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Editor:
 GIANNI SERRA

Editorial team:
 JEZ ABBOTT
 LENORE HITCHLER
 TOBY LOCKWOOD
 EUSEBIO LORIA
 ALICE MASILI
 XING ZHANG

Contributors:
 MIRIAM FRANKEL
 LAWRENCE CARTER
 CLAIRE ASHER
 KATIE SURMA
 FRED PEARCE
 NEESHA POWELL-TWAGIRUMUKIZA
 JEREMY LENT

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<https://www.onlynaturalenergy.com>
info@onlynaturalenergy.com



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The last hurrah

GIANNI SERRA

ONE

"Build back better. Blah, blah, blah. Green economy. Blah blah blah. Net-zero by 2050. Blah, blah, blah. This is all we hear from our so-called leaders. Words that sound great but so far have not led to action. Our hopes and ambitions drown in their empty promises." Greta Thunberg got it right at the recent Youth4Climate summit in Milan.

The greenwashing machine is faster and much more efficient than any climate mitigation policy, which lacks the sense of urgency we have experienced in the last pandemic. A global effort to fix a global problem ensured the creation and production of several vaccines in record time. But not for all. Less developed countries were (and still are) left behind even in the coronavirus pandemic. No surprise.

The complexity of the climate transition is undeniable. It can not be completed overnight. It can not be done in less than two years, as happened with the pandemic. It will be costly. And it will be even tougher to make it sustainably and inclusively, as promised and expected. There is a price to pay for carbon neutrality, and it will be paid by the poorest and the weakest, as usual. Extreme weather or Covid-19 does not change the script. The least developed countries are always the most exposed. See Bangladesh or Haiti.

So Greta was only partially correct. It's untrue that the powers that be are doing nothing—quite the opposite. There is a monumental effort to keep on track the system, the businesses, to protect the countries that have created the problem. A massive attempt to ensure successful energy, social and economic transitions for all of them. They can not lose ground, and a shift from top to top is the only evolution conceived. The do-nothing policy is for the others.

But abandoning the exploited ones to their destiny will backfire soon. The automotive microchip crisis should teach something. A stop in Taiwan or in Malaysia hits Detroit like Munich. And increases prices everywhere. The unintended equity of globalisation. **ONE**





The role of China's carbon price in phasing out coal

XING ZHANG

ONE

After years of negotiations, planning, and pilot testing, China's national carbon emissions trading system (ETS) finally went online at the Shanghai Environment and Energy Exchange on 16 July 2021. China expects its ETS to become the largest carbon market in the world by volume. This is a key part of China's plans to use market mechanisms to help bring carbon emissions to a peak before 2030 and reach carbon neutrality by 2060.

As of 30 September 2021, the national carbon market has been operating for 53 trading days, with a cumulative trading volume of 17.649 million tons CO₂ and a cumulative trading value of 801 million yuan (124 million US\$). The highest trading price is 61.07 yuan/tCO₂ (10.39 US\$/tCO₂), the lowest trading price is 41.00 yuan/tCO₂ (6.36 US\$/tCO₂), and the average price is 45.37 yuan/tCO₂ (7.04 US\$/tCO₂).

China's ETS is different from those operating in most other regions because it focuses on reducing the emissions intensity of power generation with benchmarks rather than imposing an absolute cap. The scheme initially only applies to the power sector, with coal and gas-fired power plants allocated a certain number of emissions allowances based on an efficiently operating plant – any shortfall must then be met by purchasing allowances on the market. 2,225 power plants are signed up for the scheme.

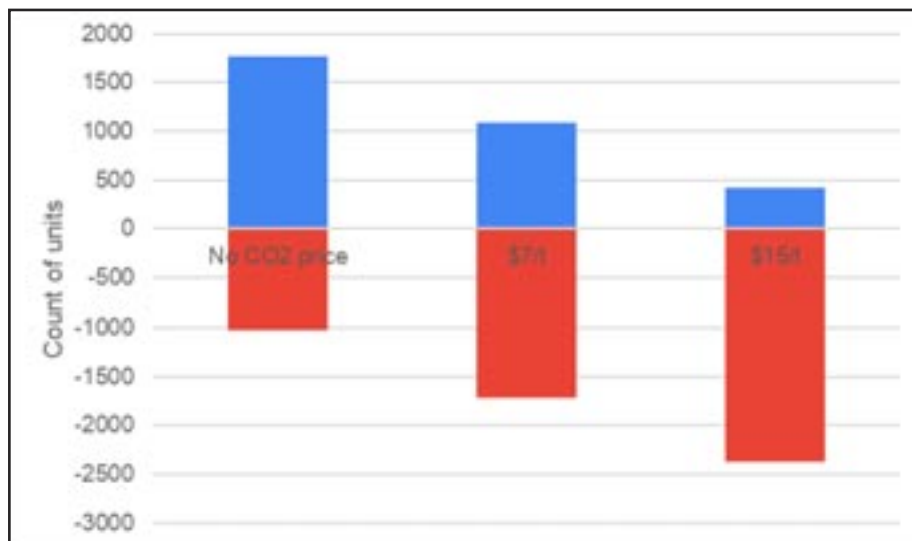
Although the share of coal-fired power in the overall generation mix has been declining, coal power generation still dominates China's power sector, accounting for 60.8% of national power generation output. By the end of 2020, operational coal-fired power capacity in China stood at 1,095 GW, accounting for about 52% of the global total. China's dominance in global power capacity is the direct outcome of a two-decade-long construction frenzy of coal-fired power plants. However, more than half of coal power companies are running at a loss, with typical plants running at less than 50% of their capacity.

Will the new carbon ETS help China to accelerate the phase out of its coal fleet?

Under China's scheme, power plants are not penalised for operating at high capacity. Instead, the system is designed to incentivise plants to run more efficiently. This accounting method means that emissions under the ETS will not necessarily decrease.

However, the carbon price does add additional operating costs which will affect the cash flows and profitability of coal plant operation. *TransitionZero's* recent analysis shows that, even without a carbon price, 36.5% of coal units are currently unprofitable. With the current average trading price of US\$7/tCO₂, the analysis indicates that nearly 60.9% of units may now be unprofitable.

According to Professor Xiliang Zhang from the Institute of Energy, Environment and Economics at Tsinghua University, during the "14th Five-Year Plan" period, the carbon price in China's carbon market may reach around US\$8-10/tCO₂ and, during the "15th Five-Year Plan" period, the carbon price may further rise to US\$15/tCO₂. At this level, 85% of units today would be running at a loss.



The proportion of Chinese coal units operating at a loss (red bar) for various CO₂ prices

Although the technical lifetime of a coal power plant unit is nominally 30 years, economic and policy conditions may influence China's decision-makers to curtail the operational life of many units. Based on its own Risk Index System (RIS) ranking and China's net-zero policy goal, *TransitionZero* estimated that the unit retirement age could be shortened by an average of seven years. Considering the power oversupply in China, it is almost inevitable that some coal-fired units will be shut down ahead of their designed life.

In order to meet the carbon reduction target, some provinces

and cities have taken the route of coal to gas conversion. For example, Beijing has closed down all coal-fired generation units, partly replacing them with gas, and partly relying on import power. The local government of Xi'an has also recently announced plans to replace all its 30 coal-fired CHP units with gas to become a 'no coal city' in 2025. However, while gas generation is cleaner than coal, this approach risks locking in a new legacy of carbon emitting infrastructure.

Some experts suggest following European examples, such as the UK's Drax power plant, by converting coal-fired power plants to fire biomass. Due to its geographical location and vast population, China is struggling to be self-sufficient for food. Major biomass resources in China include waste from agriculture, forestry, industries, animal manure and sewage, and municipal solid waste. This resource is not reliable and sustainable, and it is therefore unrealistic to expect biopower to play a substantial role in China's energy mix.

On the other hand, solar and wind power has performed strongly in China, with significant growth in both generation and capacity. The wind capacity added to the grid in 2020 achieved a record year-on-year growth rate of 178.7%, exceeding the total added wind capacity from 2017 to 2019. In

2020, China accounted for more than half of the offshore wind capacity installed globally that year. The country's installed solar capacity increased 92%.

However, this growth alone is not enough to meet the electricity demand. Only a third of China's increase in electricity demand was met from gains in wind and solar generation. Another third was from increased hydro, nuclear and bioenergy, leaving a need for increased coal generation. There is a big power demand gap for wind and solar to fill.

What is a viable route to decarbonise China's power sector to achieve its carbon

neutral target? Although an absolute emission cap would be more efficient, the carbon price has certainly added some weight to the Chinese coal-fired power generation sector, and should result in more coal-fired units taking early retirement.

Solar and wind are the most suitable options to replace these early retired coal-fired units, as China dominates in the development of solar energy and battery storage. Further expansion of this clean grid infrastructure will reduce solar and wind energy production costs and make it even more competitive with coal.





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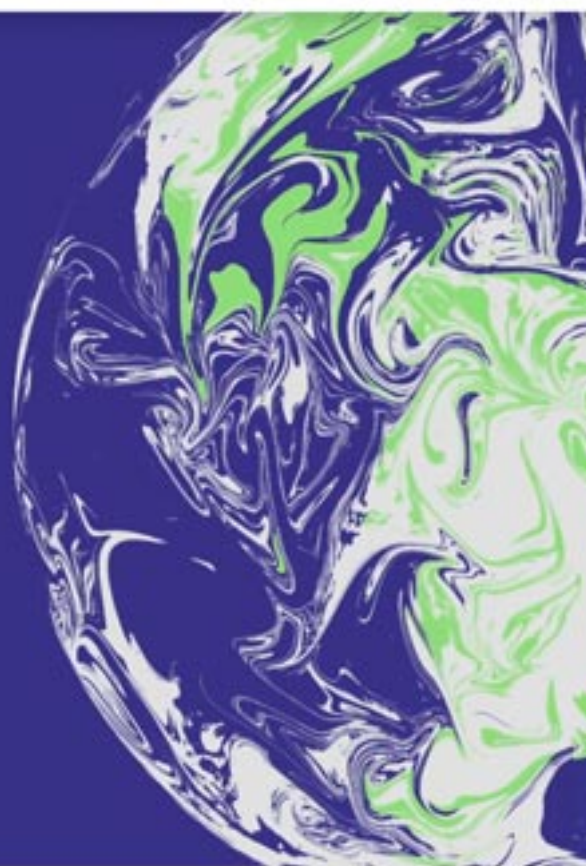
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Woven City's hi-tech community

EUSEBIO LORIA

ONE

A promised land in which people can enjoy a happy, healthy, and sustainable life and co-exist in harmony with nature and technology. The future is just around the corner.

Commissioned by Toyota Motors, the construction of the prototype city of Woven began at the base of Mount Fuji in Japan last February. A fully connected ecosystem powered by solar panels and hydrogen fuel cells. Woven City will grow in an ecosystem associated with artificial intelligence, energetically self-sufficient, with wooden houses to minimize the carbon footprint, built with traditional and high-tech robotics production methods. Homes will be equipped with the latest automation technologies to assist daily life, and rooftops covered with photo-voltaic panels integrated with

energy generated by hydrogen fuel cells.

The infrastructure of Woven City aims to create an environment flexible and attentive to needs enough to fix or prevent many social issues. Residents and researchers will test and develop a range of innovative city technologies, such as robotics, personal mobility and smart homes in a real-world environment. A living laboratory that will be ever-evolving and energy-neutral with buildings designed to become energy productive. This kind of planning shows that the concept is not technology vs nature but the two working together.

Sensors and artificial intelligence will take care of the inhabitants' needs safely and automatically. An ecosystem like the Woven City is multi-layered and will have

three types of streets interwoven on the ground level. Travelling around the city will only be possible by e-Palette, electrified zero-emission vehicles, completely autonomous. Neighbourhood parks, a large central park for recreation and a central plaza for social gatherings are designed to bring the community together.

The community will start with 360 residents gradually growing to include more than 2,000 individuals, including Toyota employees.

Toyota wants to test a hydrogen-based society nearby a fully hydrogen-based supply chain, from production, delivery to usage. That's the primary goal of Woven City. Through this effort, the company wants to lead the way towards a carbon-neutral society by 2050.

Systemic efficiency: Currently, around 8 billion people live on Planet Earth. According to the United Nations (UN), this number will reach 10 billion in 2050 and peak at nearly 11 billion around 2100. This growth has enormous environmental implications, and as a first step, every nation has to intensify efforts to reach the UN Sustainable Development Goals (SDGs).

Across the globe, cities account for nearly two-thirds of the CO2 emissions. Homes, buildings, and transportation in cities consume a large amount of high CO2 content energy. Right now, just over half the population lives in cities, but that is projected to rise to 68% by 2050, resulting in even higher energy consumption and CO2 emissions.

To limit the global temperature increase to 1.5-degrees, nature and technology must co-exist in harmony in future cities. The Woven city project may be the first and most helpful example.

To mitigate climate change issues, we need to produce more energy from renewable sources, more energy efficiency and more electric transportation. An intelligent energy infrastructure through digitalization is a key to integrate these actions and make the transition successful.

By taking a holistic approach, cities like Woven City have an opportunity to boost their resilience to a range of future climate and health-related crises and to create jobs and other economic and health benefits. This approach, defined as "systemic efficiency," encompasses efficiency, clean electrification, smart digital techno-

The Woven City project

Location	Higashi-Fuji Plant site
Leader	Toyota Motor Corporation
Partner	ENEOS Corporation
Kickoff	February 23, 2021
Completion	2022
Design	Bjarke Ingels (Bjarke Ingels Group, BIG)
Area	700.000 m ²
Residents	360 (senior citizens, families with young children)
Population	2000 (including Toyota employees)
Website	https://www.woven-city.global/

logy, and efficient buildings and infrastructure, along with a circular economy approach to water, waste and materials. Central to this approach is innovation.

Cape Town, São Paulo, Stockholm are just three of the world's major developed cities. Citizens of these three cities are already seeing more electric vehicles on their roads, smart technology for better water treatment and recycling schemes, and more solar panels on rooftops. Systemic efficiency enables a decarbonized, highly electrified and resilient city ecosystem through ultra-efficient buildings and intelligent energy infrastructure.

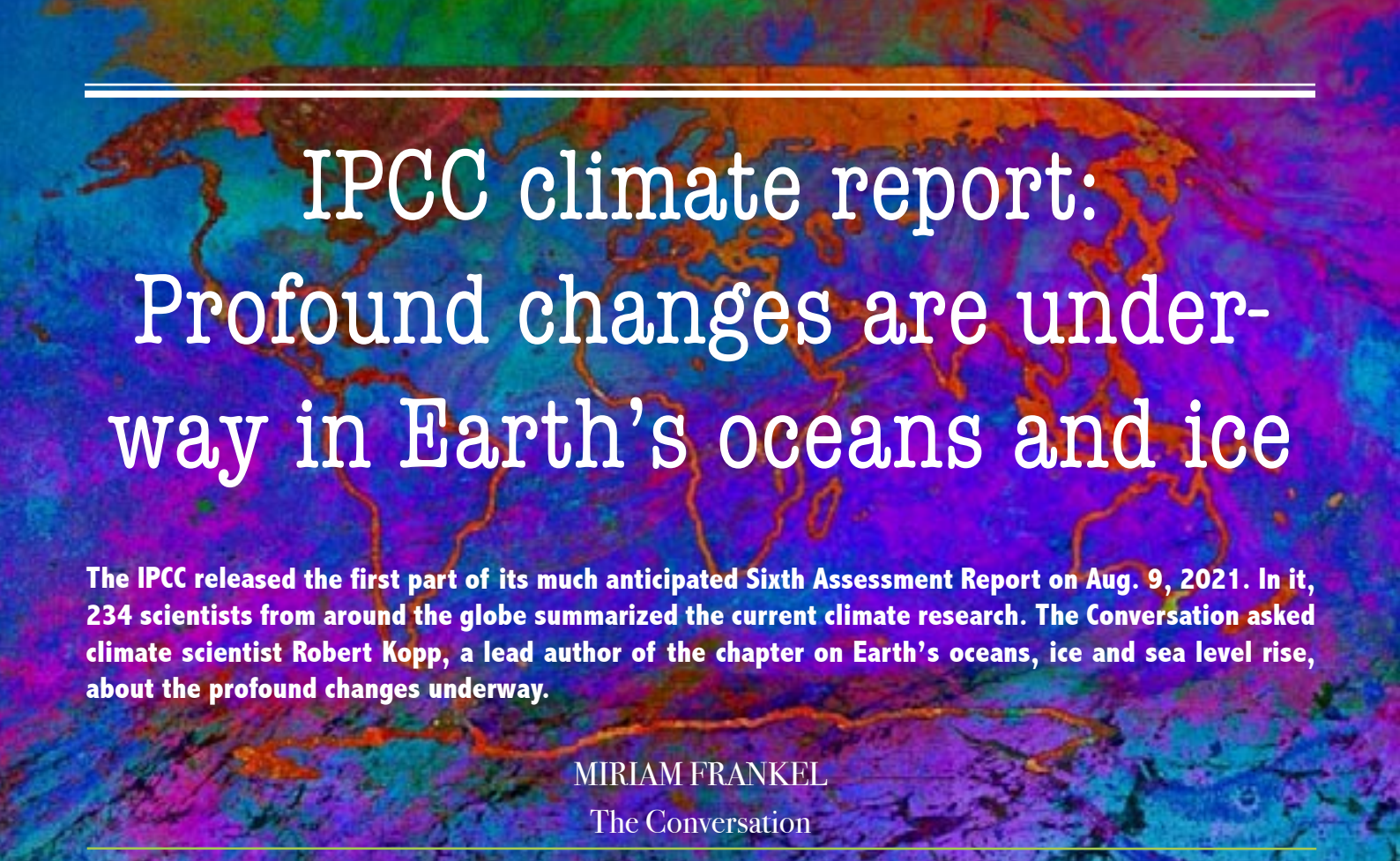
Smart cities and smart citizens: Woven city will rely on a massive amount of data, a smart city at the citizen's service, constantly adapting to the users' needs.

