could turn to dust if local opposition is not assuaged

 [VIEW ONLINE](#)



MAPA DO MINÉRIO, NIK VÖLKER

Communities fail to buy into PORTUGAL'S LITHIUM DREAMS



“I honestly believe lithium could be the new gold.” This verdict, shared by Maroš Šefčovič during his recent tenure as the European Commission’s energy chief, captures the excitement currently surrounding this silver-white, alkali metal.

Once of little commercial interest outside the glass and ceramics industries, lithium has emerged as a central component in new-generation batteries – demand for which is sky-high in the consumer electronics sector and potentially stratospheric in >



the nascent but much-anticipated electric vehicle (EV) market.

If European Parliament targets are met, 35% of new cars and vans sold on the continent will be electric (or fuelled by other zero-emission technologies) by 2030. Current trends are positive. Global EV sales presently hover around **158,000 units per month** (of which Europe accounts for 35,000), but predicted sales over the next decade are set to spike more than fourteenfold (to 2.3m per month).

But where will all the lithium come from if and when such a boom materialises? At present, by far the biggest supplier is far-off Australia, followed by Chile, China and Argentina. With no large-scale domestic production in Europe, EU-based battery manufacturers currently source 100% of their lithium supply from outside the continent.

Step forward Portugal. An extensive geological survey carried out by the Portuguese government in 2016 revealed that this western slice of the Iberian peninsula is rich in lithium reserves. Not only that, but the Portuguese government, which calculates that the five most promising areas could generate **€3.3bn in investment**, is anxious to develop them. Indeed, notification of an **international licensing**

tender for lithium exploration in a dozen areas (covering up to 3687km²) is expected any day now.

Promising as the geological and economic prospects may be, Portugal's hopes for a lithium goldrush are by no means a dead cert. Mining, like all industry sectors, requires a degree of popular support. If not, even the best-laid plans can quickly turn sour – as innumerable stalled or cancelled extractive projects around the world testify.

And in the case of Portugal, lithium's "social license to operate" remains far from secure. While no permits for large-scale lithium production have yet been granted, preparatory exploration is well advanced in three areas already: in the northern districts of Vila Real and Gerês, and in the central district of Beira. In all three cases, well-organised community groups have emerged in opposition.

In each case, the complaints of the affected communities are similar: that open-cast mining of the kind proposed is potentially polluting, that it will dramatically and irreversibly alter the local landscape, and that it represents a diametrically opposite view of economic development to the sustainable, low-impact vision they desire for their regions. >



FLICKR

Renata Almeida, leader of an active anti-lithium group in Beira, echoes the fears and frustrations of her fellow protestors as she tells Ethical Corporation: “Portugal is not China or Australia, where there are genuine deserts. Here, we don’t live in a desert. There are small communities in all these areas. Plus, 35% of our territory is already in danger of drought and these mines will disrupt the hydrological system even more.”

Portuguese protestors are quick to point to precedents in other countries where lithium is developed. Lithium mining companies in Chile stand [accused of extracting more than their legal quota of water](#), for instance. The fact that Amnesty International felt it necessary to [initiate a campaign](#) earlier this year to highlight the human rights abuses linked to lithium-ion batteries (a charge sheet that included the failure of mining companies to gain prior consent from affected communities) adds to disquiet in Portugal.

Naturally, prospective investors are quick to dispute such fears. The government has also given assurances that all operators in any future lithium sector will have to meet exacting environmental standards. In a slick [promotional video](#) targeted at investors it asserts that all regulations are aimed at providing “clarity, stability and safety, and adjusted to present-day reality”.



Lithium mining companies in Chile stand accused of extracting more than their legal quota of water

Such assurances will only wash if they are backed up by a “rigorous” human rights environmental due diligence process, says Eniko Horvath, senior researcher at the non-profit Business & Human Rights Resource Centre (BHRRC). Earlier this year, BHRRC reported on complaints by indigenous groups in South America’s so-called “[lithium triangle](#)” (Argentina, Chile and Bolivia). “We have seen what happens if [human rights due diligence] is not properly undertaken,” Horvath said.

The International Council on Mining and Metals (ICMM) directs potential investors to its [Sustainable Development Framework](#). The eight-page document articulates a host of best-practice environmental and social requirements, from water stewardship to operating in protected areas, a factor relevant in the case of both Beira and Gerès. >

“

Our advice is to maximise transparency and the integration of any proposed mine into the overall development plan

ICMM's chief executive, Tom Butler, says if Portuguese society at large (and affected communities, in particular) are ever going to buy into the introduction of large-scale lithium mining, they also need to be persuaded that lithium brings upsides.

“Our advice would be to seek to maximise communication and transparency between communities, government and mining companies [in order] to try to maximise the integration of any proposed mine into the overall development plan for the region.”

UK-based Savannah Resources, which is in the advanced stages of the permitting process for a \$110m mine at Covas do Barroso in Vila Real, says it is following ICMM's advice to the letter and has been in close discussions with local and regional authorities from the get-go. As the project develops (operations are earmarked to kick-off in 2022), it anticipates supporting vocational training for local residents, among other jointly agreed community projects.

From where chief executive David Archer sits in London, the upsides of the three-block, 2.94km² mine appear “overwhelming”. His firm's proposed investment promises to create work for 200 people (with an additional 600 or so indirect jobs). And this in one of Portugal's poorest areas, where the population has halved since 1980s because of few job prospects for young people.

At present, “the area's biggest export is its people,” Archer observes, noting that the village school recently closed for lack of pupils. Beyond the mine gates, he talks up the possibility of a mineral

The Mina do Barroso lithium deposit in Northern Portugal is being developed by UK-based Savannah Resources.

conversion plant and battery manufacturing facility emerging during the mine's 15- to 20-year lifespan. Such a vision chimes with the government's strategy for revitalising the country's struggling interior, he adds.

