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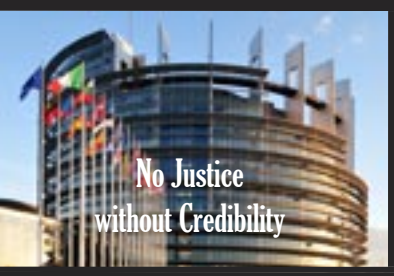
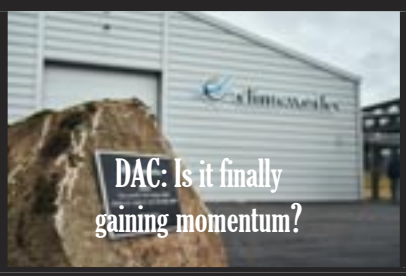
Only Natural Energy

A Criminal Lexicon for Climate Change



No Justice without Credibility

More Biomass with Irrigation from the Sea



DAC: Is it finally gaining momentum?

The Rise of Green Hydrogen in Latin America

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ONE
Only Natural Energy

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The building of European Parliament in Strasbourg (France).
Photo credit: Ralf Roletschek

No justice without credibility

GIANNI SERRA
ONE

There is a lot of rhetoric when it comes to the just transition. Beginning with the adjective chosen to describe this path from a fossil-based energy economy to a zero-emission one based on renewables.

The energy transition has many issues. The loss of traditional jobs is the most evident. Land dispossession is less intuitive but will also be a significant problem - because wind and solar need much more land than fossil fuels to produce the same amount of energy.

All these issues are so plain that potential victims and exploiters agree on one point: if a transition is to be made, it must be fair at least. The need to rebalance the relationship between economic growth and climate protection can no longer be separated from social justice. Energy transition must be an opportunity to rebalance inequalities and social hardships amplified by the present development model.

The Just Transition Fund is the European Union's Green Deal implementation tool. An instrument made of money (€ 19.32 billion), regulations, and a guiding star: to leave no one behind. "The JTF aims to reduce the social and economic costs resulting from the transition to the EU's 2030 climate target and the EU climate-neutral economy by 2050, to make sure that no region is left behind. It supports a diversification of economic activity, creating new business opportunities and helping people adapt in a changing labour market."

Sounds good. But the reality promises to be a different story.

The "Just" rhetoric holds up if the laws and the people behind them align with the principles they claim are their inspiration. Can politicians and lawmakers credibly speak of 'endeavouring to reach the furthest behind first' when they protect the status quo daily? How can you speak of inclusion at one point of the agenda and defend your interests from the poorest and the weakest at the next? The 'leave no one behind' principle cannot be credibly offered in transforming the energy sector and withdrawn in migration policy. Social justice has no borders.

The show-me-your-passport-first is the ultimate denial of humanity and inclusivity. Sacrificing those values to higher (and less commendable) interests is what happens every day on the Southern border of Europe, on the Mediterranean Sea. And this is what will happen to any vulnerable community within the European Union on the path towards carbon neutrality. The economy remains the priority, far ahead of climate change. Social justice, the first casualty of this new energy trilemma, is out of the equation. Last will stay last. ONE

The "Exxon knew" movement in Washington, DC in 2015.
Photo credit: Johnny Silvercloud

A Criminal Lexicon for Climate Change

LENORE HITCHLER

ONE

«Every person on Earth today is living in a crime scene». Journalist Mark Hertsgaard referred to the criminal nature of the fossil fuel industry when he also stated that «the climate crisis is a crime that should be prosecuted. … The crime in question is the fossil fuel industry's 40 years of lying about climate change.»

Exxon's internal records show that by the late 1970s, their scientists were informing top executives that manmade warming was real, potentially catastrophic, and caused primarily by burning fossil fuels. Shell Oil was also aware of the dangers of climate change as shown in their 1986 report that stated that "the changes may be the greatest in recorded history." A Shell 1988 report revealed that executives knew the role that Shell played in climate change. They were aware that fracking and obtaining oil from tar sands and the arctic would accelerate climate change, and they exploited tar sands and engaged in arctic oil exploration anyway. Furthermore, Shell's 1991 film, *Climate of Concern*, warned about extreme weather, floods, famines, and climate refugees.