The transition from smart citizens to smart cities is a gradual process.

Smart cities are complex relationships, and if a link in the chain fails, everything will fail. It is necessary to strengthen each link in the chain with scientists, researchers and citizens who experience smart cities first-hand using it daily. Smart cities and the tools it offers also serve as a forecast to avoid catastrophe.

Replicability will be crucial. From an inclusive perspective, smart cities "learn, grow and evolve" according to the needs of the stakeholders.

The resilience of smart building-smart homes lies in the fact that the products match the citizens' needs - including the citizen's well-being and health. That's the example Woven city promises to set. **ONE**



IPCC climate report: Profound changes are under- way in Earth's oceans and ice

The IPCC released the first part of its much anticipated Sixth Assessment Report on Aug. 9, 2021. In it, 234 scientists from around the globe summarized the current climate research. The Conversation asked climate scientist Robert Kopp, a lead author of the chapter on Earth's oceans, ice and sea level rise, about the profound changes underway.

MIRIAM FRANKEL
The Conversation

What are the IPCC report's most important overall messages in your view?

At the most basic level, the facts about climate change have been clear for a long time, with the evidence just continuing to grow. As a result of human activities, the planet is changing at a rate unprecedented for at least thousands of years. These changes are affecting every area of the planet.

While some of the changes will be irreversible for millennia, some can be slowed and others reversed through strong, rapid and sustained reductions in greenhouse gas emissions. But time is running out to meet the ambitious goal laid out in the 2015 international Paris Agreement to limit warming to well below 2 degrees Celsius above preindustrial levels (2 C equals 3.6 degrees Fahrenheit). Doing so requires getting global carbon dioxide emissions on a downward course that reaches net zero around or before 2050.

What are scientists most concerned about right now when it comes to the oceans and polar regions?

Global sea level has been rising at an accelerating rate since about 1970, and over the last century, it has risen more than in any century in at least 3,000 years. In the years since the IPCC's Fifth Assessment Report in 2013 and the Special Report on the Ocean and Cryosphere in a Changing Climate in 2019, the evidence for accelerating ice sheet loss has become clearer.

Over the last decade, global average sea level has risen at a rate of about 4 millimeters per year (1.5 inches per decade).

This increase is due to two main factors: the melting of ice in mountain glaciers and at the poles, and the expansion of water in the ocean as it takes up heat. Ice sheets in particular are primarily responsible for the increase in the rate of sea level rise since the 1990s. There is clear evidence tying the melting of glaciers and the Greenland Ice Sheet, as well as ocean warming, to human influence. Sea level rise is leading to substantial impacts on coastal communities, including a near-doubling in the frequency of coastal flooding since the 1960s in many sites around the world.

Since the previous reports, scientists have made substantial advances in modeling the behavior of ice sheets. At the same time, we've been learning more about ice sheet physics, including recognizing the potential ways ice sheets can become destabilized. We don't well understand the potential speed of these changes, but they have the potential to lead to much more rapid ice sheet loss if greenhouse gas emissions grow unchecked.

These advances confirm that sea level is going to continue to rise for many centuries to come, creating an escalating threat for coastal communities.

Sea level change through 2050 is largely locked in: Regardless of how quickly nations are able to lower emissions, the world is likely looking at about 15 to 30 centimeters (6 to 12 inches) of global average sea level rise through the middle of the century. But beyond 2050, sea level projections become increasingly sensitive to the world's emissions choices. If countries continue on their current paths, with greenhouse gas emissions likely to bring 3-4 C of warming (5.4-7.2 F) by 2100, the planet will be looking at a most li-

kely sea level rise of about 0.7 meters (a bit over 2 feet). A 2 C (3.6 F) warmer world, consistent with the Paris Agreement, would see lower sea level rise, most likely about half a meter (about 1.6 feet) by 2100. What's more, the more the world limits its greenhouse gas emissions, the lower the chance of triggering instabilities in the polar ice sheets that are challenging to model but could substantially increase sea level rise.

Under the most extreme emissions scenario we considered, we could not rule out rapid ice sheet loss leading to sea level rise approaching 2 meters (7 feet) by the end of this century. Fortunately, if the world limits warming to well below 2 C, it should take many centuries for sea level rise to exceed 2 meters – a far more manageable situation.

Are the oceans or ice nearing any tipping points?

“Tipping point” is a vague term used in many different ways by different people. The IPCC defines tipping points as “critical thresholds beyond which a system reorganizes, in a way that is very fast or irreversible” – for example, a temperature rise beyond which climate dynamics commit an ice sheet to massive loss.

Because the term is so vague, the IPCC generally focuses on characteristics of changes in a system – for example, whether a system might change abruptly or irreversibly – rather than whether it fits the strict dynamic definition of a “tipping point.”

One example of a system that might undergo abrupt changes is the large-scale pattern of ocean circulation known as the Atlantic Meridional Overturning Circulation, or AMOC, of which the Gulf Stream is part. Paleoclimate evidence tells us that AMOC has changed rapidly in the past, and we expect that AMOC will weaken over this century. If AMOC were to collapse, it would make Europe warm more slowly, increase sea level rise along the U.S. Atlantic coast, and shift storm tracks and monsoons. However, most evidence indicates that such a collapse will not happen in this century.

There is mixed evidence for abrupt changes in the polar ice sheets, but clear evidence that changes in the ice sheets can be locked in for centuries and millennia. If the world succeeds in limiting warming to 1.5 C (2.7 F), we expect to see about 2-3 meters (7-10 feet) of sea level rise over the next 2,000 years; if the planet continues to warm and reaches a 5 C (9 F) increase, we expect to see about 20 meters (70 feet) over the next 2,000 years.

Some people also discuss summer Arctic sea ice – which has undergone substantial declines over the last 40 years and is now smaller than at any time in the past millennium – as a system with a “tipping point.” However, the science is pretty clear that there is no critical threshold in this system. Rather, summer Arctic sea ice area decreases roughly in

proportion to the increase in global temperature, and if temperature were stabilized, we would expect sea ice area to stabilize also.

What do scientists know now about hurricanes that they didn't realize when the last report was written?

Since the last IPCC assessment report in 2013, there has been increasing evidence that hurricanes have grown more intense, and intensified more rapidly, than they did 40 years ago. There's also evidence that hurricanes in the U.S. are moving more slowly, leading to increased rainfall.

However, it's not clear that this is due to the effects of greenhouse gases – reductions in particulate pollution have also had important effects. The clearest effect of global warming is that a warmer atmosphere holds more water, leading to more extreme rainfall, like that seen during Hurricane Harvey in 2017. Looking forward, we expect to see hurricane winds and hurricane rains continue to increase. It's still unclear how the overall number of hurricanes will change.

The report involved 234 scientists, and then 195 governments had to agree on the summary for policymakers. Does that broad range of views affect the outcome?

When you're writing a report like this, a key goal for the scientists is to accurately capture points of both scientific agreement and scientific disagreement. For example, with respect to ice sheet changes, there are certain processes on which there is broad agreement and other processes where the science is still emerging and there are strong, discordant views. Yet knowing about these processes may be crucially important for decision-makers trying to manage risk.

That's why, for example, we talk not only about most likely outcomes, but also about outcomes where the likelihood is low or as-yet unknown, but the potential impacts are large.

The IPCC uses a transparent process to produce its report – the authors have had to respond to over 50,000 review comments over the three years we've spent writing it. The governments also weigh in, having to approve every line of a concise Summary for Policy Makers that accurately reflects the underlying assessment – oftentimes making it clearer in the process.

I'm very pleased that, as with past reports, every participating government has signed off on a summary that accurately reports the current state of climate science.

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Inside Exxon's playbook: How America's biggest oil company continues to oppose action on climate change

ExxonMobil aims to drastically weaken Biden's climate plans and used shadow groups to 'aggressively' fight climate science, insider tells undercover reporter

LAWRENCE CARTER

Unearthed

ExxonMobil continues to fight efforts to tackle climate change in the United States, despite publicly claiming to support the Paris climate agreement, an undercover investigation by Unearthed has found.

A senior lobbyist for Exxon told an undercover reporter that the company had been working to weaken key aspects of President Joe Biden's flagship initiative on climate change, the American Jobs Plan. He described Biden's new plan to slash US greenhouse gas emissions as "insane" and admitted that the company had aggressively fought early climate science through "shadow groups" to protect its investments.

Keith McCoy – a senior director in Exxon's Washington DC government affairs team – told the undercover reporter that he is speaking to the office of influential Democratic senator Joe Manchin every week, with the aim of drastically reducing the scope of Biden's climate plan so that "negative stuff", such as rules limiting greenhouse gas emissions and taxes on oil companies, are removed.

Last week – after weeks of bipartisan talks – President Biden conditionally endorsed a scaled-back version of his infrastructure plan, which eliminates hundreds of billions of dollars of proposed support for climate ini-

tiatives. During the undercover meeting, which took place via Zoom in May, McCoy suggested that Exxon's public support for a carbon tax as its principal climate policy is an "advocacy tool" and "great talking point" that will never actually happen.

"Nobody is going to propose a tax on all Americans and the cynical side of me says, yeah, we kind of know that but it gives us a talking point that we can say, well what is ExxonMobil for? Well, we're for a carbon tax," McCoy said.

A second Exxon lobbyist, Dan Easley – who left the company in January after working as its chief White House lobbyist throughout the Trump administration – laughed when asked by an undercover reporter if the company had achieved many policy wins under Trump, before outlining victories on fossil fuel permitting and the renegotiation of the NAFTA trade agreement.

"The wins are such that it would be difficult to categorise them all," he said, adding that the biggest victory was Trump's reduction in the corporate tax rate, which was "probably worth billions to Exxon".

Unearthed reporters posed as recruitment consul-

tants looking to hire a Washington DC lobbyist for a major client and approached McCoy and Easley for meetings over Zoom. During the meetings, the undercover reporter asked about Exxon's current and historical lobbying on environmental issues.

It is important to note that neither McCoy nor Easley were necessarily seeking a new job, but each was willing to talk and provide information to the purported recruiters. Over the coming days, Unearthed, will also reveal: Claims that Exxon covertly fought to prevent a ban on toxic chemicals; How Exxon is using its playbook on climate change to head-off regulations on plastic.

California Congressman, Rep. Ro Khanna, told Unearthed: "For decades, fossil fuel companies have lied to the public, to regulators, and to Congress about the true danger posed by their products. Today's tape only proves our knowledge that the industry's disinformation campaign is alive and well. In the coming months, I plan to ask the CEOs of Exxon, Chevron, and other fossil fuel companies to come testify before my Environment subcommittee. We can no longer allow Exxon, or any other companies, to prevent our collective action on the climate crisis."

A spokesman for ExxonMobil said that the allegations put to them: "contained a number of important factual misstatements that are starkly at odds with our positions on a variety of issues, including climate policy and our firm commitment to carbon pricing."

Denial and delay

Exxon claims to support global effort to tackle climate change, but it hasn't always. Throughout the 1990s and early 2000s, the company orchestrated a multimillion-dollar disinformation campaign that manufactured doubt regarding the link between global warming and the burning of fossil fuels.

It did so through a concerted strategic communications and lobbying push, which provided fringe scientists who denied climate science with funding and a platform, via Exxon-placed op-eds, advertisements, and political briefings.

Exxon also helped to found and lead a powerful cross-industry group, the Global Climate Coalition

(GCC), which spent tens of millions of dollars campaigning against a binding global climate agreement ahead of the 1997 UN climate summit in Kyoto.

The organisation spent \$13 million dollars on one advertising campaign alone, aiming to weaken US support for an agreement in Kyoto.

The efforts were successful: the US Congress refused to ratify Kyoto and Exxon later lobbied the Bush administration to pull out of the protocol altogether. This left global efforts to rein in greenhouse gas emissions in tatters.

Fighting science

Exxon continues to deny having misled the public on climate change, and no serving Exxon executive has ever admitted that the company fought climate science to protect the company's financial interests – until now.

McCoy told an undercover Unearthed reporter that although he didn't believe Exxon had buried its own science, the company had cast doubt on the scientific consensus: "Did we aggressively fight against some of the science? Yes. Did we hide our science, absolutely not. Did we join some of these 'shadow groups' to work against some of the early efforts? Yes, that's true. But there's nothing illegal about that. You know, we were looking out for our investments, we were looking out for our shareholders."

The reference to "shadow groups" is likely to relate to a powerful network of think tanks and pressure groups through which Exxon fought both the science and political action on climate change. Between 1998 and 2014, the company spent at least \$30 million funding climate denial groups, such as the Heartland Institute, Competitive Enterprise Institute, and Heritage Foundation. This network played a critical role in shifting the Republican Party from a position of support for action to cut emissions in the 1980s to its near-total opposition to tackling climate change from the mid-1990s to today.

Geoffrey Supran, a researcher at Harvard University who has written a number of scientific papers on Exxon's efforts to mislead the public on climate change, told Unearthed: "I don't believe the company has ever



publicly acknowledged its role in climate denial... to have active employees of the company acknowledge its past behaviour is significant and certainly relevant to ongoing litigation and investigations against the company.”

Supran continued: “The company has thrown up the straw man argument that they never hid or ‘covered up’ the science, but that’s never actually been our point. The point is that they misled the public about climate change by contributing quietly to climate science but loudly to promoting doubt about it, so what this person said seems exactly consistent with that.”

A new playbook

By the start of the Obama administration in January 2009, it had become untenable for ExxonMobil to continue to publicly cast doubt on climate science. Instead, ahead of Obama’s inauguration, and in an apparent break with Exxon’s long opposition to what it called “near-term policies” on climate change, the company’s then-CEO Rex Tillerson publicly backed a carbon tax.

The proposal sought to spread the cost of tackling climate change beyond the fossil fuel sector; taxing businesses in every sector of the economy for each tonne of carbon emitted – either by them directly or embedded in products they sell to consumers. The cost of this would then be passed on to the public.

In making the announcement, Tillerson sketched the outlines of a new ExxonMobil playbook on climate change – one that accepts the science but nevertheless seeks to delay rapid emissions cuts. Instead of subsidising renewables, governments should prioritise research and development to discover a “break-through” technology. In the meantime, Exxon would remain “fundamentally an oil and gas company because we think that’s what society needs and will have to have for the next 50 years”, Tillerson said.

Crucially, Tillerson explicitly framed the company’s support for a carbon tax in opposition to the incoming Obama administration’s plan to introduce a more stringent cap and trade system. Essentially, Exxon backed a carbon tax as part of its strategy to oppose cap and trade. In 2013 – after the cap and trade bill had been defeated – Tillerson backtracked:



“As to our advocacy around a carbon tax—I would not support putting a carbon tax in place today because I think we still have a lot of gains to be made through technology and other less intrusive policies.”

Geoffrey Supran explained how this new playbook is a “classic shift from denialism to delayism”.

“Sure, over the last decades the company has necessarily shifted its rhetoric, but the end goal remains the same and that’s inaction on climate change. This is just a continuation of their 30-year track record of acting in bad faith on climate change,” Supran continued.

Taxing carbon

Exxon rejects claims that its support for a carbon tax is not genuine, but Unearthed can reveal that one of its most senior lobbyists believes the company knows the policy has no chance of being enacted but nevertheless uses it as an “advocacy tool.”

“Nobody is going to propose a tax on all Americans

and the cynical side of me says, yeah, we kind of know that but it gives us a talking point that we can say, well what is ExxonMobil for? Well, we’re for a carbon tax,” McCoy said. When asked by the reporter, “So it’s basically never going to happen right, is the calculation?”, McCoy replied: “Yeah. No it’s not, it’s not. Carbon tax is not going to happen”.

He added that other members of the oil industry that have recently announced their support for a carbon tax – such as the American Petroleum Institute (API), an influential lobby group – did so because “they’ve got nothing else, so it’s an easy talking point to say, look I’m for a carbon tax”. McCoy continued: “So that’s the talking point, that is in my mind an effective advocacy tool. Many members of Congress can say, well we don’t believe you, and we’ll say well yeah, we’ve been saying this for over a decade and we’re not new to this. API is new to this, some of these other companies are new to this, but at ExxonMobil we’ve been saying this for a decade.