Archer reads the newspapers so will know how many local residents boycotted the country's national elections in October in an effort to get politicians in Lisbon to heed their concerns. He may well also know how opposition groups in Beira have written an [open letter](#) to the prime minister spelling out their fears.

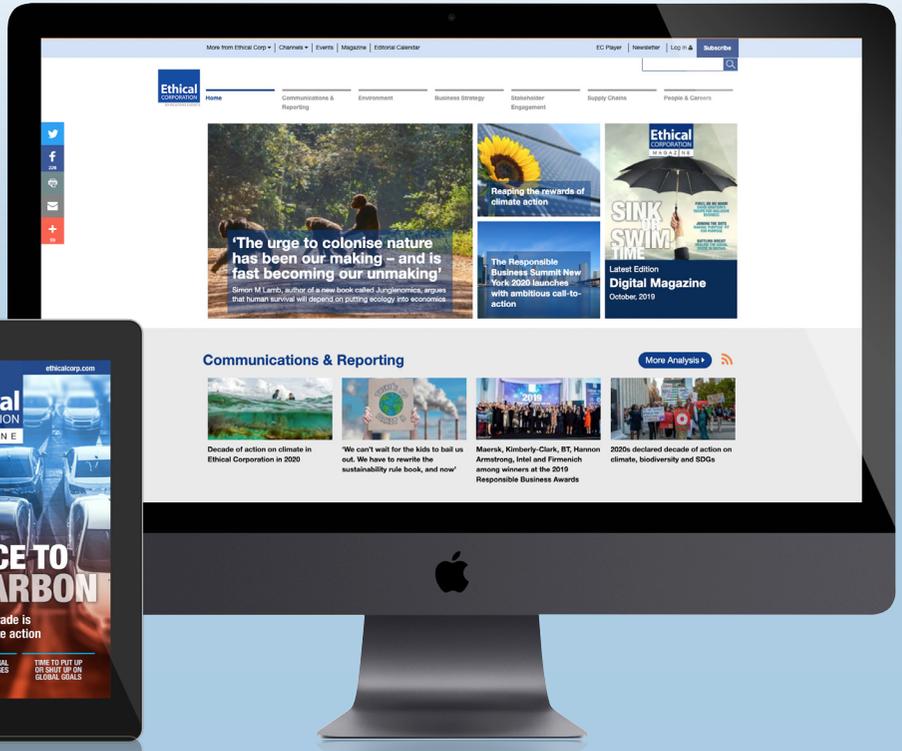
Some opponents will never be won over. But better information about the facts and benefits of mining may help win over some dissenters, lithium proponents hope. Not everyone has to buy into Portugal's plans for a national lithium industry in order for it to take root. But the more who don't, the more tarnished its new gold rush will look. ■



Oliver Balch is an independent journalist and writer, specialising on business's role in society. He has been a regular contributor to Ethical Corporation since 2004. He also writes for *The Guardian* among other UK and international media.



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SKYNRG

The long haul to getting **AVIATION BIOFUEL OFF THE GROUND**

With the IPCC warning against growing crops for fuel, alternatives to kerosene are nowhere near the 31bn litres needed by 2030.

Angeli Mehta reports on the companies producing the next generation of bioenergy

 [VIEW ONLINE](#)





MAXX-STUDIO/SHUTTERSTOCK

The first flight using a blend of kerosene and biofuel took place back in 2008. Eleven years and another 150,000 flights on, how much further forward is the industry?

The International Energy Agency estimates that aviation biofuel production was 15 million litres in 2018. To meet the 10% of consumption envisaged in sustainable development scenarios, production needs to reach 31 billion litres by 2030.

So how will it be possible to achieve the scale-up needed?

US-based LanzaTech, which makes aviation fuel from industrial waste emissions, has just secured \$72m from Novo Holdings, an achievement its chief sustainability officer Freya Burton describes as “significant”.

“There has been a bit of hesitation because there are no quick returns,” says Burton. It has taken LanzaTech almost 14 years to get from the lab to commercial scale. Investment is tied to policy and

Investment in aviation biofuels has been slow, in part because there are no quick returns.

the policy landscape has not been stable, she says.

The first generation of biofuels used crops like sugar cane and grains as feedstock – pushing up food prices and leading to changes in land use – and understandably led to a backlash.

“There is a terror of getting it wrong again,” says Burton, but equally a danger that pursuing the perfect solution “may be the enemy of the good because the legislative environment is so detailed and so prescriptive. Concern about unintended consequences means investors are nervous; they fear policy might change.”

Indeed, the [special IPCC report on land use](#), published in August, said: “Bioenergy needs to be carefully managed to avoid risks to food security, biodiversity and land degradation. Desirable outcomes will depend on locally appropriate policies and governance systems.”

It points out that some waste streams that are currently used to make alternative fuels are not sufficient. One example is tallow, a by-product of the meat and dairy industry, which will diminish if eating habits change as they need to.

Professor John Shepherd, emeritus professor in earth system science at the University of Southampton, said the report highlights that “a good bioenergy crop is something that grows fast, >

does not need a lot of water or fertiliser, and is not much use for anything else”. He adds: “Bioenergy/ BECCS [bioenergy with carbon capture and storage] crops should only be grown on land that has already been deforested and is marginal for other uses: not on agricultural soils and certainly not on land that is deforested for the purpose.”