People are concerned about crime and therefore the climate change movement has realized it's time to emphasize the criminal aspects of fossil fuel industries, particularly the petroleum industry.

Crimes such as "breaking and entering," and "assault and battery" have traditionally been charged to individuals. However, in the court of public opinion, why couldn't corporations and nations be rhetorically charged with these crimes? Also, why aren't national and international laws enacted to charge corporations and nations with negligent homicide? Additionally, in both justice systems, legal judgments should mandate full restitution to all victims instead of charging relatively low fines which in no way pays for restoring the environment or people's health.

it is not unreasonable to assert that specific industries are causing "criminal" climate change, thus, it is appropriate for climate activists to use various legal terms such as "breaking and entering," as well as "assault and battery."

The charge of "breaking and entering" usually refers to entering a building through force without authorization, but it can also include entering through fraud, threats, or collusion. Rather than using force without authorization, fossil fuel companies frequently enter resource areas with the authorization of the state which sometimes involves collusion. "Collusion" occurs when two or more parties secretly agree to defraud a third party of their rights. Also, instead of entering a specific building, fossil fuel companies enter areas that are rich with gas, coal, or oil.

Shell oil spill in Nigeria. Photo credit: Environmental Rights Action/Nigeria FOTE

"Fraud" refers to the deliberate misrepresentation of fact for the purpose of depriving someone of a valuable possession. It happens with those industries which tell the affected communities that they will provide jobs, which are frequently exaggerated in number and are often given to non-locals. Or with those industries not honest about the illness, death, and destruction of the environment that follows. In both situations, they tell the communities that they will clean up the affected areas and then default on their promises.

"Assault" is defined as the wrongful (not fair, just, or legal) act of causing someone to reasonably fear imminent harm, whereas "battery" is the actual wrongful act of physically harming someone. Water, air, and soil pollution caused by the extraction of gas, oil, and coal industries certainly result in fear for the future as well as actual damage. Even though all the fossil fuel companies could be perceived as equally guilty, it is the oil companies who have recently been taken to court. Victims of these crimes have recently won their legal cases against oil companies setting legal precedents for additional lawsuits and prosecutions.

It could be argued that Shell committed battery when it extracted oil and caused human suffering and environmental damage. Therefore, Shell has faced various court cases. In May 2021, the Dutch court ordered Shell to cut carbon emissions from its oil and gas products by 45% by 2030. In 2023, environmental lawyers from ClientEarth filed a lawsuit against the company's directors in the high court of England. It is the first court case to attempt to hold company directors personally liable for failing to enact an adequate transition to net zero energy.

Shell has also been sued in London's high court by 13,652 Nigerian individuals, as well as churches and schools. Shell is responsible for many oil spills in Nigeria. The victims are asking Shell to clean up oil pollution they caused and for compensation for contaminated drinking water, agricultural land, and the destruction of the fishing industry due to poisoned fish. According to the Nigerian journalist Orji Sunday «in 2013 researchers estimated that nearly 546 million gallons of oil spilled into the Niger Delta. A study reported in PNAS found that nearby oil spills that occur before conception increase neonatal mortality by 38.3 deaths per 1,000 births.»

Multinational corporations are not the only entities facing legal action as countries may soon be held liable for their negligence in combating climate change. Vanuatu, a small Pacific island country, has brought a resolution, supported by 105 countries, to the United Nations General Assembly. Vanuatu requested the International Court of Justice issue an advisory opinion on both the obligations of governments to protect the environment from human-caused climate change and the legal consequences of those obligations.