“I think the carbon tax is an effective way of saying to

them [members of Congress]: put up or shut up.” McCoy was asked whether Exxon’s support for the “talking point” of a carbon tax makes it easier for the company to oppose more punitive climate regulations, “whilst still having this kind of bold proposal that makes sure you are still for something, not just against it?”

He nodded and replied: “Well that’s the danger right, so they realised that they can’t get the sort of large bill put forth so what ends up happening is it’s death by 1,000 cuts right.”

McCoy continued: “They just go through the regulatory process and they put a moratorium on federal leasing, they’ll do something on pipelines you know, they’ll look at offshore drilling, they’re looking at the royalty rates now for onshore drilling so there’s going to be each step of the way they’re going to try to cripple the oil and gas sector.”

An Exxon spokesman said: “We have been clear in supporting an efficient, economy-wide price on carbon as the best way to achieve the goals of the Paris Agreement. While there is not broad support for a tax, we are actively and publicly discussing other op-

tions, including lower-carbon fuels and other sector-based approaches that would place a uniform, predictable cost on carbon.”

A spokeswoman for the API said: “We’ve endorsed a host of climate actions and are advocating for a carbon price policy as the most impactful way to spur innovation and reduce emissions across all economic sectors. We’ll continue to advance technology innovation, policy solutions and industry actions to help shape a lower-carbon future.”

Infrastructure plan

One of the threats facing Exxon, according to McCoy, is President Biden’s proposal to pour billions of dollars into renewable energy and electric vehicles through the \$2 trillion American jobs plan, his flagship initiative to tackle climate change. Unearthed can reveal that Exxon has been working hard behind the scenes to eliminate the proposed funding.

As alluded to by McCoy, in the absence of major legislation limiting US emissions – such as the cap-and-trade system proposed during the Obama administration – Biden has moved to accelerate the



ExxonMobil plant in Chicago, Illinois.
Photo credit: Richard Hurd

transition to clean energy and transport through government spending. The proposals, the most ambitious clean energy legislation ever put forward by a US President, included more than \$100 billion in subsidies for electric vehicles alone and would have been paid for by higher taxes on corporations like Exxon. But last week Biden endorsed an alternative plan, which eliminates the vast majority of spending on climate change after being forced into a compromise by “moderate” Democratic senators, including Joe Manchin, senator for West Virginia.

Now, Unearthed can reveal that – according to one of its most senior lobbyists – ExxonMobil targeted a number of these moderate senators, with the aim of scaling back the plan’s ambition by scrapping the tax hikes that would pay for it. Speaking in early May, McCoy said: “We’re playing defence, because President Biden is talking about this big infrastructure package and he’s going to pay for it by increasing corporate taxes. So it’s a delicate balance we’re asking for help with taxes over here [lobbying for subsidies for a carbon capture project] and we’re saying, don’t increase our taxes over here.”

He explained that if the plan stuck to “roads and brid-

ges”, the budget could be reduced from \$2 trillion to \$800 billion, limiting the need for tax rises: “The international tax piece is for, for ExxonMobil is close to a billion dollars.”

This would mean “the negative stuff starts to come out, because there’s a germaneness right... that doesn’t make any sense for a highway bill. Why would you put in something on emissions reductions, on climate change to oil refineries in a highway bill?”

Targeting senators

When asked which senators Exxon is lobbying on these specific points, McCoy said: “Senator [Shelley Moore] Capito [Republican senator for West Virginia]... who’s the ranking member of environment and public works. Joe Manchin, I talk to his office every week, he is the kingmaker on this because he’s a Democrat from West Virginia which is [a] very conservative state, so he is, and he’s not shy about sort of staking his claim early and completely changing the debate.”

“On the Democrat side we look for the moderates on these issues”, McCoy continued, highlighting figures



including Arizona senator Kyrsten Sinema; John Tester, senator for Montana; and Chris Coons, senator for Delaware, President Biden's home state.

"Senator Coons... has a very close relationship with Senator [President] Biden, so we've been working with his office – as a matter of fact our CEO is talking to him next Tuesday and having those conversations and just teeing it up, and then that way I can start working with his staff to let them know where we are on some of these issues," McCoy said.

He added that he targets senators like Mark Kelly, Democrat senator from Arizona, New Hampshire Democrat senator Maggie Hassan, and Florida Republican senator Marco Rubio, who are up for reelection in 2022. "I can't worry about the 2027 class because they're not focused on re-election. The 2022 [class] is focused on re-election so I know I have them... you can have those conversations with them because they're a captive audience, they know they need you and I need them," McCoy said.

With the vast majority of the clean energy and transport spending now stripped from the proposed bipartisan legislation, Biden has signalled that he will attempt to address climate change through a separate budget reconciliation bill, which can be passed with a simple majority vote. But the President faces the same challenge of convincing Joe Manchin, Kyrsten Sinema – and the other senators targeted by Exxon – to support the tax increases necessary to fund the transformation in energy and transport that he originally envisaged. An Exxon spokesman said: Our discussions on the current infrastructure bill are not accurately portrayed. Our lobbying efforts are related to a tax burden that could disadvantage U.S. businesses, and we have made that position known publicly. Exxon-Mobil stands by our position that increased taxes on American businesses make the U.S. less competitive. "The comments describing interactions with government officials and non-governmental organizations are entirely inconsistent with the way we expect our people to engage. The individuals interviewed were not involved in developing the company's policy positions on the issues," he continued.

Clean energy

Unearthed can further reveal that Exxon's new strategy for delaying action on climate change goes beyond opposition to specific pieces of legislation. A core objective for Exxon on Capitol Hill is undermi-

ning confidence that a transition to clean energy and transport is possible over the next decade, according to McCoy.

"You're not going to be able to just switch to battery operated vehicles or land for your electricity and it's having that conversation around why that's not possible in the next 10 years is critically important to the work that we do... and that's at every phase: that's in the Senate, that's in the House, that's with the Administration," he said.

McCoy went on to describe President Biden's new targets to cut US greenhouse gas emissions as "insane", before suggesting that ambitious action on climate change is unlikely to succeed, because it isn't an existential threat like the pandemic. "Outside like, of something like Covid where there's this existential crisis and people rally to support each other. On something like climate change there's the forest fires, there's an increase [of] .001 Celsius, that doesn't affect people's everyday lives," he said.

'A lot of wins'

The investigation also revealed one former Exxon lobbyist's disbelief at the scale of influence the company had during the Trump administration. Dan Easley, who was a senior director for federal relations at Exxon until February 2021, when he joined a clean technologies firm, laughed when asked by an undercover reporter if the company had achieved many big policy wins under Trump, before outlining victories on fossil fuel permitting and the renegotiation of the NAFTA trade agreement.

"You should Google 'ExxonMobil announcement' and 'Donald Trump'. So he live-Facebooked from the West Wing our big drill in the Gulf project, he mentioned us in two States of the Union, we were able to get investor state dispute settlement protection in NAFTA, we were able to rationalise the permit environment and you know, get tonnes of permits out."

"The wins are such that it would be difficult to, to categorise them all. I mean, tax has to be the biggest one right, the reduction of the corporate rate was, you know, it's probably worth billions to Exxon, so yeah there were a lot of wins," Easley continued.

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Statement from ExxonMobil in full

Greenpeace has waged a multi-decade campaign against our company and industry, which has included false claims and unlawful actions at our facilities as well as those of other companies around the world. Greenpeace now appears to have posed as a recruiter, and gone so far as to create a fake website and persona, to interview and secretly record a current and former employee under false pretenses. Greenpeace and Channel 4 have refused to provide the full, unedited videos that would allow us to assess their veracity and the context in which the statements were made.

The written excerpts they did provide contained a number of important factual misstatements that are starkly at odds with our positions on a variety of issues, including climate policy and our firm commitment to carbon pricing. For example, among the many inaccuracies in the statements, ExxonMobil does not manufacture PFAS. Furthermore, the comments describing interactions with government officials and non-governmental organizations are entirely inconsistent with the way we expect our people to engage. The individuals interviewed were not involved in developing the company's policy positions on the issues. With respect to claims made in the excerpts:

- Again, ExxonMobil does not manufacture PFAS.

- Our discussions on the current infrastructure bill are not accurately portrayed. Our lobbying efforts are related to a tax burden that could disadvantage U.S. businesses, and we have made that position known publicly. ExxonMobil stands by our position that increased taxes on American businesses make the U.S. less competitive.

- We have been clear in supporting an efficient, economy-wide price on carbon as the best way to achieve the goals of the Paris Agreement. While there is not broad support for a tax, we are actively and publicly discussing other options, including lower-carbon fuels and other

sector-based approaches that would place a uniform, predictable cost on carbon.

- For more than a decade, ExxonMobil has supported an economy-wide price on CO₂ emissions as an efficient policy mechanism to address greenhouse gas emissions. ExxonMobil is a founding member of the Climate Leadership Council (CLC), which calls for simplifying regulations and adopting a carbon fee. We have provided funding to the advocacy efforts of the CLC, which says its bipartisan plan could cut U.S. CO₂ emissions in half from 2005 levels by 2035.

- We have supported climate science for decades. Greenpeace and others have distorted our position on climate science and our support for effective policy solutions.

- Contrary to the implication in the excerpt summary, natural gas is a versatile, abundant fuel. When used for power generation, it plays an important role in reducing global emissions, emitting up to 60 percent less greenhouse gases and significantly fewer air pollutants than coal. The power sector's switch from coal to natural gas is a main reason why U.S. emissions have declined more than any other country since 2000.

- On sanctions, the company's long-standing position is not to lobby for or against sanctions, but to inform policymakers on the potential unintended consequences certain aspects of sanctions policy can have on U.S. businesses, as was the case in the situation referenced. The U.S. and EU have adopted sanctions on Russia, and we fully comply with all sanctions.

- Regarding the manufacturing of plastics, there is no doubt that plastics provide significant sustainability benefits versus other materials. Without plastics, we would not have many of the life-saving materials that have helped our world fight COVID-19 and store food safely. This is in addition to the important role plastics play in helping society mitigate greenhouse gas

emissions.

- According to a 2020 Imperial College of London study, if all plastic bottles used globally were replaced with glass, the additional resulting CO₂ emissions would be equivalent to adding about 22 large coal-fired power plants.

- The same study found replacing plastic food packaging with alternatives would increase CO₂ emissions nearly 3 percent and more than double energy use.

- Of course, we take the issue of plastic waste management very seriously. ExxonMobil is addressing plastic waste by increasing recyclability, supporting improvements in waste recovery – for example, through our founding membership in the Alliance to End Plastic Waste.

- ExxonMobil has completed an initial phase trial of a proprietary advanced recycling process for converting plastic waste into raw materials for production of high-value polymers. The trial, at the company's existing facilities in Baytown, Texas, marks another step in ExxonMobil's efforts to help reduce plastic waste in the environment and maximize resource recovery.

- In some cases, ExxonMobil works with third-parties to advocate for policies that are important to the industry. ExxonMobil transparently engages with a variety of trade associations, think tanks and coalitions in order to promote informed dialogue and sound public policy in areas pertinent to the Corporation's interests.

- ExxonMobil exercises its right to engage in lobbying in the United States at both the Federal and State levels to advocate our positions on issues that affect our Corporation and the energy industry. We have a responsibility to our customers, employees, communities and shareholders to represent their interests in public policy discussions that impact our business.

- Our lobbying efforts fully comply with all laws and are publicly disclosed on a quarterly basis, including the issues we discuss.

A photograph of a rural village scene. In the foreground, a young boy in a brown tank top stands with his back to the camera, looking towards a mural on a wall. To his left, a woman in a white sari is pointing at the mural. A man in a blue shirt is walking away from the camera towards a doorway. A small child is visible in the lower center. The mural depicts several figures in traditional Indian attire. The background shows a building with a tiled roof and a wall with small square openings.

No more vitamin CD (Carbon Dioxide)

Not all cases of brain dysfunction are caused by elevated CO₂ and air pollution. But articulates found in air pollution from burning fossil fuels may lead to brain dysfunction.

LENORE HITCHLER

ONE

While some people may not be concerned with the plight of polar bears or the destruction of rainforests, no one wants to suffer from diminished brain capacity. Unfortunately, the latest research suggests that burning fossil fuels may increase the chances of brain damage. Particulates found in air pollution from burning fossil fuels may lead to brain dysfunction. Additionally, elevated carbon dioxide (CO₂) levels will likely reduce plant nutrition leading to cognitive and emotional difficulties.

The theory is new and has not yet reached full scientific consensus. And indeed, not all cases of brain dysfunction are caused by elevated CO₂ and air pollution. However, all of the following information comes from respected scientific journals.

Air pollution from burning fossil fuels might be a contributing factor in the rising prevalence of diabetes. Diabetes increases the risk for both brain-damaging strokes and Alzheimer's. The article "Carbon Dioxide Emissions and Change in Prevalence of Obesity and Diabetes in the United States: An Ecological Study" was published in *Environment International*. The authors stated that a recent study found a significant relationship between county levels of PM_{2.5}, one of the particulates found in air pollution, and the prevalence of diabetes.

Moreover, air pollution limits the ability of human skin to synthesize vitamin D leading to an increased risk of vitamin D deficiency. This was shown



Participants of the Smokescreen public engagement art project in Nepal. The Smokescreen explores the issues around air pollution with women.
Photo credit: Dinesh Deokota

in “The Effects of Air Pollution on Vitamin D Status in Healthy Women—A Cross Sectional Study”, published in *BMC Public Health*.

And vitamin D deficits can lead to brain dysfunction. Low gestational vitamin D levels are associated with an increased risk for attention-deficit/hyperactivity disorder. This was shown in “Maternal Vitamin D Levels and the Risk of Offspring Attention-Deficit/Hyperactivity Disorder”, published in the *Journal of the American Academy of Child & Adolescent Psychology*.

Mothers with lower gestational levels of vitamin D are also more likely to have a child with autism. This was shown in “Lower Maternal Serum 25 (OH)D in First Trimester Associated with Higher Autism Risk in Chinese Offspring”, published in the *Journal of Psychosomatic Research*. Similar results were found in “Maternal Vitamin D Deficiency and the Risk of Autism Spectrum Disorder: Population-based Study”, published in *The British Journal of Psychiatry*. The authors reported

that a recent study demonstrated lower neonatal vitamin D levels in children with autism spectrum disorder than their siblings.

Various other mental disorders have also been associated with low vitamin D levels. “The Role of Vitamin D in Brain Health: A Mini Literature Review” was published in *Cureus*. This meta-analysis found lower vitamin D levels increased the risk for dementia and several studies find a link between vitamin D and depression.

Older adults are at risk of losing cognitive function because of lower vitamin D levels. The article “Identification of Neuroprotective Factors Associated with Successful Ageing and Risk of Cognitive Impairment Among Malaysia Older Adults” was published in *Current Gerontology and Geriatrics Research*. The authors found that the risk of mild cognitive impairment was reduced when vitamin D levels were higher.

Vitamin D deficiency is associated with greater

than twice the odds of all types of dementia, Alzheimer's and strokes. This was found in "Cognitive Consequences of Vitamin D Deficiency", which was published in *Practical Neurobiology*.

Besides fossil fuel air pollution negatively affecting nutrition, increasing levels of atmospheric CO₂ will likely damage the nutritional value of essential food crops. The article "Rising CO₂ and Human Nutrition: Toward Globally Plant Stoichiometry" was published in *Trends in Ecology & Evolution*. The paper reported that "every terrestrial plant is exposed to 30% higher [CO₂] relative to pre-industrial times; during this century [CO₂] levels could double or triple over pre-industrial levels."

Rising CO₂ levels have been found to lower the amount of minerals found in plants. For example, higher levels of CO₂ decrease the amount of boron found in leaves and roots, as reported in "Elevated CO₂ Affects Plant Responses to Variation in Boron Availability", published in *Plant and Soil*. And lower dietary boron has been found to cause significantly poorer performance on tasks emphasizing manual dexterity, eye-hand coordination, attention, and short and long-term memory.

Zinc levels in plants are also affected by rising CO₂ levels. The article "Effect of Increased Concentrations of Atmospheric Carbon Dioxide on the Global Threat of Zinc Deficiency: A Modelling Study", published in *The Lancet*, reported that "increasing concentrations of atmospheric carbon dioxide lower the content of zinc and other nutrients in important food crops." This could lead to global zinc deficiencies.

The importance of zinc was also stressed in the article "Zinc Deficiency and Its Effect on the Brain: An Update" published in the *International Journal of Molecular Genetics and Gene Therapy*. The authors found that zinc deficiency was associated with neurological disorders, mental development, learning disabilities, autism depression, alcoholism, and schizophrenia.

Higher levels of CO₂ also lead to lower iron levels in plants and iron deficiency can lead to brain dysfunction. The article "Long-term Brain and Behavioral Consequences of Early Iron Deficiency" was published in *Nutrition Reviews*. The authors

reported "Multiple studies demonstrate long-term motor cognitive and socio-emotional behavioral deficits in children and young adults following a period of ID [iron deficiency] early in life. ... formerly iron deficient children demonstrate more anxiety-depression symptoms at 11 to 14 years of age ... children born to iron deficient mothers are more likely to develop schizophrenia later in life in a dose-dependent manner related to the degree of maternal ID."