Investors and airlines will want to know that fuels described as sustainable are approved by the [Roundtable on Sustainable Biomaterials](#) (RSB), an international collaboration of 60 businesses, NGOs, academics, government and UN organisations that is driving best practice for sustainable biomaterial production through certification, innovation and partnerships.

CHICKEN AND EGG

For Burton of LanzaTech, it is a chicken and egg challenge. “If you can’t sell the product, why would investors build the plant? And if you don’t have an off-take you can’t get investment,” says Burton.

And for many airlines, there’s no incentive to invest in fuels that can cost two to three times the price of kerosene.

“From a global perspective, the lack of sufficient policy incentives for sustainable aviation fuel (SAF) is constraining [its] affordability, and availability as a result,” says Aaron Robinson, United Airline’s senior manager for environmental strategy and sustainability. United has been buying biofuels since 2016 from what is now World Energy, a US advanced biofuels company, and is awaiting an almost seven-fold expansion of the company’s California facility, due to be complete in 2021.

Robinson noted that while some regions, like California, Netherlands and the UK, did have good policy frameworks, these aren’t enough to fully close the price gap for all producers. “This price premium exists in large part because producers can opt to produce SAF or biodiesel; today they can earn more by producing biodiesel [due to lower cost of production plus higher revenues] unless airlines are willing to pay significantly more to compensate [them].”

In the Netherlands, SkyNRG and KLM are working to persuade corporates to pay the difference in price between the two fuels for the flights they make, arguing that this will lower their own carbon footprint, and help scale up biofuel production.

Stable and long-term policy is essential if the industry is to grow. Last month, Norway became the first country in the world to mandate that 0.5% sustainable fuel be blended with kerosene from >



Bioenergy crops should only be grown on land that has already been deforested and is marginal for other uses, not on agricultural soils



The first generation of biofuels used crops like sugar cane, which pushed up food prices and led to changes in land use.

KLM has committed to take 75m litres from SkyNRG a year for 10 years.



MILOSZ MASLANKA/SHUTTERSTOCK

2020. The aim is to grow the blend to 30% by 2030. Only fuels from waste and residue will qualify, and these cannot be based on palm oil.

In Europe, just getting into the market has been difficult, according to Burton. LanzaTech announced it would build a plant in Belgium a year before it announced one in China. The Chinese plant is operating; the one in Belgium, at ArcelorMittal's steel plant, is still being built. LanzaTech, she said, couldn't access loan guarantees because they are tied to policy framework.

Europe's updated Renewable Energy Directive (RED II), which moves the industry away from food-based fuels, may now allow it to enter the EU market, although some technical hurdles remain.

In the UK, LanzaTech's fuel doesn't qualify for subsidy under the government's [Renewable Transport Fuel Obligation](#) (RTFO), but Burton says there is the potential for development fuel credits, which could help bridge the price gap. Discussions are ongoing with the Department for Transport but "for us it's make or break – we can only be in the UK if we fit within the policy," she says. LanzaTech is, however, a finalist in the UK government's [Future Fuels for Flight and Freight](#) competition, with a share of £20m capital funding available to the winners. A decision is expected later this year.

The UK picture is more optimistic for Velocys. It makes jet fuel from commercial and municipal



SkyNRG claims its fuel, which runs on green hydrogen, will mean an 85% reduction in greenhouse gas emissions

solid waste and for the first time qualifies within the RTFO. It's awaiting planning permission to build on Humberside, with the backing of British Airways and Shell.

SkyNRG is building its first plant at Delfzijl on the Dutch coast. Its partner KLM has committed to take 75m litres a year for 10 years from its planned 100m litre output, covering 2% of the airline's global carbon footprint. Running on green hydrogen, SkyNRG claims its fuel will mean an 85% reduction in greenhouse gas emissions.

Many so-called advanced aviation fuels are made from waste. SkyNRG uses waste fats, while Velocys turns municipal solid waste into aviation fuel. But as campaign group Transport & Environment points out, the supply of waste is limited because it's incidental to other processes.

That's why SkyNRG is trying to diversify – exploring options from forestry residue to carbon dioxide.



The question is: is it going fast enough? The amount of fuel needed to meet targets is quite daunting

“There’s not really a silver bullet; no one technology that will dominate the others. In five to 10 years, we’ll have different technologies sitting alongside each other. That will be the answer to feedstock supply,” says Misha Valk, its head of future fuels.

Transport & Environment expects that in 2050, availability of sustainable fuels for the aviation sector will total 7.5bn litres, meeting just 11.4% of European aviation fuel demand, and less if aircraft efficiency and carbon pricing measures are not realised. But, says aviation manager Andrew Murphy, a sizeable level of investment is needed.

ELECTROFUEL

Today’s sustainable aviation fuels claim up to 85% reduction in carbon emissions over the lifecycle of their product (taking into account production, energy requirements and chemical inputs).

Getting to 100% could be achieved by using a so-called “electrofuel”.

To make electrofuels, green hydrogen (which is produced by electrolysis and using renewable energy) is combined with carbon dioxide to make a drop-in fuel. Carbon dioxide directly captured from the air would lock it in a use/reuse cycle, instead of adding to atmospheric emissions.

In its bid to diversify, SkyNRG is working toward a pilot plant at Rotterdam airport that will make 100 litres of fuel a day using green hydrogen and Climeworks’ direct air capture technology. Valk describes it as a “very interesting route – although not without its challenges.”

The development of electrofuels would also address the problem of using biomass – even residues – for biofuels when land resources are even more stretched, as they will be in future because of climate change.



LANZATECH CHINA

LanzaTech's Chinese plant is already in operation.