Elevated CO₂ levels may also lower the amount of protein synthesized by plants. And the lower levels of protein in rice is especially catastrophic as it is the global primary food source for more than two billion people. The article "Global Health Implications of Nutrient Changes in Rice Under High Atmospheric Carbon Dioxide", published in *GeoHealth*, warned that globally, by 2050, 132 million are at risk for folate deficiency, and 67 million at risk of thiamin deficiency.

Another nutrient necessary for proper brain functioning is Docosahexaenoic Acid (DHA). The article "Projected Declines in Global DHA Availability for Human Consumption as a Result of Global Warming" reported that DHA is an essential omega-3 fatty acid that is usually obtained from consuming fish. Higher water temperatures are predicted to reduce the synthesis of DHA by the algae which is later consumed by fish. Less DHA production will be detrimental to health.

One consequence of lowered DHA consumption is shown in "Maternal Seafood Consumption in Pregnancy and Neurodevelopmental Outcomes in Childhood (ALSPAC [Avon Longitudinal Study of Parents and Children] study): An Observational Cohort Study" published in *The Lancet*. The authors reported that the lowest maternal seafood intake during pregnancy was associated with lower verbal intelligence, plus an "increased risk of suboptimum outcomes for prosocial behaviour, fine motor, communication, and social development scores."

Psychological health is critical, and being overweight is an emotional burden for millions. Rising levels of CO₂ might be linked with obesity. Again, this is a new theory and is not yet part of the scientific consensus. However, there is a growing



Elevated CO₂ levels may lower the amount of protein synthesized by plants. And the lower levels of protein in rice is especially catastrophic as it is the global primary food source for more than two billion people. (Rice fields near Doi Inthanon National Park. Photo credit: Supercarwaar)

body of evidence that indicates the validity of this new theory.

The article “A Proposed Potential Role for Increasing Atmospheric CO₂ as a Promoter of Weight Gain and Obesity” reported that over the past two million years, the atmospheric concentration of CO₂ remained between 180-280 ppm (parts per million). Therefore, humans evolved to function at much lower CO₂ levels than the current level. In the last century, atmospheric CO₂ levels were at 280 ppm. According to the *US National Oceanic and Atmospheric Administration*, the 2020 level was 412.5 ppm.

The effect is worse in industrialized societies, where people spend 80 to 90% of their time indoors and the CO₂ level is even higher than the outdoor level.

“Increased CO₂ concentration in inhaled air decreases the pH of blood, which in turn spills over to cerebrospinal fluids. Nerve cells in the hypothalamus that regulate appetite and wakefulness have been shown to be extremely sensitive to pH. We

hypothesize that an increased acidic load from atmospheric CO₂ may potentially lead to increased appetite and energy intake, and decreased energy expenditure, and thereby contribute to the current obesity epidemic.”

In the hypothalamus, “there are specialized nerve cells (orexin neurons), involved in the regulation of appetite, energy metabolism, wakefulness, feeding behaviour and libido. These orexin neurons are extremely sensitive to changes in pH, a decrease of only 0.1 pH units leading to a doubling in their activity. [...] Activation of the orexin system will lead to less sleep, and lack of sleep has been reported to decrease levels of the satiety hormone leptin, increase levels of the hunger hormone ghrelin, and alter glucose homeostasis.”

Acidic stress could also lead to the production of cortisol, which increases the risk of obesity. To add to the legitimacy of the theory, “a recent study found that 24 populations of 8 different species, including laboratory animals that had been fed the same diets for decades all displayed significant weight gain.” **ONE**

Why Europe cannot afford to shun nuclear power

Sustainability Times

With the EU Parliament's approval of the European Commission's package of legislative proposals on climate and energy, the bloc's ambitious emissions reduction targets of least 55% below 1990 levels by 2030, are now legally-binding. The vote on 24 June reinforces the EU's commitment to achieving climate neutrality by 2050 set out in the Green Deal, with the EU now needing to "reduce emissions more in the next decade than it has in the previous three decades combined".

The law is a great success for the lawmakers who hope it will serve as a blueprint for similar initiatives elsewhere in the world. And indeed, the difficulty of the challenge can hardly be overstated: in 2019, the EU emitted approximately 3.3 billion metric tons of CO₂, 80% of which as a result of fossil fuel combustion. However, while the Green Deal has made the final destination clear, the path to reaching it remains muddled with internal contradictions – all of which make achieving its objectives much harder.

While Brussels focuses on decarbonization by means of electrification using solar and wind, the big elephant in the room remains nuclear power. Although it is recognized as a low-carbon and reliable energy source and therefore relevant to carbon cuts, the EU has been hesitant to count it as a technology eligible for green financing. Politically, Brussels cannot forbid its members to use nuclear, but the issue remains a hot button topic because of negative public sentiments towards nuclear power, buoyed by concerns in Brussels over national security implications of foreign-built nuclear reactors within the EU, with a view to Russian and Chinese technology.

This became clear on the same day the European Parliament took its vote on the climate law, when the Czech Republic – one of several Eastern EU members intent on

expanding their nuclear fleet to reduce their reliance on fossil fuels – excluded Russian and Chinese vendors in security assessments for potential bidders for the \$7 billion expansion project at the Dukovany NPP.

But Samuele Furfari, Professor of the Geopolitics of Energy at the Free University of Brussels, argues the issue goes deeper than mere concerns about national security emanating from a specific vendor: "When dealing with nuclear energy, unfortunately, one must always take into account that ideology is always at play", he tells Sustainability Times. Since the 1970s, the anti-nuclear movement has been growing at a rapid pace, so that today, "the EU is only interested in solar and wind energy and the rest has become a pariah." In other words, "the alarmism is not about Russian nuclear power per se, but about nuclear power in general."

Western observers have repeatedly argued that Russian and Chinese energy projects are part of a strategic goal "to build spheres of energy dependence". However, as Prof. Furfari says, this is more the result of energy shocks in the past than a real possibility: "The trauma created by [the oil shocks of the 1970s] has shaped the way we think about energy. We still think in terms of geopolitical control over a country through energy supply. Today, energy resources are abundant, and new countries have become energy producers. For example, who would have thought that Israel would become an exporter of natural gas?"

Importantly, this holds true for nuclear power as well, given that not one country has a monopoly over reactor technology: "Just think that it was South Korea's Kepco that won the contract for the Barakh-1 NPP in Abu Dhabi", rather than Russia's Rosatom or China's Nuclear Power Corporation. According to Prof. Furfari, "to think that Russia

will be able to exert geopolitical pressure thanks to NPPs is a totally unfounded". Instead, Furfari points to the role of the market in deciding which company is chosen for nuclear projects the world over: "whether it is for resources or for energy equipment, the law of the market is imposing itself and will impose itself more and more. In the end, in a dynamic globalized world, the market will prevail. The best will win the markets."

It's true that the nuclear market has developed, which is particularly noticeable in the international market for nuclear fuel, thanks to rapid diversification in recent years. This is important in cases where it is feared that operating Russian reactors are making countries dependent on Russia as a single supplier. But thanks to diversification, this is no longer the case. "The first contract between Energoatom and Westinghouse was signed in 2008 so that VVER-1000 fuel produced by Westinghouse is already in use in six nuclear reactors in Ukraine", Furfari says. At the same time, Russia also supplies TVS-K fuel assemblies for Western-designed PWR reactors, notably in Sweden.

Even so, the geopolitical debate, and how it fits into the wider questions about nuclear power as an energy source, continues – with far-reaching implications for the technology's future in the EU and Brussels' climate goals. Prof. Furfari is clear about the adverse effects the exclusion of nuclear power for political and ideological reasons will have: "How is it possible to claim to reduce CO2 emissions by 55% in 2030 compared to 1990 by relying almost ex-

clusively on solar and wind energy? After spending more than a thousand billion Euros since 2000, these two energy sources represent 2.5% of the EU's primary energy. And those who are the most concerned about the climate emergency are those who oppose nuclear power, which is the only large-scale energy resource without CO2 production", he tells Sustainability Times.

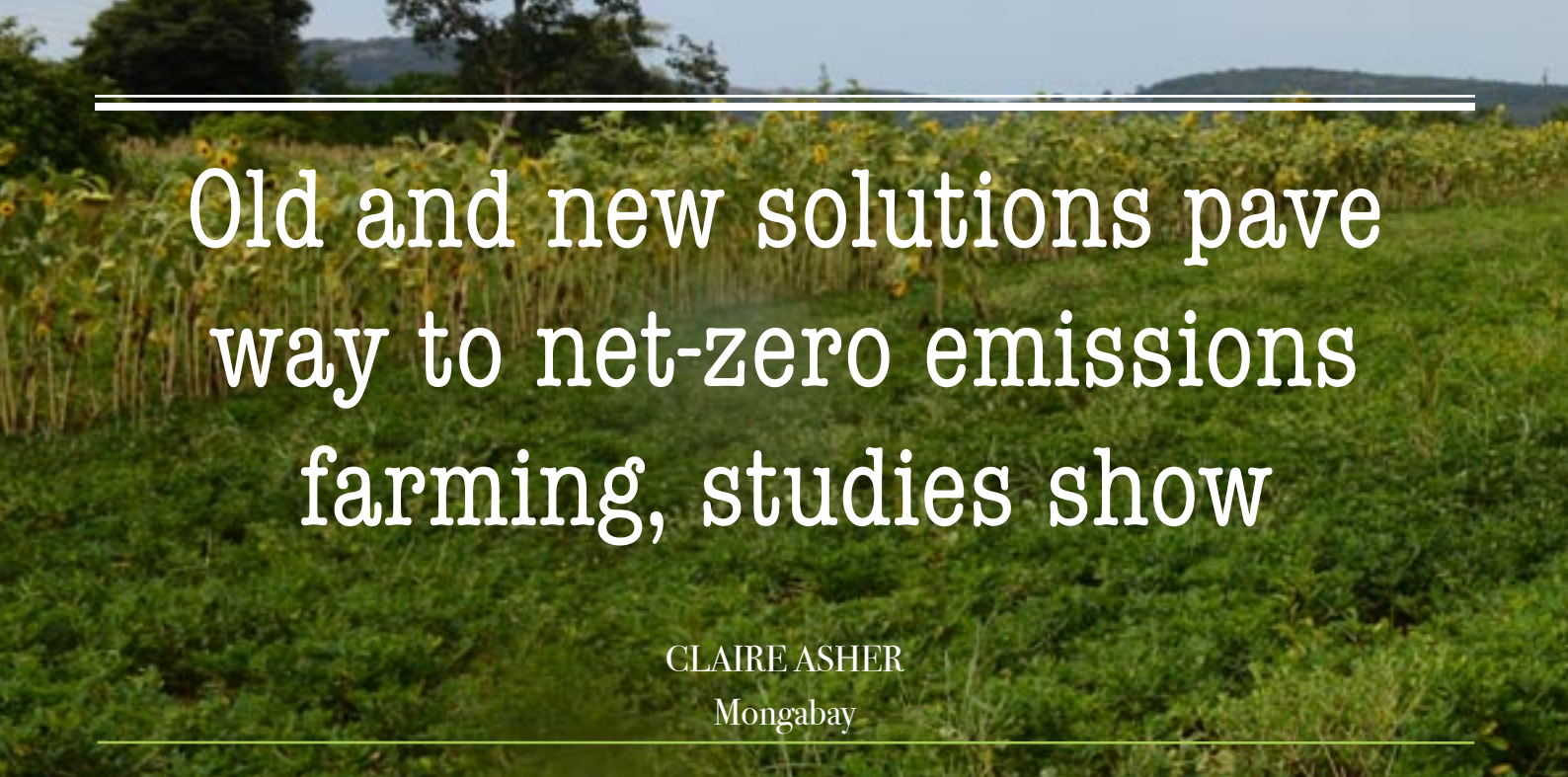
But the negative effects extend beyond mere energy production, with the professor warning that Europe will be left behind in the race for energy technologies. After all, "the future of nuclear electricity will be determined by new generation reactors, including SMRs and certain molten salt reactors whose particularity will be to burn the spent fuel of heavy water reactors, thus considerably alleviating the issue of long half-life transuranics."

At a time when the US, Russia, China and Canada are intensifying research on these new reactor concepts amid growing pressure to find sustainable solutions to climate change, Europe would do well to rethink its stance on the technology. With climate neutrality by 2050 the ultimate objective, Brussels will hardly get around nuclear in any realistic decarbonization and electrification scenario. After all, in the words of Prof. Furfari, "nuclear energy is the future of electricity."

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Shoreham Nuclear Power Plant in Shoreham.
Photo credit: Paul Searing





Old and new solutions pave way to net-zero emissions farming, studies show

CLAIRE ASHER

Mongabay

New and emerging technologies could pave the way to net-zero carbon emissions agriculture in the next two decades, according to a study published in the journal *Proceedings of the National Academy of Sciences* (PNAS) last month.

A host of new and emerging agricultural technologies lie on the horizon that could revolutionize how we think about food production, but a separate report published in the journal *One Earth* suggests that low-tech solutions could be just as effective.

Agriculture and food production account for 34% of global greenhouse gas emissions, making these sectors critical in efforts to address our current overshoot of the climate planetary boundary. They are also having profound impacts on freshwater, biodiversity, and nitrogen and phosphorous nutrient cycling – each of them planetary boundaries that we must balance if we are to keep conditions on Earth habitable for generations to come.

Yet, within the agri-food problem may lie a golden opportunity for climate solutions: That's because the productivity and, ultimately, the profitability of agri-food systems are based on photosynthesis, a process that removes CO₂ from the atmosphere, and our agricultural lands have huge potential to become a net carbon sink and contribute positively to addressing the climate emergency.

Novel tech's key role in curbing carbon emissions

In a perspective article for PNAS, Daniel Northrup and colleagues compared projected greenhouse gas emissions from dif-

ferent agri-food technologies with current emissions for maize cultivation.

They found that a combination of novel technologies – including digital agriculture, crop genetics, and electric vehicles – implemented as part of a three-phase transition could achieve a 71% reduction in greenhouse gas emissions from row-crop agriculture in the next 15 years. At the same time, these practices aim to build soil carbon stores, which could pave the way to net negative emissions from the sector.

The first phase would optimize current agri-food technology by employing digital agriculture to reduce the amount of nitrogen fertilizer used on crops by applying smaller amounts more precisely, a method that could cut emissions by 23%.

Next, existing technologies would be replaced with low-emission equivalents, including green methods for synthesizing fertilizers, and replacement of fossil fuel-powered farm equipment with electric equivalents run by renewables.

This step could include selective breeding or genetic engineering for certain crop traits, such as improved nitrogen absorption through plant roots.

The final step in the agri-tech transition would involve a full redesign of the agricultural system, making use of swarms of small agricultural robots to practice automated precision agriculture with high-performing crop varieties, guided by distributed sensors. An advanced agricultural system like this might reduce carbon emissions by more than 1,700 kilograms per hectare, according to the study.



Crop rotation of maize and velvet bean Maize crop rotated with velvet bean at Kumbirai and Lilian Chiambadza's plot in Ward 4, Murehwa, Zimbabwe has guaranteed high yields in an El Nino season. Photo credit: Shiela Chikulo/CIMMYT

“The report focused on one of the most common cropping systems on the planet – high intensity maize – and worked out a pathway to dramatically decarbonize,” explained Northrup.

He argued that high-tech solutions can speed humanity's transition to more sustainable crop cultivation that maintains vital ecosystem services like carbon sequestration and water filtration. “Because these tools can comfortably operate within current agricultural markets, they are a great place to build trust and converge on sustainable [agricultural] solutions,” he said.

Livestock decarbonization solutions

But crops tell only half the story, defining half the problem and half the solution: 50% of agricultural emissions come from animal production, and new technologies can help here, too.

In a separate study, also published in the journal PNAS, a team led by Arren Bar-Even at the Max Planck Institute of Molecular Plant Physiology in Germany investigated how microbial protein could be used to reduce the environmental footprint of meat production and offer a healthy, sustainable, vegan protein for human consumption at the same time.

Microbes have been cultivated for protein production for both feed and food since the First World War, and a recent renaissance in the field has seen many companies developing microbial systems to produce this “single-cell protein” (SCP) as a source of animal feed, fish feed, and commercial food products. Typically, companies use methane or agriculturally grown sugars to cultivate bacteria intended for feed and food, but production of both substrates is associated with accom-

panying environmental impacts. However, the new study found that those impacts could be bypassed by single-cell protein cultivation powered by solar panels. This new technology, dubbed photovoltaic single-cell protein (PV-SCP), could achieve up to 10 times higher protein yield per unit of land than staple crops like soybeans, reducing greenhouse gas emissions from land conversion and synthetic fertilizers.

“Engineering [and] electrochemistry are very good at certain things, and biology is very good at other things, and if we take the best of both then we can unlock new possibilities that were not available before,” said study lead author Dorian Leger, now an intern at the European Space Agency.

The process works like this: Electricity from a solar farm is channelled to an electrochemical unit, which uses CO₂ captured from the atmosphere to produce an energy-rich growth medium for microbial protein, which can then be converted into animal feed or further purified as an edible protein for a variety of human foods. The resulting protein is highly nutritious and meets the recommendations of the U.N. Food and Agriculture Organization (FAO) for healthy amino acid composition, as well as being rich in B vitamins.

The team modeled the energy efficiency of PV-SCP compared to staple crops and found that the technique could generate 1.2 kg of protein per square meter of land per year – 10 times more than the highest-yielding crop alternative, soy, which outputs 0.115 kg of protein per square meter per year on average.

Rapid implementation of this technology could potentially mean the salvation of the Amazon rainforest and Cerrado savanna in Brazil, where vast areas of native vegetation are



being converted to soy annually.

“To put it mildly, plants’ photosynthetic machinery is mind-blowingly impressive, yet I’m not that surprised that human engineered systems can outperform them from an energy efficiency point of view,” said Leger.

Microbes can direct most of their energy into producing protein, whereas crop plants, like soybean, must invest additional energy in root systems, leaves and other non-edible components, he explained.

SCP also sidesteps an important trade-off faced by plants between photosynthesis and water loss, because microbes can be grown in closed vats where almost no water is lost due to evaporation. So the process protects another planetary boundary: our freshwater systems.

New focus on old, low-tech agricultural techniques

Despite a great deal of excitement, research and investment into novel agri-technologies, some experts say the same end goal could be achieved with existing, low-tech solutions. The key: closing the loop on the agricultural nitrogen cycle.

Another new study, published in the journal *One Earth*, re-

ports that by implementing three simple principles, Europe could feed its growing population, break its reliance on imported feed, and achieve a substantial reduction in greenhouse gas emissions.

The three principles: reducing human consumption of animal products, implementing organic crop rotation systems, and reconnecting livestock and cropping systems via manure.

“The surprise is that, with organic farming, without any synthetic fertilizer, by just reconnecting livestock and by adapting our diet to health standards, we can feed everybody,” said study lead author Gilles Billen, a biogeochemist and emeritus research director at the French National Center for Scientific Research (CNRS by its French acronym) in Paris.

The researchers calculate that regionally appropriate crop rotation systems, directly linking crop cultivation to livestock, could meet the protein requirements for 600 million Europeans in 2050, when the population is expected to peak.

“By making use of legumes — those plants able to fix atmospheric nitrogen into proteins in their roots — as the head of the crop rotations, you can bring lots of nitrogen naturally to the soil,” Billen said. Diverse crop rotations like these also reduce pests and diseases that thrive in the uniform conditions of agricultural monocultures, thereby reducing or eliminating



the need for pesticides – addressing another planetary boundary, polluting novel entities.

It's all about nitrogen

Rather than relying on new technology, Billen's scenario would see a return to agricultural principles that were commonplace just a century ago, but which would now be boosted by modern agro-ecological know-how.

Europe was then dominated by mixed crop and livestock farms, recycling livestock manure to fertilize a diverse rotation of crops, including nitrogen-fixing legumes like clover and alfalfa. Those old ways were exploded by the discovery of the Haber-Bosch chemical process in 1909, which uses high pressures and temperatures to extract nitrogen from the atmosphere – a technology that revolutionized agriculture by making cheap synthetic fertilizers readily available.

By 2015, the Haber-Bosch process was feeding an estimated 44% of the world's population. The catch: for every ton of nitrogen extracted, Haber-Bosch uses a ton of fossil fuels and releases 1.87 tons of CO₂. This single industrial process is responsible for an estimated 1.2% of global greenhouse gas emissions.

The irony is, after expending so much energy to process that nitrogen, much of it never makes it into our crops.

"The plant-soil interface is very inefficient in terms of how it deals with nitrogen; only 50% of the nitrogen we apply as fertilizers is ending up in our food," explained Leger.

The rest becomes pollution – washed into waterways where it can cause harmful algal blooms, or released from the soil back into the atmosphere. Here, it acts as a potent greenhouse gas, with 265 times the climate-warming potential of CO₂. In fact, humanity's abuse of the nitrogen cycle has already resulted in one of our worst overshoots of a planetary boundary.

"Although often overlooked, our influence on the nitrogen cycle is much greater than the one we have on the carbon cycle, and this depends massively on how we produce our food," said Silvio Matassa, postdoctoral researcher at the University of Naples in Italy and co-author on the PV-SCP study.

"One of the most terrible consequences of the generalization of the use of Haber-Bosch nitrogen synthetic fertilizer is the fact that it made possible to completely disconnect cereal cultivation and livestock farming," said Billen. As production was scaled up, farmers in the most fertile regions focused on cultivating highly productive cereal crops, pushing livestock farming to less fertile regions and to where it became necessary to import feed.

"That [agricultural specialization] leads to a terrible disfunctioning [because] you are not able to close the biogeochemi-

cal cycles,” he explained. By closely pairing livestock and crop cultivation in the modeling study’s 2050 scenario, Billen and colleagues were able to dramatically reduce reliance on synthetic nitrogen fertilizers in favor of manure and legumes, resulting in a 57% reduction in nitrogen emissions.

Other sources of waste nitrogen could also be redirected toward agriculture. For example, wastewater purification plants are legally required to remove nitrogen to prevent it entering streams and rivers; once extracted, it is released back into the atmosphere as nitrogen and the greenhouse gas nitrous oxide.

“That’s completely crazy, of course, because it’s the same nitrogen; you can reuse it as long as you want by simple systems and you don’t need this energetic input and you can avoid the associated greenhouse gas emissions,” Billen said. “That’s why it was completely obvious for us to integrate [recycling wastewater nitrogen] in our scenario.”

Reusing the nitrogen filtered from domestic wastewater back into the industrial agricultural system could be an environmental and economic win-win, saving roughly 2 tons of fossil fuel for every ton of nitrogen recycled.

Changing diets, changing the world

Experts interviewed for this article agree that a reduction in the dominance of animal products in Western diets is a necessary change if we are to feed a growing global population with a healthy, sustainable, and equitable diet.

The proportion of animal protein in European diets has increased from 35% in 1961 to 55% in 2013, but nutritional science suggests that reversing this trend would have significant health benefits.

For example, the EAT–Lancet Commission on healthy diets from sustainable food systems recommends a reference diet containing 33% animal protein. Billen’s scenario uses a diet composed of 30% animal protein, with the rest of human requirements met by cereals, fruit and vegetables, and grain legumes such as beans, chickpeas and lentils.

“You cannot hope [to feed] all the world population [in] 2050 with a diet as rich in animal proteins as it is [today in] Europe or the United States,” said Billen. “Between 30-40% [animal protein] is the maximum allowable as what I call an equitable diet – a diet that can be shared by all populations in the world,” he explained.

“I’m not opposed to livestock, nor do I think we should aim to eliminate all livestock farming, but we probably need to strike a more delicate balance than what we’ve done up to date in the West,” agreed Leger.

Currently, “30-40% of all land is being used for agriculture, and yet there’s something like 800 million people – one in 10 people – that are undernourished,” he noted. “Although we’re projecting that there’s going to be problems in the food system in the future, clearly there are already limitations to what we can achieve [now], and despite these limitations it already has a huge environmental burden, so we need to do something.”

High-tech and low-tech solutions are often considered separately, but integrating these approaches could be the fastest route to agricultural sustainability and lowered carbon emissions. Imagine a future agricultural system combining digital agriculture (such as automatic crop monitoring and robotic fertilizer application), with regenerative practices (like legume-based crop rotations and mixed crop-livestock systems), all supplemented by renewables-driven microbial protein.

“I would find it very cool if PV-SCP could be integrated into farmland, so that it could work in conjunction with crops [and] with nature, so that it shares land with insects, animals, and plants,” said Leger.

High time for an agri-food paradigm shift

Rethinking the global food system is essential if we are to meet the Paris Agreement goal of limiting global average temperatures to an increase of 1.5-2° Celsius (2.7-3.6° Fahrenheit) above pre-industrial levels. A sobering fact: current trends in greenhouse gas emissions produced by our business-as-usual global agri-food system are sufficient to blow humanity’s entire carbon budget before 2063.

With a century of investment in the current industrial agricultural system, it won’t be easy to radically change course, but “there are moments in history where you are forced to change paradigm and that’s urgent now because of the climate urgency, and biodiversity loss,” said Billen. Fortunately, he believes the tide of opinion is starting to turn, concluding, “I am an optimistic guy.”

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Status in Global Energy Transition: Achievements, Barriers, Innovations and Future Perspectives



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Are Brazil's Amazon Policies 'Crimes Against Humanity'?

**Indigenous chiefs and human rights organizations think so.
But others call the idea a legal "hail mary."**

KATIE SURMA

Undark

On a Tuesday afternoon in late March 2020, Zezico Rodrigues Guajajara was killed by gunmen as he was driving a motorbike near his home village on the Araribóia reservation in Maranhão, Brazil.

A member of the Guajajara tribe, he had worked for years to protect land in the Amazon belonging to his ancestors and other uncontacted, or isolated, tribes. For Zezico, fending off illegal incursions had become increasingly dangerous as emboldened logging and mining groups targeted him and other Indigenous environmental activists. He was the fifth Guajajara to be killed in a five-month period.

Indigenous chiefs and human rights organizations have linked such killings to a "state policy" implemented by Brazilian President Jair Bolsonaro to "plunder the wealth of the Amazon," and asked the International Criminal Court to open an investigation into whether the actions of the far-right leader and other top Brazilian officials constitute crimes against humanity.

Some court watchers say the requests are a legal "hail mary," given that the international court doesn't have jurisdiction over peace-time environmental destruction and that national governments have long had control over natural resources within their own borders. But Bolsonaro's rampant deforestation of the Amazon and the threat posed by climate change have

prompted world leaders like Pope Francis and French President Emmanuel Macron to support a campaign for a new international crime called "ecocide" that would outlaw widespread environmental destruction. Supporters cite Bolsonaro's actions in the Amazon as a prime example of ecocide happening in real-time.

For now, the court's jurisdiction is limited to genocide, war crimes, crimes against humanity and the crime of aggression. But in 2016 the court's Office of the Prosecutor expressed a willingness to give "particular" consideration to crimes related to environmental destruction, illegal exploitation of natural resources or the illegal dispossession of land.

Some legal analysts think Karim Asad Ahmad Khan, the court's new prosecutor as of June 16, may for the first time authorize an investigation related to environmental destruction because Bolsonaro's alleged crimes against humanity—murders and the forced displacement of Indigenous groups—are so closely related to the Amazon's deforestation.

Whatever Khan decides, the Bolsonaro case presents the international court with a novel way to advance legal thinking about peace-time environmental destruction and how deforestation can be linked to the commission of crimes against humanity, defined legally as widespread or systematic attacks against a civilian population, with knowledge of the attacks.

Environmental destruction during times of conflict is already considered a war crime that falls within the jurisdiction of the court, which has historically focused on crimes associated with armed conflict.

In January, two Brazilian Indigenous chiefs, Almir Narayamoga Suruí and Raoni Metuktire, filed what is known as an Article 15 Communication, essentially an informative legal document requesting that the prosecutor open an investigation. The request detailed Bolsonaro's environmental and Indigenous policies, ecological harms, and accounts of murder, forced displacement and persecution carried out against Brazil's Indigenous population. They argued in the 68-page document that further destruction of the Amazon, 60 percent of which is in Brazil, also poses a threat to humankind.

"The Amazon rainforest plays an essential role in global climate regulation. A point of no return must be avoided at all costs," the chiefs said in a statement attached to their request. Scientists have warned that a tipping point, where the rainforest can no longer regenerate itself, may be near, and that the collapse of the Amazon would cause cascading environmental disasters. Suruí is from Sete de Setembro Indigenous land and Metuktire is from the Xingu Indigenous Reserve, both located in the rainforest.

"What is happening is ecocide," said French lawyer Valérie Cabanes, who helped prepare Suruí and Metuktire's request and serves on a panel of international lawyers that released a legal definition of "ecocide" on Tuesday as part of a campaign to criminalize "severe" and "widespread or long-term" environmental damage.

Cabanes said Suruí and Metuktire "filed the case alleging crimes against humanity because that's what's available right now, and the crimes that are happening fit that definition, too."

The other Article 15 Communication, submitted in November 2019 by Brazil's Human Rights Advocacy Collective (CADHu) and the Dom Paulo Evaristo Arns Commission for Human Rights (Arns Commission), asked the prosecutor to "establish an innovative construal" of the law, based upon the recognition that "Indigenous ways of life are grounded on very specific links between human and non-human lives, the land itself, wildlife, plants, and rivers." The groups also detailed similar

policies and acts as did the Suruí and Metuktire request, but said Bolsonaro's actions also amount to genocide, which generally is the commission of certain acts committed with the intent to destroy, in whole or in part, a national, ethnical, racial or religious group. A third request pertaining to Bolsonaro's handling of the Covid-19 pandemic was filed last year, as well.

What is distinct about the two other requests is that they argue the livelihoods, culture and survival of Indigenous groups are directly linked to the natural environment around them. As such, policies that encourage mass ecological harm are effectively an attack on those individuals. They extend that argument to the rest of humanity in light of the climate crisis and the Amazon's key role in storing carbon.

Bolsonaro has denied the allegations and staunchly defended Brazil's right to develop the rainforest, citing the country's sovereignty, and accusing foreign actors of wanting to impede Brazil's lucrative agricultural and commodity export industries. His supporters also point out that Brazil has historically contributed very little to climate change compared to developed countries like the United States. Brazil's Embassy in Washington and its Ministry of Foreign Affairs did not respond to questions and a request for comment from Inside Climate News.

While neither request alleges that Bolsonaro had knowledge of, or was personally involved in, any of the alleged murders or other crimes, they say he and other officials bear ultimate responsibility because their policies and rhetoric encouraged the attacks on Indigenous groups.

In asking the "court of last resort" to investigate their president, Suruí and Metuktire said in their request that Brazil's justice system is unwilling to carry out a meaningful investigation into the alleged crimes. Their plea comes nearly 50 years after the release of a damning government report that detailed thousands of atrocities—including torture, murder and land theft—carried out with impunity by Brazilian officials against Indigenous peoples during the country's military dictatorship.

The mentality of that regime, namely that Indigenous persons should assimilate and have no land rights, has become ascendant under Bolsonaro, Indigenous groups and lawyers say.

“It’s a completely wrong mentality, but that’s Bolsonaro. He comes from this school that believes Indigenous peoples aren’t peoples, He sees them as obstacles to development and when there’s an obstacle, you have to remove it.”

Ana Valéria Araújo, a Brazilian attorney who has represented Indigenous groups for over 30 years

“It’s a completely wrong mentality, but that’s Bolsonaro. He comes from this school that believes Indigenous peoples aren’t peoples,” said Ana Valéria Araújo, a Brazilian attorney who has represented Indigenous groups for over 30 years and is now the executive director of the non-profit Fundo Brazil. “He sees them as obstacles to development and when there’s an obstacle, you have to remove it.”

Bolsonaro has a history of making anti-Indigenous statements. He has compared isolated Indigenous peoples to animals in a zoo, and in 2020 said that “Indians are undoubtedly changing ... They are increasingly becoming human beings just like us.” In 1998, he lamented that Brazil wasn’t as “efficient” as the United States, which “exterminated the Indians.” And as president, his administration opened investigations into Indigenous leaders, including Suruí, who have spoken out against his policies, accusing them of defaming the President.

Over the past 40 years, Indigenous groups have won hard-fought legal gains in Brazil and internationally. At the same time, the fields of international criminal and human rights law have developed, piercing the previously unassailable shield of state sovereignty and culminating in the 1998 creation of the International Criminal Court. In possibly taking on environmental destruction, some question if the court is being asked to do too much. Critics say the institution has underperformed and is already overextended.

As the prosecutor considers the requests to investigate Bolsonaro, the campaign to make ecocide an international crime is gaining momentum. Supporters of the campaign hope one of the court’s 123 member countries will trigger a formal process to amend the court’s founding treaty, known as the Rome Statute, by formally requesting that ecocide be added as the court’s fifth crime.

The panel’s release on Tuesday of the legal definition, after six months’ work, was seen as an important precursor to such a request from a member nation. The panel defined ecocide as “unlawful or wanton acts committed with knowledge that

there is a substantial likelihood of severe and either widespread or long-term damage to the environment being caused by those acts.”

The process for considering, debating and ultimately approving ecocide as an international crime could take years. And even if successful would ultimately require the agreement of two-thirds of the court’s member countries. In the meantime, the only way the court can hold Bolsonaro accountable is if he has committed acts that fall within one of the court’s four existing crimes. The two requests allege that he has.

Still, Suruí and Metuktire argue that their request advances the case for the “recognition of ecocide” as an international crime. For them and others, the scale and urgency of the climate crisis, along with the lack of alternative mechanisms to stop the depletion of the Amazon, make the International Criminal Court their last and best hope.

“The prosecution of [Bolsonaro] in Brazil is blocked. The only person who can investigate him is the [Brazilian] Chief Prosecutor of Justice, who is an ally of Bolsonaro,” said Ana Carolina Alfinito, a legal advisor with the non-profit Amazon Watch. “We’ll never have true justice for his crimes if the International Criminal Court doesn’t act.”