Valk is optimistic. “I’ve been involved [in this industry] for six or seven years – the momentum is really encouraging to see. It’s a lot different from what it was even three years ago. There’s so much more interest from airlines, the public, large industrial players. The question is: is it going fast enough? The amount of fuel needed to meet targets is quite daunting.” ■



Angeli Mehta is a former BBC current affairs producer, with a research PhD. She now writes about science, and has a particular interest in the environment and sustainability. [@AngeliMehta](https://twitter.com/AngeliMehta).



Flight shame not enough to tackle rising passenger numbers



IVAN MARC/SHUTTERSTOCK

Angeli Mehta reports on growing pressure, for governments to tax air fuel or penalise frequent flyers

 [VIEW ONLINE](#)

W

hen the boss of the 100-year-old airline KLM suggests you take the train instead of a domestic flight, you wonder what's going on. Is it a marketing ploy or the beginning of a conversation: a sign that airlines have realised it's no longer enough to say their aircraft are more efficient? >



ONDREJ ZABRANSKY/SHUTTERSTOCK

“Airlines are under pressure,” says Andrew Murphy, aviation manager at campaign group Transport & Environment. “The Paris Agreement was economy-wide ... It’s taken a while to realise what the implications of that are, but governments are recognising they can’t ignore aviation emissions.”

In July, the French government announced it would levy an eco-tax of €1.50 (£1.30) on all outgoing domestic and European flights; rising to €18 for business-class travellers flying outside Europe. The tax, to come into effect next year, is intended to fund less polluting transport projects.

Some airlines offer passengers the choice of paying to offset their emissions, but last month British Airways (BA) announced it would start offsetting the 400,000 tonnes of carbon emissions generated by its UK flights, at a cost of £3m a year. It pledged the money would go into verified emission-reduction schemes.

However, as environmental campaigners have been quick to point out, offsetting doesn’t address the growing numbers of people flying – and that’s really what’s needed to meet the net-zero challenge.

BA has announced it will start offsetting 200,000 tonnes of carbon emissions generated by its UK flights.

Aviation’s share of emissions continues unabated: while other sectors start to decarbonise, aviation will be responsible for an increasing share of the planet’s greenhouse gas emissions.

That knowledge is behind a movement called Flygskam, which is Swedish for “flight shame”. It began when several Swedish celebrities committed to give up flying, explaining that we should all know enough about climate change to feel too ashamed – or embarrassed – to take a plane.

Is it working? Sweden’s airports have been reporting a steady drop in domestic passengers over the past year. At Stockholm’s Arlanda airport, passenger numbers fell 11% in August, compared with 2018. The picture is more mixed for international flights so, overall, passenger numbers continued to grow. At the same time Sweden’s rail operator reported a near-doubling of passengers over 18 months.

In the UK, transport campaigner Anna Hughes is trying to persuade 100,000 people not to fly in 2020 through the [Flight Free UK campaign](#). Making the pledge “is not saying you can never fly again. It’s just saying have you considered travelling in a different way? Just like Veganuary, it might rub off in other >



The Committee on Climate Change has suggested a ban on frequent flyer programmes and an air miles levy

areas of your life”, Hughes says. So far around 3,700 people have committed.

Maria Wolrath-Söderberg, a Swedish researcher investigating the gap between knowledge and action, is exploring the motivations of those who’ve given up flying.

From research carried out in 2019, she says, “We could see that a common way to justify flying, for example, was to imagine a personal climate account. If you bike to work, sort your waste and eat vegetarian, you deserve a trip to Asia over Christmas.”

Many of those who’ve taken part in the research have experienced an emotional tussle between knowing the damage flying is inflicting and acting on that knowledge. “It can be quite stressful,” says Wolrath-Söderberg.

Some academics and NGOs have started to take a stand. Last month, a panel at Edinburgh University discussed the pressures on members of the business and academic communities to fly. Zero Waste Scotland is on track to meet a 40% reduction in flights. Staff avoid flying within the UK; or to the Benelux countries or Paris.

Meanwhile, a “European Citizens initiative” is running a petition to end the tax exemption for aviation fuel in Europe.

The Committee on Climate Change (CCC) has suggested a [ban on frequent flyer programmes](#) and an air miles levy that would increase with the number of miles travelled by an individual passenger. The levy should factor in larger emissions



MATEJ KASTELIC/SHUTTERSTOCK

The Flight Free UK campaign is trying to persuade 100,000 people not to fly in 2020.

for first class and business tickets. A separate scheme would be needed for business flyers.

Figures show 70% of flights are for leisure and 19% for business. While half the UK population doesn’t fly at all in any given year, just 15% of Brits take 70% of flights.

So it argues that those who pollute the most are the very people who benefit from the UK’s generous tax regime, which puts no duty on aviation fuel, or VAT on flights. The report’s author also suggests that the government should mandate that all marketing of flights show emissions information, expressed in meaningful terms, such as the proportion of an average household’s annual emissions now and under a future net-zero scenario.

For Justin Francis, co-founder of Responsible Travel, such a mechanism sounds too time-consuming to set up. “We need to create a system where we reduce demand and invest in future technology research and development to bring forward the date when we can fly guilt-free.” That means increasing and ringfencing the existing air passenger duty, which raises £3.4bn a year. “I don’t think it’s appropriate for aviation to be exempt from fair taxation. And for governments to pass responsibility to customers.”

Indeed a leaked EU report seen by Transport & Environment shows that imposing a 33 cent (28p) fuel tax on all departing flights would lead to a 10% rise in ticket prices, an 11% fall in passengers and emissions, and raise an extra €17bn, with no overall impact on jobs or GDP. ■





By the end of 2022 Germany should have more than 40 hydrogen trains built by Alstom.