Conceived as a forum to end impunity and hold accountable perpetrators of the world’s most heinous crimes, the International Criminal Court is the world’s only permanent international criminal tribunal. The progeny of the post-World War II tribunals at Nuremberg and Tokyo, the court was created by the agreement of 120 nations, including most U.S. allies, to end impunity for individuals who commit “the most serious crimes of concern to the international community.” Though the United States has been a leader in the development of international justice, it is not a member of the court and, depending on the U.S. administration, has vacillated between cooperation and hostile relations with the institution.

Meant to complement and not replace national judicial sy-

stems, the court exercises jurisdiction only if and when nations fail to do so themselves. Supporters of the court, which came into force in July 2002, see it as an advancement of the rule of law, where no individual is too powerful, or above the law. And no victim is below the law or powerless to access justice. The court acts as a deterrent for criminal activity and is a forum where victims can be heard, recognized and seek redress.

In considering the requests to investigate Bolsonaro, the Office of the Prosecutor must first decide whether to open a preliminary examination to determine if the Court has jurisdiction and if the case is “in the interest of justice.” To do so, the prosecutor will have to decide among the hundreds of investigation requests filed with the Court each year. In 2020, 800 were filed, and as of May, eight preliminary investigations and 14 investigations were pending.

If selected, the notoriously slow-moving court could take years to process the case from investigation to trial and post-trial appeals. And there are sure to be obstacles along the way. Lacking any enforcement mechanism of its own, the court relies on its member states to cooperate in the investigation and detention of suspects. Cases are often politically charged, and the Bolsonaro matter is no exception.

The prosecutor’s consideration of the Bolsonaro case is taking place just as the global campaign to criminalize ecocide completes its opening phase. The process for considering, debating and ultimately ratifying ecocide as an international crime could take years and, if successful, the resulting ecocide law will not apply retrospectively. Thus, it is unlikely Bolsonaro could be charged with ecocide for any acts he has taken up to the date the law goes into effect.

While the law’s ramifications will depend on its final definition, as agreed to by the court’s member nations, the panel of lawyers defined “widespread” damage to the environment as “damage which extends beyond a limited geographic area, crosses state boundaries, or is suffered by an entire ecosystem or species or a large number of human beings.”

The panel wrote that “‘severe’ means damage which involves very serious adverse changes, disruption or harm to any element of the environment, including grave impacts on human life or natural, cultural or economic resources,” and defined “long-term” as “damage which is irreversible or which cannot

be redressed through natural recovery within a reasonable period of time.”

For Robert T. Coulter, an Native American lawyer who has fought for Indigenous rights for decades, a “properly defined” crime would reduce harms to Indigenous peoples, lands and resources. But “if poorly defined and badly applied,” he said, “it could conceivably be used to stop and punish Indigenous traditional uses of their own resources.”

Supporters of an ecocide crime say Bolsonaro’s policies toward the Amazon show that nation-states should no longer have unchecked control over natural resources within their own borders, when mismanagement of those resources can affect the rest of humanity. The Amazon rainforest acts as an important carbon sink, making it a core part of humanity’s fight against climate change, they said.

Each time a portion of the Amazon is cut down, less rainfall is cycled from the ground through tree roots and leaves, then released into the atmosphere as water vapor. This cycling process affects precipitation patterns and has a cooling effect on local areas. But as more trees are cut down, less water is cycled, temperatures go up, drought is more likely and more forest dries out and dies off. The process threatens millions of plant and animal species, many of which live nowhere else on earth, and makes the forest more susceptible to fires. In 2019, those fires raged out of control. As the world watched the Amazon burn, French President Emmanuel Macron called the situation “ecocide” and an “international crisis.”

“We expect the case against Bolsonaro to open the door for the recognition of ecocide in the context of international law,” said William Bourdon, a French attorney who filed the January request on behalf of the Indigenous chiefs. “We believe the court understands the gravity of the international environmental emergency.”

In making their case that the destruction of the Amazon is linked to the commission of crimes against humanity, such as the murders of environmentalists and the forced displacements of Indigenous peoples, the Article 15 requests filed by the tribal leaders and the human rights organizations also describe Bolsonaro’s environmental rollbacks in detail.

They include at least 57 legislative acts that weaken environ-



Welcome dance of Tukanos from Amazon rainforest. Photo credit: James Martins

mental protection that took place from his inauguration through last September and a slew of budget cuts and restructurings of key agencies that protect and monitor the environment. The requests note that Bolsonaro has staffed key environmental agencies with former federal police and military officers. “The goal, according to Bolsonaro, is to ‘put an end to the ideological framework of the sector, led by NGOs and entities concerned with the environment,’” Suruí and Metuktire said.

The chiefs accuse Bolsonaro of acting aggressively to try and silence activists and others who might interfere with his agenda. When Brazil’s National Institute for Space Research, or INPE, which uses satellite imagery to monitor deforestation, reported a spike in deforestation during his first year in office, Bolsonaro fired its director and questioned the accuracy of the agency’s data. His administration has also attempted to restrict public access to government officials, issuing a moratorium on press contact with employees in Brazil’s environmental agency, Ibama.

Under Bolsonaro’s administration, enforcement of laws protecting the environment has plummeted, according to the requests. Environmental fines in Brazil decreased 72 percent, even as deforestation rates rose to a 12-year high.

His Environment Minister, Ricardo Salles, has been the main architect of the remaking of Brazil’s regulatory framework,

Suruí and Metuktire said. In May of 2020, Salles was captured on video advising Bolsonaro to take advantage of the media’s fixation on the Covid-19 pandemic to “push through” environmental rollbacks. Salles resigned on Wednesday, weeks after Brazil’s federal police opened an investigation into his alleged involvement in illegal timber exports. Salles has denied the allegations. His office did not respond to requests for comment. Environmental advocates in and outside of Brazil believe his departure will do little to slow the ruination of the Amazon. “Whoever sits in the chair of minister will obey the orders of Bolsonaro and continue to

implement the policy of environmental destruction, just as Salles did,” said Marcio Astrini, head of Climate Observatory, in a statement.

The Article 15 requests argue that Bolsonaro’s environmental rollbacks are linked to the widespread destruction of the Amazon. The deforestation, according to the requests, “has a marked and disproportional effect on the Indigenous peoples, whose physical existence and lifestyles depend on the forest, the land, and the rivers in material, social and symbolic terms.”

Bourdon said, “The exploitation alters the Amazon rainforest and destroys ecosystems, polluting water, natural resources and the livelihoods of Indigenous people. They suffer from diseases due to contamination of their resources and they are sometimes forced to leave their lands.” He added, “The massive and violent exploitation of the Amazon is a direct attack on the rights of Indigenous peoples.”

The two requests go on to detail murders, trespassing and displacements connected to Bolsonaro’s environmental and Indigenous policies. Human rights advocates say the alleged crimes are the latest in a centuries-long campaign to eradicate and assimilate Brazil’s Indigenous people. Torture through the slow crushing of ankle bones. Intentional introduction of lethal diseases into isolated populations. Air attacks using sticks of dynamite. The donation of food laced with arsenic.

These and other forms of murder, rape, starvation, slavery, land theft and torture were carried out by Brazil's Indian Protection Service against Indigenous persons during the country's 1964 to 1982 military dictatorship, according to a 7,000-page report compiled by then-public prosecutor Jader Figueiredo in 1967. The dictatorship was installed following a U.S.-backed coup targeting a communist regime.

The so-called Figueiredo report catalogs thousands of crimes perpetrated by the federal agency charged with helping Indigenous communities. The crimes took place starting in 1910, but had roots as far back as the 1500s, when Portugal first colonized the region. The dictatorship's large-scale and coordinated attempt at eradicating Indigenous groups was based in large part on a desire to exploit the natural resources on their land. "The military considered Indigenous peoples obstacles to development," Araújo said.

After the Figueiredo report came out, the Indigenous Protection Service was replaced by the National Indian Foundation, or FUNAI, the agency in charge of Indigenous affairs today. Despite the rebranding, the government's policy remained one of assimilation, and successive administrations acted at times to strip land and cultural protections from tribes until 1988 when Brazil enacted a new constitution, Araújo said, "But now those policies have resurfaced."

In the decades after the Figueiredo report, Indigenous groups won hard-fought legal protections, but that hasn't stopped new efforts to seize Indigenous land and assimilate native groups. The country's 1988 constitution marked a turning point of sorts for Indigenous groups and was the culmination of their efforts to codify their rights to land they've continuously occupied for centuries.

Today, the constitution has been the main tool for Indigenous groups to fight back at the national level against infringements on their rights. Among the document's protections is a guarantee to a "balanced environment" and a mandate for the government to demarcate—or identify and set aside—all Indigenous territories within five years of the constitution's enactment. Though the time-bound goal was not reached, the government had steadily made progress, demarcating about 40 percent of the more than 1,200 Indigenous territories in Brazil. But that progress stopped when Bolsonaro took office.

The requests by the chiefs cataloged an array of Bolsonaro's actions that weaken protections for Indigenous people, including placing a moratorium on demarcations. As a candidate, he promised not to demarcate "one centimeter" more of Indigenous land, and on his first day in office, he transferred responsibility for the process from the National Indian Foundation (FUNAI) to the Ministry of Agriculture, which is known to cater to industry, the requests said.

After the country's Supreme Court overturned the move, Bolsonaro installed at the head of FUNAI a former federal police officer known to have close ties to the agriculture industry. The government's unwillingness to enforce laws protecting Indigenous groups has also been harmful, the requests said.

These policy changes, coupled with environmental rollbacks, effectively opened up parts of the Amazon long inhabited by Indigenous groups to mining, logging and agriculture, and that flood of development activity, most of which is illegal, has led to violence and the destruction of protected Indigenous lands, according to the requests.

Since Bolsonaro took office in January 2019, there were 256 cases of property damage, illegal occupation and exploitation of Indigenous land, up from 109 incidents in 2018, according to The Missionary Council for Indigenous Peoples (CIMI).

Other accounts of illegal intrusions are much higher, according to the requests. A spokesman for the over 40,000 Yanomami peoples who occupy protected land in northwest Brazil and parts of Venezuela, told the United Nations Human Rights Council in March 2020, "There are already around 20,000 illegal miners invading our territory, contaminating our water and bringing back diseases such as mercury intoxication and malaria."

At least one study has shown an association between illegal gold mining on Yanomami territory and high levels of mercury in tribal members' hair samples, including those from children. Elevated levels of mercury in humans can cause neurological problems and other serious and irreversible health problems. Mercury is especially dangerous for fetuses. Gold miners use mercury to extract gold from sediment, a process that contaminates water sources and decimates surrounding ecosystems.

In 2019, the murder rate of Indigenous persons reached an 11-year high. In one case, detailed in the January request, Emyra Wajãpi, the leader of the Wajãpi people, was stabbed to death by illegal miners who invaded her village. United Nations High Commissioner for Human Rights Michelle Bachelet said the murder was a “worrying symptom of the growing problem of encroachment on Indigenous lands—especially forests—by miners, loggers, and farmers in Brazil.” In public comments after the murder, Bolsonaro reiterated his desire to legalize mining in Indigenous areas.

Suruí and Metuktire placed special emphasis on Bolsonaro’s effect on Brazil’s isolated Indigenous peoples. Without official recognition of their territories, the population of over 100 uncontacted tribes is acutely at risk, because any outside contact could spread disease among the population. That danger increased during the Covid-19 pandemic, according to a recent United Nations Human Rights Council report. The report attributed the rise of incursions to “harmful government rhetoric” that has “emboldened” miners, loggers and others.

Other governmental policies under Bolsonaro have restricted Indigenous groups’ access to food aid and health care, Boudon said. “President Bolsonaro and agribusiness groups are

imposing unbearable living conditions on Indigenous peoples to force them to move.”

The requests also blame Bolsonaro for “inflamed rhetoric,” that has been “denigrating these communities, with a constant discourse of dehumanisation, radicalisation and disparagement of their lifestyles.”

He has expressed nostalgia for the days of military rule, telling NPR it was a “very good period,” and has said, “The dictatorship’s mistake was to torture but not kill.” As president, Bolsonaro reinstated a national day commemorating the start of the dictatorship.

“Rather than assisting the Indigenous peoples and legally imposing respect for their rights, President Jair Messias Bolsonaro is instead acting in ways that strip them of their humanity in the eyes of Brazilian society,” said CADHu and the Arns Commission. “Bolsonaro is portraying Brazil’s Indigenous peoples to society in general as either sub-human or a potential threat to national sovereignty, with ‘integration’ as the solution.”

The Bolsonaro case gives the International Criminal Court the



The Amazon river, Brazil.
Photo credit: Neil Palmer/CIAT

opportunity to hold the Brazilian president and other officials accountable and play a role in fighting peace-time environmental harms, the lawyers filing the requests said.

But not everyone sees the court as the best mechanism to address environmental harms, or sees deforestation and the rollback of Indigenous rights as wrong.

To his supporters, Bolsonaro's decisive 2018 electoral victory gave him a mandate to carry out his campaign agenda to enact market-friendly policies, limit the rights of Indigenous groups, repeal environmental regulations and, in his words, "authorize industrial, hydraulic and mining in protected areas." They also question why Brazil, a developing country, should sacrifice monetizing its natural resources when other nations got rich doing the same thing.

In response to the criticism that he is mismanaging the Amazon, Bolsonaro has said Brazil's "sovereignty is non-negotiable," calling the criticisms evidence of a "misplaced colonialist mindset." And Bolsonaro isn't the first to open up the Amazon. Successive administrations across political parties have taken steps to develop the rainforest and curtail environmental protections.

But to Bourdon, the right to sovereignty doesn't make it lawful to undermine the rights of Indigenous peoples.

"The role of international law is to regulate the behaviour of states and their leaders. No one disputes the sovereignty of the President to carry out a policy, but this policy must respect the rights of Indigenous peoples," he said. "The right to sovereignty cannot be equated with the right to freely dispose of the lands of Indigenous peoples, much less to have the right of life and death over them."

Regarding the International Criminal Court, some have doubts about the institution's ability to expand its reach into environmental destruction. Supporters have said the institution has had poor management and that the quality of some legal proceedings has been lacking. To date, there have been just 10 convictions and four acquittals.

Last year, a group of independent experts published a 350-page report critical of the court's operations, and some legal

scholars have said the institution has overextended itself and should stick to its core mission.

"There's a lot of talk going on now at the ICC about the need for reform, and the need for the court to focus on the cases that are truly most important," said Todd Buchwald, who formerly served as ambassador at-large and special coordinator for the State Department's Office of Global Criminal Justice.

Decisions to allow investigations into possible crimes committed in Afghanistan and Palestinian territories have also proved controversial. But the criticism and controversy could push the prosecutor for the international court to take up an unconventional case like Bolsonaro's to "divert attention from these highly controversial areas by looking at something that has more universal support from nations," said Richard Falk, a well-known international legal scholar from the United States who first wrote about ecocide in 1973.

Should the court step into the environmental arena, either through the adoption of an ecocide crime or by taking up a case like Bolsonaro's, environmentalists and lawyers say that just the prospect of court action or an impending international crime would have a deterrent effect on polluting businesses, financial institutions and politicians like Bolsonaro. The crimes the court prohibits are considered not just a violation of victim's rights, but an affront to humanity at large. "Treating that level of environmental harm as ecocide would associate the behavior of Bolsonaro with a form of ultimate criminality," said Falk.

Cabanes, referring to the moral weight of Suruí and Metuktire's request, said, "That's why filing this communication about the Amazon and doing it with Indigenous leaders was so important.

"When you destroy an environment, you ultimately destroy your home, culture and people," she said. "Because we are part of nature and we can't guarantee our fundamental human rights if we don't protect the rights of nature to exist, regenerate and thrive."

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Is hydrogen the new oil?

Hydrogen may have lost the race to fuel electric cars but looks a likely contender to replace fossil fuels in trucks, ships, planes and heavy industry

FRED PEARCE

Diálogo Chino

The Tokyo Olympics will be powered by a fuel with ambition – hydrogen. The Olympic flame is already burning it. The Olympic village will be powered by hydrogen made at a solar power plant in the exclusion zone created after the Fukushima nuclear accident a decade ago. Toyota's Mirai cars, which run on hydrogen-fuel cells, will provide most of the Games' official transport.

"The 1964 Tokyo Olympics left the Shinkansen high-speed train system as its legacy. The upcoming Olympics will leave a hydrogen society as its legacy," Yoichi Masuzoe, then governor of Tokyo, declared in 2016.

Japan, once a passionate advocate of nuclear energy, now has serious hydrogen ambitions. The country has the world's largest network of hydrogen filling stations. It is planning to replace fossil fuels with hydrogen in heavy industries such as steel-making. And it has a head start in organising imports of the fuel. In 2019, Kawasaki Heavy Industries launched the Suiso Frontier, the world's first ship designed to carry liquefied hydrogen. It aims to tap promised Australian hydrogen production.

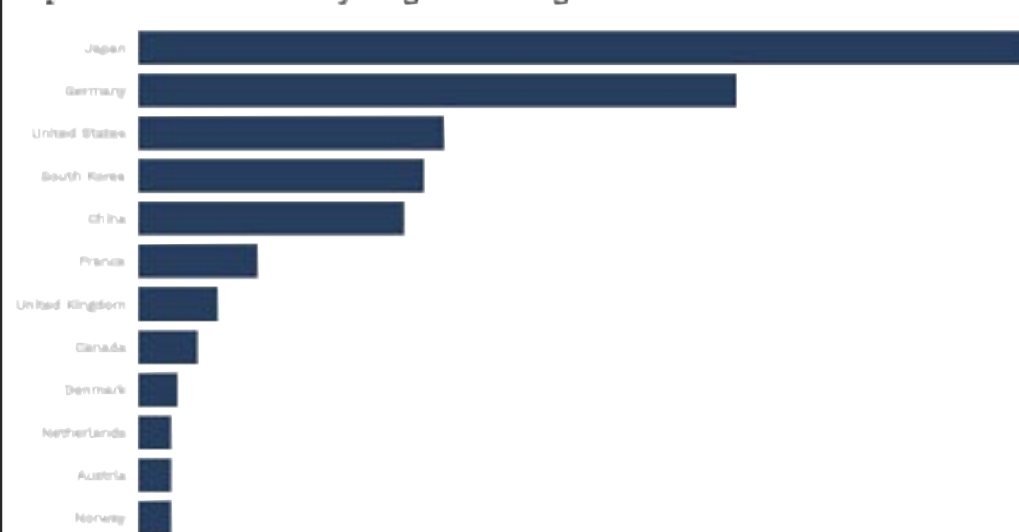
Neighbouring South Korea

has similar plans. In March this year, car-maker Hyundai, the SK Group conglomerate and others announced a US\$38 billion project to develop a hydrogen-based economy in the coming decade.

Wide-spread use of hydrogen, if it really happens, will have been a long time coming. The first hydrogen-powered engine was working as long ago as 1807, and people were proposing making hydrogen by electrolysis of water, to replace coal as early as the 1860s. But coal and oil were always cheaper. And the Hindenburg disaster, when a hydrogen-filled airship exploded in 1937, gave the fuel a reputation as unsafe.

There is talk that a global "hydrogen economy" can emerge to save the climate from carbon emissions. Hydrogen could power trucks, ships and planes and be used to produce everything from cement to steel and fertiliser.

Top 12 countries with hydrogen fuelling stations for road vehicles



Source: US Department of Energy

Saehoon Kim, the head of Hyundai's fuel cell division told a British trade association webinar last year: "In the past, our technology and industry was all about collecting oil, delivering oil and using oil. And now, in the future, it will be collec-

ting sunshine, delivering sunshine and using sunshine – and what will make that possible is hydrogen.”

Others are much more sceptical. “It is only ever going to be a niche energy source,” said Tom Baxter, a chemical engineer at the University of Aberdeen. With current technology, hydrogen has an advantage for fuelling industrial processes where temperatures above 400C are required, Baxter added. But otherwise, green hydrogen will usually lose out to electricity where the latter can do the job. “Green hydrogen can never be cheaper than the green electricity needed to make it,” he said.

Grey, green or blue hydrogen?

Hydrogen is rarely burned directly as a fuel source. Instead it is used as a carrier of energy, made where cheap energy is available for manufacture and shipping round the world to where it is needed. Usually that means in a fuel cell inside a vehicle engine, where the gas is mixed with oxygen, releasing its energy and emitting only water vapour.

In the past two years, electric cars have stolen a march on hydrogen, with most major car makers bringing out models and some, like General Motors, promising to manufacture only electric vehicles within 15 years.

They have government backing too, with heavy spending on recharging networks. But for other fossil-fuel guzzling transport systems which cannot easily plug into the mains, such as long-distance shipping and aviation, hydrogen may turn out to be the key to lowering carbon emissions.

The gas contains more energy for every tonne than any fossil fuel, and avoids the need for batteries. But manufacturing it takes a lot of electricity. So it is only as climate friendly as the energy used to produce it. Engineers thus distinguish between grey, blue and green hydrogen. Grey is made from natural gas or coal, and has a large carbon footprint. Blue is also made from fossil fuels but the carbon dioxide emissions are captured or re-used. Green is from renewable electricity and need have no carbon footprint at all.

Right now, grey hydrogen is cheapest and the predominant type for industrial uses. China produces around a third of the global total, largely from lignite coal. Russia is working on plans to use its abundant gas reserves to produce grey and blue hydrogen.

To be a viable climate-friendly alternative to fossil fuels, manufacturers would have to capture the CO₂ generated during production and bury it out of harm's way. However, carbon capture and storage (CCS) is still very much work in progress.

Baxter, of the University of Aberdeen, said fossil fuel companies are behind the push to promote hydrogen as an alternative to electricity for everything from vehicle fuel to home heating. Oil giant BP is considering plans for a blue hydrogen plant on Teesside in England that it says would capture and store the resulting CO₂ emissions underground.

In their long-term plans, major oil companies are looking at hydrogen as a potential source of income, once demand for petrol and diesel starts petering out. Their move towards alternative fuels has been painfully slow. BP will make a final investment decision on Teesside only in three years' time and it doesn't expect to start actual construction before 2027 – three years before all new cars in the UK are expected to be electric.

“For the moment, fossil fuels are cheaper and much more widely available than hydrogen. This comes in part because of large government subsidies across the globe which amount to US\$400 billion. If those subsidies were removed, alternative fuels like hydrogen would stand a better chance of becoming widely adopted,” said Seifi Ghasemi, chief executive of US industrial gas company Air Products at a BNEF conference in New York this year.

The real prize, if the world is serious about developing a low-carbon hydrogen economy, would have to be the mass production of green hydrogen. Some countries already see themselves as potentially the “Saudi Arabia of hydrogen”, mass producing the fuel using cheap renewable energy. Among them are Canada and Iceland, which both have abundant hydroelectricity that could help manufacture it. Iceland also has geothermal energy. Morocco is rapidly developing solar power in the Sahara desert and has designs on production.

Saudi Arabia has its own plans. The country recently announced that, with Air Products, it is building a US\$5 billion green hydrogen plant along the shore of the Red Sea. A vast estate of solar panels and wind turbines will eventually cover a patch of desert the size of Belgium, powering what would be the world's biggest hydrogen factory. Production is set to begin in 2025.

The project would be part of the proposed eco-city of Neom, a scheme of the country's de facto leader Mohammed bin Salman. Besides supplying the eco-city, the hydrogen would be exported, one day replacing Saudi oil with Saudi hydrogen on world markets.

Neighbouring Oman has plans to go even bigger. Its proposed US\$30-billion hydrogen plant on the shores of the Arabian Sea would export both green hydrogen and “green ammonia”, to replace fossil-fuel produced chemical fertilisers.

If those subsidies were removed, alternative fuels like hydrogen would stand a better chance of becoming widely adopted.

Seifi Ghasemi, chief executive of US industrial gas company Air Products

Australia has similarly ambitious plans for five giant “hydrogen hubs”. Last year it said it would turn an area of desert more than twice the size of Luxembourg in Western Australia into a green hydrogen production facility, with 10 million solar panels and 1,500 wind turbines.

The project is currently on hold after blueprints were rejected by ministers in June because of threats to biodiversity, but may ultimately go ahead. Meanwhile, there are plans for another green hydrogen hub in Hunter Valley, a region of coal fields in New South Wales, as well as a grey hydrogen scheme, using lignite in the Latrobe Valley in Victoria. All aim at exporting to Japan and elsewhere in Asia.

Who will create the Tesla of the skies?

Aviation may be the biggest prize. Airbus, the world's second largest plane maker, last year unveiled plans for three different zero-emission “concept” hydrogen planes that it says could be in service by 2035.

Meanwhile, California start-up ZeroAvia has a six-seater research plane already running on the gas. It took off for the first time from the UK's Cranfield airport last autumn. The plane crashed in a field in April, but nobody was hurt, and it could yet become the Tesla of the skies.

“A substantial reduction in carbon dioxide emissions is almost impossible without hydrogen,” says Christian Bauer of the Paul Scherrer Institute, a Swiss engineering research centre. “I'd say that within the next ten years, we will see substantial developments here.”

Other deals between potential suppliers and major markets are proliferating. Danish wind-power company Orsted has signed a deal with Maersk, the world's biggest shipping carrier, and Scandinavian Airlines to use offshore wind generated in the North Sea to produce green hydrogen for buses and trucks in the Copenhagen area from 2023, with ships and aircraft to follow.

Will all this happen? Sceptics say creating global supply chains to manufacture, ship and deliver hydrogen is too cumbersome and inefficient, especially when the infrastructure would have to be built from scratch. By some counts, around two-thirds of the energy would be lost along the

way. “Efficiency losses happen both on the supply side, in the production process of the hydrogen-based fuels, and on the demand side – a combustion engine wastes a lot more energy than an electrical one,” said Romain Sacchi, a colleague of Christian Bauer at the Paul Scherrer Institute.

Even so, hydrogen could work for freight transport over long distances, Bauer told China Dialogue: “A large truck today would need to be equipped with a battery weighing a few tonnes to travel more than a hundred kilometres.”

Hydrogen's availability is “too uncertain to broadly replace fossil fuels, for instance in cars or heating houses,” according to Falko Ueckerdt of the Potsdam Institute for Climate Impact Research. The world should instead prioritise applications for which hydrogen is indispensable as a source of low-carbon energy, he says. Hydrogen could be used to remove the hardest 10% or so of carbon emissions, as the world targets zero emissions.

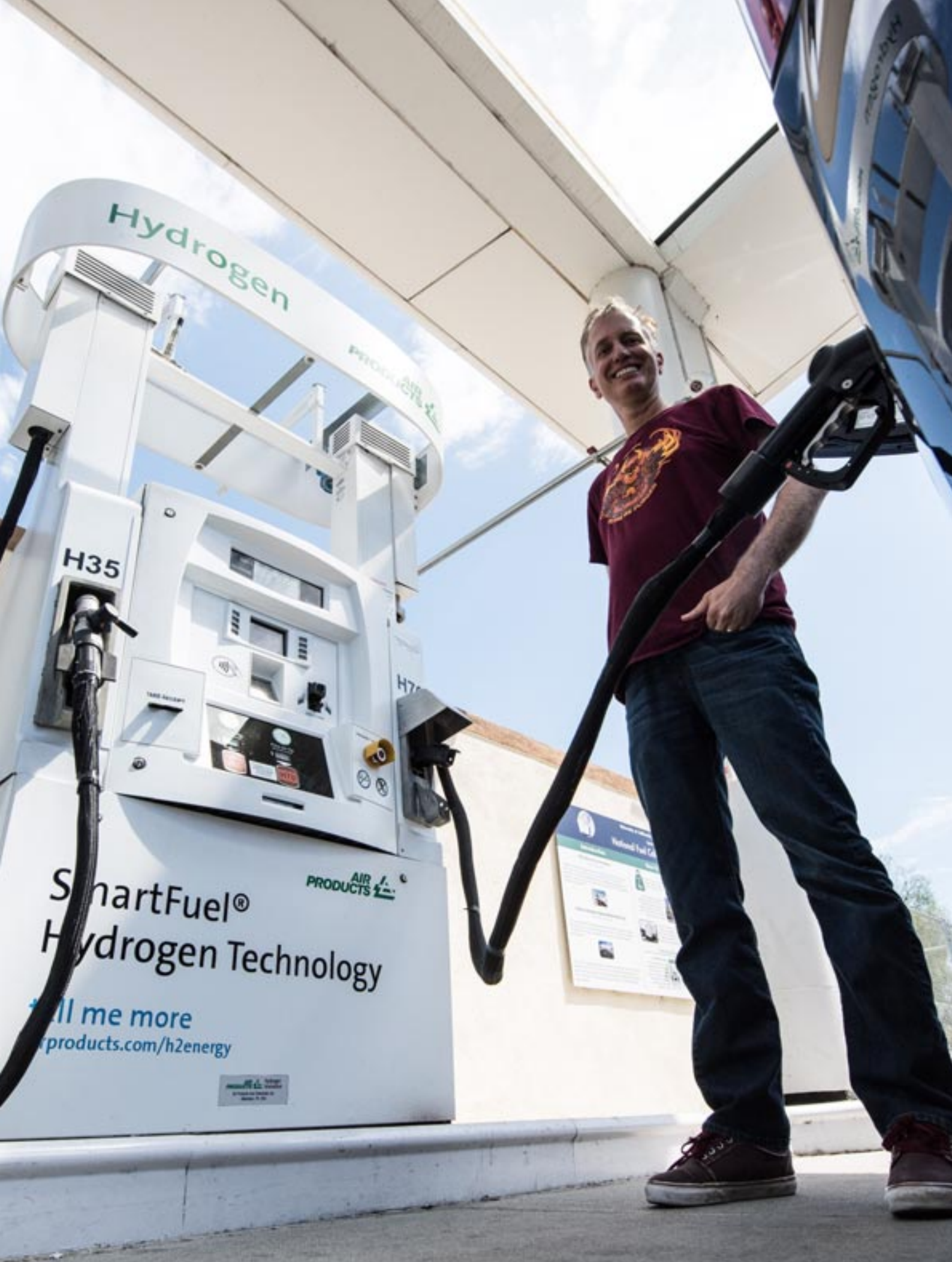
“Primary steel and ammonia production are sensible entry points for green hydrogen,” he says. In both cases, the hydrogen can replace fossil fuels as an essential part of the process, as well as providing energy. But he warns that rising demand in areas such as heating buildings could give an advantage to cheap blue hydrogen and create a “fossil-fuel lock-in that endangers climate targets.”

Fuels based on hydrogen as a universal climate solution might be a bit of false promise. “While they're wonderfully versatile, it should not be expected that they broadly replace fossil fuels,” argued Ueckerdt.

“The hydrogen economy can establish itself only if it makes sense energetically. Otherwise, better solutions will conquer the market. Infrastructures exist for almost any synthetic liquid hydrocarbon, while hydrogen requires a totally new distribution network,” argued Ulf Bossel, a fuel cell consultant and Baldur Eliasson, researcher for ABB Switzerland, in a white paper on the hydrogen economy.

Hydrogen-based fuels will likely be scarce and not competitive for at least another decade.

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The Toyota Mirai hydrogen vehicle (FCEV) at the fueling station in Irvine, California. Photo credit: Dennis Schroeder/NREL

Smell something, tell something

How Black residents in coastal Georgia are holding polluters accountable. Redlining, disinvestment, and lack of political power has made Southern communities of color prime targets for industries that often provide jobs in the areas they pollute.

NEESHA POWELL-TWAGIRUMUKIZA

Southerly

Spanline Dixon, a retired teacher's aide, is used to unpleasant smells. Her home in Brunswick, Ga. is near a waste and recycling facility, a water pollution control plant, and two facilities that emit toxic chemicals into the air: a pulp mill, Georgia Pacific (GP) Cellulose, and Pinova, a resin manufacturer. But on the evening of January 17, Dixon could literally feel a strong chemical odor, she said. She was disoriented. "I turned the air conditioner off, and it just attacked my respiratory system. I was coughing, and I didn't know what was going on. I felt sick, nauseated.... and it was in the back of my throat," Dixon said.

She called 911. "My pulse and my heart rate were pounding," she said. She tried to escape the smell by going outside, but she found it there, too. The EMTs who arrived on the scene said they could smell the chemical odor down the street from her home. They administered oxygen to Dixon and ventilated her house.

Dixon started feeling better that night. But she soon filed an official air quality complaint with the Environmental Protection Division of the Georgia Department of Natural Resources, or EPD, following the advice of Brunswick-based environmental nonprofit Glynn Environmental Coalition, where she serves as a board member.

Around the same time, several members of a Brunswick-area Facebook group, "SMELL SOMETHING, TELL SOMETHING!", posted about a chemical odor similar to what Dixon experienced. A January 20 post in the group reads: "Toxic putrid smell. How many people have to get sick before something is done??? Is it time to hire a [sic] attorney?" In response to many posts like these, Glynn Environmental Coalition executive director Rachael Thompson suggested filing an official complaint with the state. Dixon's is one of 170 air quality complaints about a noxious chemical odor in Brunswick and surrounding areas that were submitted to the EPD via phone and on-

line between December 2020 and May 2021. People reported symptoms such as nonstop coughing, irritation of the throat and nose, rashes, and difficulty breathing. The complaints triggered an EPD investigation, as well as an independent one by the environmental coalition.

Brunswick is a coastal city in Glynn County with a population of about 16,000, 55% of whom are Black. Industrial pollution has long plagued Brunswick, home to four Superfund sites, some of the most hazardous waste sites in the nation, and 14 sites on Georgia's hazardous site inventory. All but one of these sites lie within a one-mile radius of a "majority-minority" population. To investigate the chemical odor, Glynn Environmental Coalition partnered with researchers from the University of Georgia to analyze 26 separate complaints filed by eight individuals in the Brunswick area between December 2, 2020 and May 8, 2021. Their analyses examined the location, date, time, weather, wind speed, and wind direction of each complaint to determine the source of the chemical odor.