ALSTOM

High hopes for **HYDROGEN**

Net-zero emissions targets in UK and France are helping to drive the regulations and incentives that will be needed to finally take this low-carbon transport technology to scale, reports [Angeli Mehta](#)

 [VIEW ONLINE](#)





London is set to run 20 hydrogen double-decker buses from 2020.

MARTIN HOSCIK/SHUTTERSTOCK

H

ydrogen has long been viewed as critical to getting mass transportation on the road to zero emissions by a host of bodies, from the International Energy Agency to the European Commission and the UK government, which also point to its contribution to tackling air pollution.

But its development has been stymied by the need for investment in costly infrastructure from the get-go, in contrast to electric vehicles, whose growth has not faced the same barriers.

“Hydrogen works at scale – it’s completely the opposite of the battery electric vehicle. EVs are great – you plug your car in at home. But scale up, and significant new charging infrastructure and grid upgrades are needed,” says Ben Madden, director at consultancy the UK’s Element Energy.

“It’s the opposite for hydrogen. Supply and demand need to be together. Given the investment

“

Given the investment required for a hydrogen filling station, it needs more than one or two buses. It can’t be ‘build it and they will come’

in a filling station, it needs more than one or two buses. It can’t be ‘build it and they will come.’”

So far there have been a series of demonstrator projects across Europe, backed by the Fuel Cells and Hydrogen Joint Undertaking. Over the past 10 years, this public-private partnership has tackled every aspect of hydrogen infrastructure, from >



Mark Griffin of BOC says the Aberdeen bus project has raised public awareness of hydrogen.

buses and taxis to fuel cell technology and hydrogen production. Its aim is to drive down prices and develop expertise and experience.

One example is Aberdeen's hydrogen bus project. Since 2015, 10 hydrogen buses have helped the city avoid more than 100 tonnes of CO₂ and built public awareness of hydrogen, according to Mark Griffin, hydrogen market development manager at industrial gas group BOC.

Fuel costs for new vehicles are getting closer to parity with diesel. Moving from retrofitting buses, to having the whole bus designed to run on hydrogen, means "a lot of inefficiencies have been removed," says Griffin. He estimates that whereas a single-decker bus used to require 10-11kg of hydrogen to travel 100km; now the same distance can be covered on 7kg by a higher-capacity double-decker.

Griffin points out that past funding has been directed at isolated projects – a 60kg-a-day station and a small number of vehicles.

Now city-regions are starting to work with infrastructure providers to build up demand and drive the price down, he says.

Next year, London will have 20 hydrogen double-deckers, made by Northern Ireland's Wrightbus, which was rescued from administration last month by Bamford Bus Company. They'll run alongside electric buses in a new ultra-low emission zone, which drivers of conventional vehicles will have to pay £100 a day to enter. Hydrogen fuel cells >

EXPLAINER

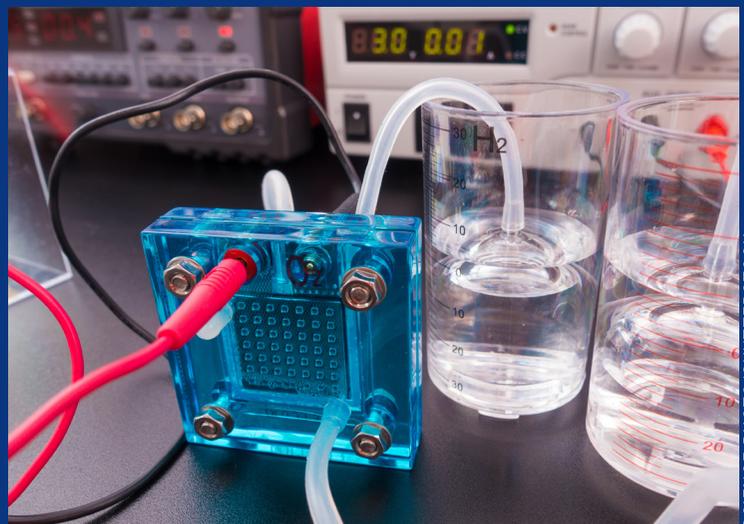
Like battery electric vehicles, fuel cell electric vehicles (FCEVs) use electric motors to drive the wheels. However, they store energy onboard as compressed hydrogen, rather than just in a battery.

Hydrogen reacts with oxygen from the air in an onboard fuel cell to produce electricity. Water is the only by-product. No greenhouse gas or air pollutant emissions are produced, meaning FCEVs are zero-emission vehicles. Fuel cells are typically 40-60% efficient (comparing energy input to energy output) and since hydrogen occurs rarely in its pure form, energy is required to create it.

Overall greenhouse gas emissions from hydrogen as a transport fuel are therefore highly dependent on its production method. Hydrogen is primarily produced for chemical feedstock applications. Used in a fuel cell, hydrogen produced via steam methane reformation (SMR) – currently the typical hydrogen production pathway – delivers greenhouse gas savings of between 10% (compared with a diesel HGV) and 43% (compared with a petrol car). The addition of carbon capture and storage (CCS) technology to the SMR production pathway could significantly increase greenhouse gas savings, but has yet to be demonstrated at a commercial scale in the UK.

Hydrogen can also be produced by electrolysis: using electricity to split water into hydrogen and oxygen. Assessed using current electricity grid emissions, this pathway does not deliver significant greenhouse gas savings compared to conventional fuels. Using electricity to produce hydrogen creates an efficiency loss compared to the direct use of electricity in a battery electric vehicle. However, as the electricity grid decarbonises, this pathway has the potential to deliver larger greenhouse gas savings.

Extract from UK government's [Road to Zero strategy](#)



SCIENCE PHOTO/SHUTTERSTOCK



TOYOTA



The policy-making conversation is a little more real, with net-zero economy-wide targets. That really focuses minds

produce only water, so are an important tool in reducing city pollution.