Their research pointed them to the GP Cellulose facility. GP Cellulose senior manager of public affairs, Randal Morris, said in an email that the company highly values their relationship with the Brunswick community and is working cooperatively with the EPD to help determine if their operation is a contributing source to the chemical odor complaints. He also said that GP Cellulose has been monitoring for hydrogen sulfide, a colorless gas that smells like rotten eggs, at locations on and around its Brunswick pulp mill since April, and will continue monitoring it for several months.

"Given the proximity of our Brunswick operation to the location of some of the complaints along with a review of available meteorological data, we cannot rule out our operation as a potential contributing source of odor in the area," Morris said. "Based upon the complaint informa-

tion shared with us, our daily operations data does not indicate irregularity with our emissions that would correlate with the nature, timing and pattern of the citizen complaints.”

The EPD identified a Clean Air Act violation at GP Cellulose last April involving nitrogen dioxide, one of several incurred by the corporation over the years. Nitrogen dioxide and hydrogen sulfide are two toxic chemicals emitted by GP Cellulose; others include ammonia, nitrous oxide, and sulfur dioxide. Over time, emitting these chemicals into the air can cause major health consequences to humans, including a higher risk of heart disease, respiratory disease, certain types of cancer, and birth outcomes.

The university and Glynn Environmental Coalition plan to release their findings in a report later this month. Thompson said her group will use it to continue organizing city officials and local polluting industries to help resolve community concerns about air quality. They’re advocating for the EPD to monitor Brunswick’s air for sulfur dioxide, nitric oxide, and nitrogen dioxide. The agency currently only monitors the city’s air for particulate matter—PM 2.5—and ozone. Additionally, the coalition is building an “air quality toolbox” that will include an online complaint portal and an anonymous tip hotline to make it easier for community members to submit air quality complaints to the EPD and the EPA and to track information the EPD withholds from the public.

EPD director of communications Kevin Chambers said in an email that, agencies are able to withhold information related to a pending investigation of unlawful activity until the investigation is closed. Since the EPD is nearing the end of its air quality investigation in Glynn, they’ve released details of closed complaints “to assist the community in their understanding of the issue.” The agency used meteorological data, modeling, odor complaint information, and onsite inspections, yet did not make a definitive determination of the source of the chemical odor.

“Odor investigations are difficult in nature due to a multitude of factors,” Chambers said. The unusually harsh chemical odor that invaded Brunswick and Dixon’s home has mostly subsided, but there’s no course of action to prevent it in the future. The complexity of this issue underscores the necessity of local monitoring by community members and organizations, according to some researchers.

Dr. Christina Hemphill Fuller, an associate professor in Georgia State University’s School of Public Health, researches the effects of air pollution on communities of color. She said communities are using tools like low-cost sensors and smartphone apps to monitor local air pollution. For example, the advocacy nonprofit Air Alliance Houston’s community-based air monitoring network uses low-cost sensors in Latinx and Black neighborhoods near oil and gas refineries in the Houston area. “Part of my research is understanding that the regulatory monitors that are out there aren’t protective of public health in many

areas because there’s just not enough of them to really understand where the pollution is in those highly impacted neighborhoods,” Hemphill Fuller said. “That’s why it’s important to do local monitoring.”

Historically, redlining, disinvestment, and lack of political power has made Southern communities of color prime targets for industrial polluters, Hemphill Fuller said. According to a 2017 study, Black Americans are 75% more likely than white Americans to live next to a company, industrial, or service facility that directly affects their health or quality of life. Air pollution is already taking its toll on Brunswick residents. Asthma was among the top six diseases self-reported by Glynn residents who responded to a 2019 community needs health assessment conducted by the Southeast Georgia Health System. According to the Georgia Department of Public Health, trachea, bronchus, and lung cancers were the third top cause of premature deaths in Glynn between 2013 and 2017. But getting rid of polluting industries to protect residents’ health is a nuanced issue in Brunswick, where 35% of the population lives in poverty. GP Cellulose and Pinova are two of the top employers in the city, employing 550 and 216 individuals, respectively.

Some Brunswick residents would love to see the city’s manufacturing plants disappear, but it doesn’t make sense economically because they’ve supported local families, including many Black families, for generations. By advocating for these industries to adopt more modern technologies that discharge less pollutants, Thompson said Glynn Environmental Coalition is aiming to solve the question: “How do we get them to sustain our economy while also keeping our people healthy and safe?”

Dixon said city officials and governmental agencies are reluctant to hold industrial polluters accountable because of the jobs they bring: “They really don’t want to put the finger on any one particular industry and say, ‘You’re responsible for doing this. You need to do something about it.’ I know that it’s the bread and butter for a lot of people, and nobody wants to say, ‘We take responsibility for the odor.’”

The neighborhood where Dixon lives, Magnolia Park, used to be a point of pride in Brunswick—home to Black doctors, lawyers, and postal workers. Today, it’s better known for its uphill battles with chemical and nuisance odors. Dixon hears about a lot of her neighbors dying from cancer and wonders whether their deaths are linked to air pollution.

“I feel like if this were a Caucasian neighborhood and community,” she said, “more would be done about it.”

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Nature Is Not a Machine— We Treat It So at Our Peril

From genetic engineering to geoengineering, we treat nature as though it's a machine. This view of nature is deeply embedded in Western thought, but it's a fundamental misconception with potentially disastrous consequences.

JEREMY LENT

Patterns of meaning

Climate change, avers Rex Tillerson, ex-CEO of ExxonMobil and erstwhile US Secretary of State, “is an engineering problem, and it has engineering solutions.” This brief statement encapsulates how the metaphor of the machine underlies the way our mainstream culture views the natural world. It also hints at the grievous dangers involved in perceiving nature in this way.

This mechanistic worldview has deep roots in Western thought. The great pioneers of the Scientific Revolution, such as Galileo, Kepler, and Newton, believed they were decoding “God’s book,” which was written in the language of mathematics. God was conceived as a great clockmaker, the “artificer” who constructed the intricate machine of nature so flawlessly that, once it was set in motion, there was nothing more to do (bar the occasional miracle) than let it run its course. “What is the heart, but a spring,” wrote Thomas Hobbes, “and the nerves but so many strings?” Descartes flatly declared: “I do not recognize any difference between the machines made by craftsmen and the various bodies that nature alone composes.”

In recent decades, the mechanistic conception of nature has been updated for the computer age, with popularizers of science such as Richard Dawkins arguing that “life is just bytes and bytes and bytes of digital information” and as a result, an animal such as a bat “is a machine, whose internal electronics are so wired up that its wing muscles cause it to home in on insects, as an unconscious guided missile homes in on an aero-

plane.” This digital metaphor of nature pervades our culture and is used unreflectively by those in a position to direct our society’s future. According to Larry Page, co-founder of Google, for example, human DNA is just “600 megabytes compressed, so it’s smaller than any modern operating system . . . So your program algorithms probably aren’t that complicated.”

But nature is not in fact a machine nor a computer—and it can’t be engineered or programmed like one. Thinking of it as such is a category error with ramifications that are both deluded and dangerous.

A four-billion-year reversal of entropy

Ultimately, this machine metaphor is based on a simplifying assumption, known as reductionism, which approaches nature as a collection of tiny parts to investigate. This methodology has been resoundingly effective in many fields of inquiry, leading to some of our greatest advances in science and technology. Without it, most of the benefits of our modern world would not exist—no electrical grids, no airplanes, no antibiotics, no internet. However, over the centuries, many scientists and engineers have been so swept up by the success of their enterprise that they have frequently mistaken this assumption for reality—even when advances in scientific research uncover its limitations.

When James Watson and Francis Crick discovered

the shape of the DNA molecule in 1953, they used metaphors from the burgeoning information revolution to describe their findings. The genotype was a “program” that determined the exact specifications of an organism, just like a computer program. DNA sequences formed the “master code” of a “blueprint” that contained a detailed set of “instructions” for building an individual. Prominent geneticist Walter Gilbert would begin his public lectures by pulling out a compact disk and proclaiming “This is you!”

Since then, however, further scientific research has revealed fundamental defects in this model. The “central dogma” of molecular biology, as coined by Crick and Watson, was that information could only flow one way: from the gene to the rest of the cell. Biologists now know that proteins act directly on the DNA of the cell, specifying which genes in the DNA should be activated. DNA can’t do anything by itself—it only functions when certain parts of it get switched on or off by the activities of different combinations of proteins, which were themselves formed by the instructions of DNA. This process is a vibrant, dynamic circular flow of interactivity.

This leads to a classic chicken-and-egg problem: if a cell is not determined solely by its genes, what ultimately causes it to “decide” what to do? Biologists who have researched this issue generally agree that the

emergence of life on Earth was most likely a self-organized process known as autopoiesis—from the Greek words meaning self-generation—performed originally by non-living molecular structures.

These protocells essentially staged a temporary, local reversal of the Second Law of Thermodynamics which describes how the universe is undergoing an irreversible process of entropy: order inevitably becomes disordered and heat always flows from hot regions to colder regions. We see entropy in our daily lives every time we stir cream into our coffee, or break an egg for an omelet. Once the egg is scrambled, no amount of work will ever get the yolk back together again. It’s a depressing law, especially when applied to the entire universe which, according to most physicists, will eventually dissipate into a bleak expanse of cold, dark nothingness. Those first protocells, however, learned to turn entropy into order by ingesting it in the form of energy and matter, breaking it apart, and reorganizing it into forms beneficial for their continued existence—the process we know as metabolism.

Ever since then, for roughly four billion years, the defining quality of life has been its purposive self-organization. There is no programmer writing a program; no architect drawing up a blueprint. The organism is the weaver of its own fabric, using DNA as an instrument of transmission. It sculpts itself according to its own

inner sense of purpose, which it inherited ultimately—like all of us—from those first autocatalytic cells: the drive to resist entropy and generate a temporary vortex of self-created order in the universe. In the words of philosopher of biology Andreas Weber, “Everything that lives wants more of life. Organisms are beings whose own existence means something to them.”

This implies that, rather than being an aggregation of unconscious machines, life is intrinsically purposive. In recent decades, carefully designed scientific studies have revealed the deep intelligence throughout the natural world employed by organisms as they fulfil their purpose of self-generation. The inner life of a plant, biologists have discovered, is a rich plethora of complex experience. Plants have their own versions of our five senses, as well as up to fifteen other ways of sensing their environment for which we don't have analogues. Plants act intentionally and purposefully: they have memories and learn, they communicate with each other, and can even allocate resources as a community through what biologist Suzanne Simard calls the “wood-wide web” of mycorrhizal fungi linking their roots together underground.

Extensive studies now point to the profound realization that every animal with a nervous system is likely to have some sort of subjective experience driven by feelings that, at the deepest level, are shared by all of us. Bees have been shown to feel anxious when their hives are shaken. Fish will make trade-offs between hunger and pain, avoiding part of an aquarium where they're likely to get an electric shock, even if that's where the food is—until they get so hungry that they're willing to take a risk. Octopuses, one of the earliest groups to evolve separately from other animals about 600 million years ago, live predominantly solitary lives, but just like humans, get cozy with others when given a dose of the “love-drug” MDMA.

The ideology of human supremacy

As we confront the existential crises of the twenty-first century, the mechanistic thinking that brought us to this place may be driving us headlong toward catastrophe. As each new global problem appears, attention gets focused on short-term, mechanistic solutions, rather than probing deeper systemic causation. In response to the worldwide collapse of butterfly and bee populations, for example, some researchers have designed tiny airborne drones to pollinate trees as artificial substitutes for their disappearing natural pollinators.

As the stakes get higher through this century, the dangers arising from this mechanistic metaphor of nature

will only become more harrowing. Already, in response to the acceleration of climate breakdown, the techno-dystopian idea of geoengineering is becoming increasingly acceptable. Following Tillerson's misconceived logic, rather than disrupt the fossil fuel-based growth economy, policymakers are beginning to seriously countenance treating the

Earth as a gigantic machine that needs fixing, and developing massive engineering projects to tinker with the global climate.

Given the innumerable nonlinear feedback loops that generate our planet's complex living systems, the law of unintended consequences looms menacingly large. The eerily named field of “solar radiation management”, for example, which has received significant financing from Bill Gates, envisages spraying particles into the stratosphere to cool the Earth by reflecting the Sun's rays back into space. The risks are enormous, such as causing extreme shifts in precipitation around the world and exacerbating damage we've already done to the ozone layer. Additionally, once begun, it could never be stopped without immediate catastrophic rebound heating; it would further in-



Photo credit: Gerd Altmann/Pixabay

crease ocean acidification; and would likely turn the blue sky into a perpetual white haze. These types of feedback effects, arising from the innumerable nonlinear dynamic interdependencies of Earth's complex systems, get marginalized by a worldview that ultimately sees our planet as a machine requiring a quick fix.

Further, there are deep moral issues that arise from confronting the inherent subjectivity of the natural world. Ever since the Scientific Revolution, the root metaphor of nature as a machine has infiltrated Western culture, inducing people to view the living Earth as a resource for humans to exploit without regard for its intrinsic value. Ecological philosopher Eileen Crist describes this as human supremacy, pointing out that seeing nature as a "resource" permits anything to be done to the Earth with no moral misgivings. Fish get reclassified as "fisheries," and farm animals as "livestock"—living creatures become mere assets to be exploited for profit. Ultimately, it is the ideology of human supremacy that allows us to blow up mountaintops for coal, turn vibrant rainforest into monocropped wastelands, and trawl millions of miles of ocean floor with nets that scoop up everything that moves.

Once we recognize that other animals with a nervous system are not machines, as Descartes proposed, but likely experience subjective feelings similar to humans, we must also reckon with the unsettling moral implications of factory farming. The stark reality is that around the world, cows, chicken, and pigs are enslaved, tortured, and mercilessly slaughtered merely for human convenience. This systematic torment administered in the name of humanity to over 70 billion animals a year—each one a sentient creature with a nervous system as capable of registering excruciating pain as you or I—quite possibly represents the greatest cataclysm of suffering that life on Earth has ever experienced.

The "quantum jazz" of life

What, then, are metaphors of life that more accurately reflect the findings of biology—and might have the adaptive consequence of influencing our civilization to behave with more reverence toward our non-living relatives on this beleaguered planet which is our only home?

Frequently, when cell biologists describe the mind-boggling complexity of their subject, they turn to

music as a core metaphor. Denis Noble entitled his book on cellular biology *The Music of Life*, depicting it as "a symphony." Ursula Goodenough describes patterns of gene expression as "melodies and harmonies."

While this metaphor rings truer than nature as a machine, it has its own limitations: a symphony is, after all, a piece of music written by a composer, with a conductor directing how each note should be played. The awesome quality of nature's music arises from the fact that it is self-organized. There is no outside agent telling each cell what to do.

Perhaps a more illustrative metaphor would be a dance. Cell biologists increasingly refer to their findings in terms of "choreography," and philosopher of biology Evan Thompson writes vividly how an organism and its environment relate to each other "like two partners in a dance who bring forth each other's movements."

Another compelling metaphor is an improvisational jazz ensemble, where a self-organized group of musicians spontaneously creates fresh melodies from a core harmonic theme, riffing off each other's creativity in a similar way to how evolution generates complex ecosystems. Geneticist Mae-Wan Ho captures this idea with her portrayal of life as "quantum jazz," describing it as "an incredible hive of activity at every level of magnification in the organism . . . locally appearing as though completely chaotic, and yet perfectly coordinated as a whole."

What might our world look if we saw ourselves as participating in a coherent ensemble with all sentient beings interweaving together to collectively reverse entropy on Earth? Perhaps we might begin to see humanity's role, not to re-engineer a broken planet for further exploitation, but to attune with the rest of life's abundance, and ensure that our own actions harmonize with the Earth's ecological rhythms. In the profound words of 20th century humanitarian Albert Schweitzer, "I am life that wills to live, in the midst of life that wills to live." How, we may ask, might our future trajectory change if we were to reconstruct our civilization on this basis?

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LAST STAND

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KENNICOTT

Kennicott is an abandoned copper mining camp in the U.S. state of Alaska. The search for the mineral began in the summer of 1900. The US Geological Survey geologist Oscar Rohn had predicted copper would be found in the edge of the Kennicott Glacier. Clarence Warner and Jack Smith were amazed by the green cliffs of exposed copper. A treasure that without a way to transport the copper to market could not be exploited. Building a railroad from the coast, across mountains, rivers and glaciers looked almost impossible. Almost.

After four years of work, often at temperatures down to 40 degrees below zero, in 1911 the White Pass & Yukon Railroad was completed. Ten days later the first train left Kennicott filled with copper. The mine activity did not last long. The highest grades of ore were largely depleted by the early 1930s. The last train left Kennicott on November 10, 1938, leaving it a ghost town.

In June of 1998, the National Park Service acquired many of the significant buildings and lands of the historic mining town of Kennicott. Listed on the National Register of Historic Places in 1978 and designated as a National Historic Landmark since 1986, Kennicott is considered the best remaining example of early 20th Century copper mining. **ONE**

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