But it's time to go beyond demonstrator projects, says Madden.

Kobad Bhavnagri, head of special projects for Bloomberg New Energy Finance, says investors will back hydrogen once they see a viable business case, but this needs to be created by governments through regulation or subsidy. "One of the most effective levers is emissions standards or fuel economy standards – that's driven the development of battery electric. Another [lever] is subsidy – both are needed."

The zero-emission vehicle mandate in California, together with expanding refuelling infrastructure, is leading to more hydrogen vehicles on the roads. The US, Japan, Korea and China have all announced ambitious targets for fuel-cell electric vehicle deployment by 2030.

"The policy-making conversation is becoming a little more real, with net-zero economy-wide emissions targets [in UK and France]. That really focuses minds and sharpens the pencils."

There are a couple of examples where supply and demand are lining up. Madden points to a partnership between Hyundai and Swiss company H2 Energy, which has found enough buyers for 1,600 HGVs and persuaded Hyundai to build them. The aim is a nationwide network by 2023. A 2 megawatt (MW) electrolysis system will be built at a hydropower plant, and the energy partners will develop the refuelling infrastructure to make the business case.

In Germany, rail operators are moving ahead with hydrogen trains. The world's first two have been running on regional lines since last year. By the end of 2022 Germany should have more than 40 trains built by Alstom, with 27 of them replacing diesel engines in the Rhine-Ruhr industrial zone. The hydrogen supply is the by-product of other chemical processes from the region's industry, and the trains will refuel at an industrial park, which is already used by trucks and buses.

"Fuel cell traction is ... a quickly feasible alternative to expensive electrification," said Tarek Al-Wazir, minister of transport for the state of Hesse, when the deal was announced in May. "In Hesse, transport is responsible for one third of greenhouse gas emissions. Steam instead of diesel soot is therefore an exciting approach."

The fact that buses and trains refuel at depots means a guaranteed demand at a small number of locations, which will be crucial if hydrogen prices are to fall.

Griffin suggests hydrogen trains will not be far >

In Paris, the HysetCo collaboration plans to run a fleet of 600 hydrogen-powered taxis.



RHONDA ROTH/SHUTTERSTOCK

behind in the UK. “We definitely need to think about volume from the train perspective, and use it to encourage other markets to start to build momentum.”

Alstom and Eversholt Rail have been designing a train that could operate on UK tracks by re-engineering existing diesel stock. Meanwhile, a collaboration between Birmingham University and industrial partners have led to the development of

The zero-emission vehicle mandate in California is leading to more hydrogen vehicles on the road.

the HydroFLEX, an existing train retrofitted with hydrogen fuel tanks, fuel cell and battery pack that will enable it to run independently, and on electrified routes. It’s been given the go-ahead for mainline testing.

Last year, the government announced diesel trains should be phased out by 2040, but it has balked at the costs of electrification. Hydrogen would have the advantage that no rail infrastructure changes are required, says Griffin.

In Paris, HysetCo, a collaboration between Air Liquide, Société du Taxi Électrique Parisien (STEP), energy infrastructure group IDEX, and Toyota, plans to have a fleet of 600 hydrogen-powered taxis in the Ile de France region by the end of next year. Having 600 taxis will guarantee sufficient demand at a limited number of refuelling stations. The effort forms part of Paris’s aim to have zero emissions mobility for the 2024 Olympic games, following on from Tokyo’s efforts to promote hydrogen for next year’s games.

If increasing hydrogen demand depends on bringing costs down, then the other side of the coin is to be able to produce enough of the fuel cleanly. At the moment most hydrogen used in industry is produced by steam reformation of methane, which produces carbon dioxide. Carbon capture and storage would be needed to tackle those emissions. >



The other side of the coin of increasing hydrogen demand to cut costs is to be able to produce enough of the fuel cleanly



SERGIO BERTINO/SHUTTERSTOCK

A cleaner, but so far less efficient, process is to use electricity from renewables to split water into its components of hydrogen and oxygen.

In the Netherlands, the gas infrastructure company Gasunie and Nouryon (formerly AkzoNobel's fine chemicals division) are to expand their proposed green hydrogen plant by a factor of three after it won a contract to supply the hydrogen to SkyNRG, a company making sustainable aviation fuel ([See The long haul to getting aviation biofuel off the ground](#)).

In the UK, the Committee on Climate Change says that to produce enough green hydrogen for power and transport would mean "extremely challenging" build rates for low carbon electricity generation, and green hydrogen will still be more expensive than gas reforming. Globally, the International Energy Agency (IEA) expects the cost of producing hydrogen from renewables could fall 30% by 2030 and it wants to see trade in hydrogen encouraged.

The UK government has allowed hydrogen into the mix through inclusion in the Renewable

A hydrogen refinery under construction – producing enough green hydrogen requires 'extremely challenging' build rates.

Transport Fuel Obligation (RTFO). This places an obligation on transport fuel suppliers to ensure that 8.5% (in 2019) of their supply comes from renewable or sustainable sources.

"But it is concerned [that hydrogen] might mess up the biofuels policy, so they've made it hard for hydrogen to get access to RTFO certificates. This seems like a big missed opportunity to get hydrogen moving," says Madden.

The government contends that using existing renewable energy to power an electrolyser, is "robbing" the grid, so production is considered to have used high greenhouse gas intensity power. The only, but challenging, solution is to have a direct connection between a new windfarm and deployment of an electrolyser.

The IEA is urging governments to tackle the hurdles of infrastructure development, and regulation that limit the development of a clean hydrogen industry. "If hydrogen's long-standing potential is to be reached, it says, governments and companies need to be taking ambitious and real-world action now. ■





IKEA

Two and three wheels good, as India aims for electric mobility

With low private car ownership, the world's second-most populous country is going down a road of shared mobility to tackle some of the worst air pollution in the world, writes [Terry Slavin](#)





CATHAL MCNAUGHTON/REUTERS

Compare the electrification of transport in the world's most populous two countries and the difference could not be more stark. More electric cars are sold in China, the world's undisputed EV leader, in two days than have been sold in India in the past six years, according to Bloomberg New Energy Finance.

This despite the Indian government saying in 2017 that all new vehicles will be electric by 2030, as part of the country's efforts to reduce dependence on imported oil and clean up the air in its cities, which suffer some of the worst air pollution in the world. According to *The Lancet*, 1.7 million Indians died prematurely from noxious air in 2017, shaving 1.7 years off of average life-expectancy. And the situation will rapidly get worse, with India's urban population projected to nearly double in the next decade.

But unlike elsewhere, the prime targets for India's EV policy are not cars. Car ownership, though

1.7 million Indians died prematurely from noxious air in 2017.

rising, is among the lowest in the world, at 22 motor vehicles per 1,000 people in 2015, compared with 179 in China, 543 in the European Union and 811 in the US, according to the [International Organisation of Motor Vehicle Manufacturers](#).

Two-wheelers, which can navigate standstill traffic in India's congested cities, are kings of the road, accounting for over 70% of vehicles, while three-wheel auto-rickshaws are ubiquitous.

At a high-level session on the electrification of transport in India at Climate Week New York it was clear that while an EV market for private cars is still some way off, in public transport and shared vehicles such as buses, taxis, motorcycles and rickshaws, electrification is already under way.

Anup Bandivadekar, programme director for the International Council on Clean Transportation (ICCT), told the session, convened by the multi-stakeholder Electric Mobility Initiative for India, that there has been a surge in startups investing in vehicles, batteries and charging infrastructure in the last 18 months.

They have been lured by a plethora of generous federal incentives and tax breaks, along with additional help from 10 Indian states, and cities like Delhi, which has set a target for 25% of new vehicle registrations to be electric by 2023. >



TRAVELWILD/SHUTTERSTOCK

“There’s so many startups it’s hard for us to keep track, from two-wheelers to different business models,” Bandivadekar said. “The overall message is loud and clear that India is very serious about vehicle electrification, but where it could do better is in setting concrete targets, either targeting manufacturers [by] saying you need to have a percentage of sales to be EV,” by a certain date, or giving commercial fleet owners or ride-hailing firms like Uber and Ola a deadline to electrify their fleets.

According to a [Reuters report](#) in June, NITI Aayog, an influential thinktank chaired by Indian Prime Minister Narendra Modi, has recommended that the government set targets for taxi aggregators to convert 40% of their fleet of cars to electric by April 2026. It also recommends a target for all new cars sold for commercial purposes to be electric from April 2026.

However, Bandivadekar told Ethical Corporation that he understood that policymakers were not actively discussing such regulatory targets. “So, while it serves to highlight the ambition level of some in the government, I would not cite it as an indication of where the national policy is headed.”

Bandivadekar said regulations matter “because mainstream manufacturers haven’t stepped up with [electric] model offerings ... And without

India’s cities often grind to a standstill due to traffic congestion.



The overall message is loud and clear that India is very serious about vehicle electrification

regulatory targets those will be slow to come, so that’s where we need to focus.”

Clay Stranger of the Rocky Mountain Institute, which has been working on electric mobility in Indian cities for the past four years, said there are numerous state and city-level targets for electrification that build on the central government’s FAME II EV policy, announced earlier this year.

The priority should be to deliver on the existing commitments, he said. “There’s a risk of slipping on commitments like having 5,600 [EV] buses >

“

Production of EV buses is an issue, but if that isn't a demand signal I don't know what is

deployed by December 2020. ... [To deliver on that] would require producing 15 buses per day, starting last week. ... Production is an issue, but if that isn't a demand signal I don't know what is. We are really hoping that industry will step in.”

Stranger said electric delivery in cities is ready to go, with 30 companies having joined RMI in a pilot called “Deliver Electric Delhi.”

The pilot aims to deploy 1,000 electric delivery vehicles on the road by 2020, and to collect data on their performance in order to further make the case for the electrification of final mile delivery. Announced participants include Amazon and its Indian competitor Flipkart, which has said it is shifting 40% of its last-mile fleet to electric by as soon as next year.

In addition, Indian signatories to [The Climate Group's EV100 group](#) have pledged to electrify their fleets in India by 2030. They include IT company Wipro, the State Bank of India, New Delhi-based utility BSES Yamuna Power, ride-sharing company Shuttl, and Bangalore-based scooter rental company Bounce. EV100 founding company IKEA, which opened a large-format store in Hyderabad last year, has a delivery fleet of electric rickshaws powered by solar panels from the store's roof.

In Delhi, Stranger said, “the economics work now. They will work even better when the draft Delhi EV policy is implemented.”

Anand Shah is co founder of Ola Electric Mobility (OEM), the electric mobility arm of Bengaluru-based Ola, one of the world's largest ride-hailing companies, with 150 million users in 150 cities around the world.

OEM spun out of the parent company on the back of an EV project in Nagpur, in the state of >

TURNING CYCLE RICKSHAW DRIVERS INTO E-ENTREPRENEURS IN UTTAR PRADESH



ASHDEN

SMV Green is a social enterprise that operates in two of India's most populous states, Uttar Pradesh and Bihar, and is helping poor people to buy and operate electric auto-rickshaws.

Winner of this year's Ashden Award for international sustainable mobility, SMV has created a one-stop shop for drivers that offers low-interest finance, vehicle supply, licensing and permits, money management training, road safety training, and after-sales service. Drivers pay a 10% deposit on the e-rickshaw, and the balance over 24 to 30 months.

Since batteries are the most expensive capital cost, drivers are also given the choice of either lithium or cheaper lead-acid batteries, with drivers of the former able to swap their depleted batteries for freshly charged ones through SMV's battery-swapping service, and keep their vehicles on the road.

Many of the drivers of the 1,140 e-rickshaws sold so far previously drove cycle rickshaws, and have seen their incomes doubled, Ashden said. Deepak Goel, regional director of Shell Foundation in India, said the impact on SMV's e-rickshaw owners had been profound.

“We have observed 60-150% increase in income of manual rickshaw drivers moving to e-rickshaw, and we have noticed significant improvement in lives of family ... They are able to send their kids to school and afford three meals a day.”

SMV Green also has a special all-female team with a mission to recruit women as owner-drivers. Not only does it mean women from poor, socially conservative communities, who would never have been allowed to drive a cycle rickshaw, can earn a decent wage, female passengers feel safer in women-driven rickshaws – especially as the Vahini vehicles are equipped with security features such as cameras, mobile phones and panic buttons.

Terry Slavin



We are observing a transformation in mobility. The question is not whether we will do it, but if we will do it well



ADITI SHAH/REUTERS

Maharashtra, to build charging infrastructure, and bring 200 electric vehicles, from cars to two-wheelers and auto-rickshaws, on to its app.

Now one of the largest deployers of electric vehicles in India, Shah said OEM has delivered 20 million electric kilometres so far, and has an ambitious target to get one million EV vehicles on the road by 2021. But he said the focus is on the two- and three-wheel markets.

Electrification in India hasn't been driven by the middle classes, he said, but by the likes of the auto-rickshaw drivers in northern India, who are making money running their lead-acid battery vehicles on consumer demand alone.

OEM's model is to convince e-rickshaw drivers to abandon lead-acid batteries, which are heavy, deteriorate quickly, and take many hours to charge, and instead install lithium-ion batteries, which when out of charge can be swapped out for a fresh one at Ola's charging stations.

But he added that "to win, India will need to be able to make batteries." Without indigenous battery production there is concern that India will be reliant on battery imports from China, which is a key global supplier of raw materials like lithium, cobalt, nickel and manganese.

Another big barrier to India's electric dreams is lack of charging infrastructure, with some 500 publicly available chargers in all of India, compared with 50,000 in the city of Beijing alone.

Anirban Ghosh is chief sustainability officer for India's Mahindra Group, which is one of the few carmakers with Tata, producing EV passenger cars. [He argues](#) that supply constraints to electric

Ola is now one of the largest deployers of electric vehicles in India.

mobility can be overcome in time if there are sufficient demand-side incentives in the short term.

Ghosh told the session that although demand for EV cars is "trundling along now, it will shoot through the roof at some point in the not distant future".

Almost all the major car manufacturers are planning to launch an electric model in India next year, Ghosh said. "We are observing a transformation in mobility... The question is not whether we will do it, but if we will do it well."

[A report on electric mobility in India](#) co-authored by RMI and Indian business organisation FICCI in 2017 suggested that if India could "leapfrog the western mobility paradigm of private-vehicle ownership and create a shared, electric, and connected mobility system" it could save 876 million metric tons of oil equivalent and 1 gigatonne of carbon-dioxide emissions by 2030.

Bandivadekar of ICCT agreed that the prize is worth having for India, and for the world. "If we pulled out all the stops on efficiency and electrification we could see oil demand peak within a decade's time. That's pretty amazing for an economy that is going to continue to grow ... but that's the potential we see." ■



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In Africa, public transport is mostly operated by individual-owned minibuses.

HOW DIGITAL IS EASING THE PAIN OF PUBLIC TRANSPORT IN AFRICA

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Can digital technology improve public transport in Africa, home to some of the world's most congested cities?

While Uber claims to be getting more people into fewer cars across 15 African cities through its rideshare service, and launched a motorbike-hailing service on its app in Kampala and Nairobi last year, public transport users often can't afford smartphones.

Dr Herrie Schalekamp at the University of Cape Town has been reviewing what's happening with digital across the sub-continent. He points out that in Africa, public transport means minibuses owned by hundreds of thousands of individuals and operating on a cash basis, often under the radar of city authorities. They don't want to be visible on a digital platform.

Where digital is working so far is in Lagos, in response to a particular local need. "Getting hold of small-denomination currency is difficult and there were always rows with bus drivers, so it's in operators' interests to have a digital system," says Schalekamp. A new pre-

payment platform, GONA, is enabling cashless payments on a fleet of minibuses. Commuters simply scan a QR code for the vehicle they want to travel on.

Ironically, the platform exploits a 20-year-old mobile phone technology called USSD, that means users don't require a smartphone.

Earlier this year, Cairo startup Swvl attracted \$42m in investment to help expand its minibus offering. Billed as an answer to unreliable public services, commuters book on a particular vehicle on a scheduled route. Schalekamp suggests it's particularly valuable to commuters living in the new towns on the edge of the city, where there is no mass transit system.

Another, and expanding, means to get around in East Africa is by hailing a ride on the back of a motorcycle. In Kampala, it's a notoriously dangerous way to travel, but Ugandan startup SafeBoda, like UberBODA, uses an app to connect passengers to drivers, who are equipped with spare helmets and trained in road-safety and bike maintenance.

Angeli Mehta

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