Lawsuits and criminal prosecutions against oil companies have already occurred and will certainly escalate. It is easily predictable that also natural gas and coal companies will soon see their legal expenses bills increase. ONE

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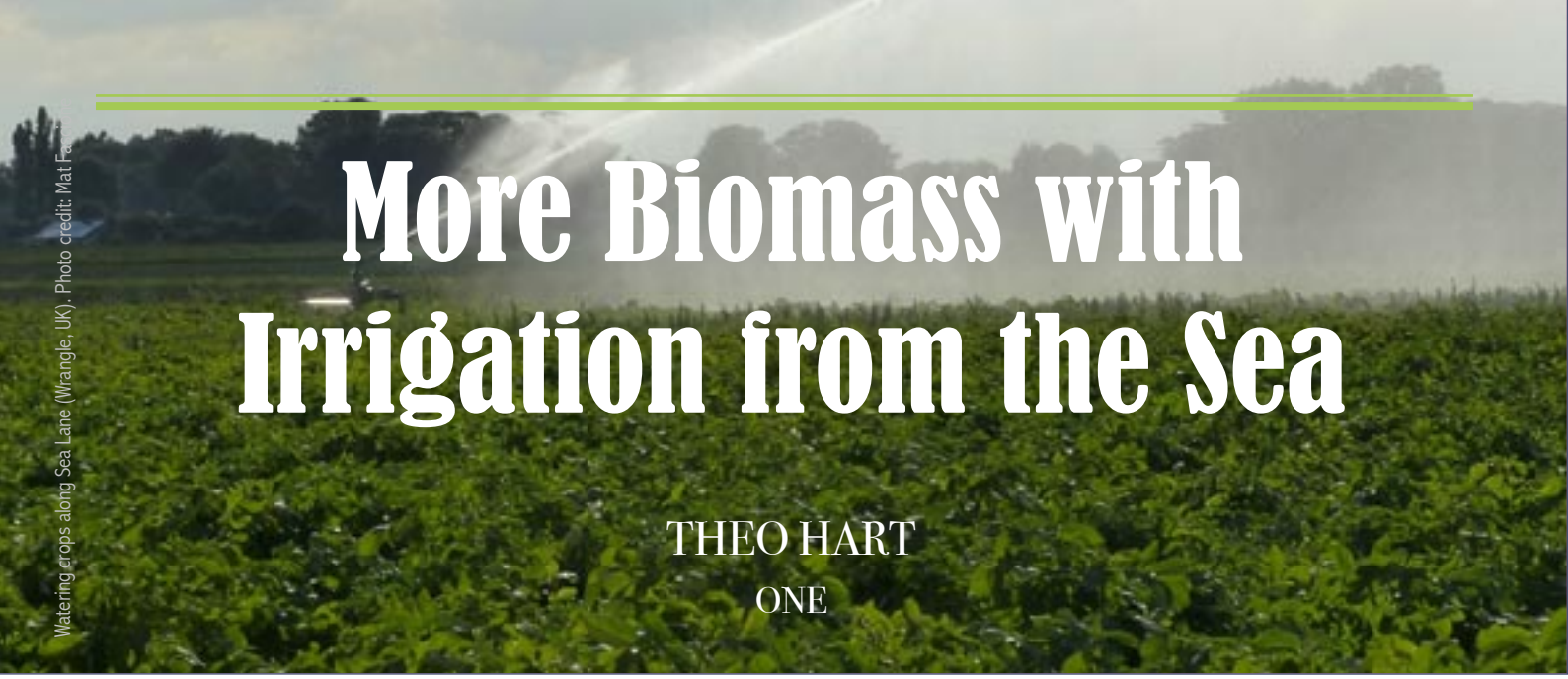

Watering crops along Sea Lane (Wrangle, UK). Photo credit: Mat F

More Biomass with Irrigation from the Sea

THEO HART

ONE

Seawater cannot be used for irrigation due to its sodium (Na) content, which most plants don't tolerate. Seawater's various salts ordinarily total circa 3.5% by weight, though nearly 4% in some places, with almost all being simple table salt: NaCl. However, irrigation water with practically no sodium can be obtained from the sea at no great expense using a unique method. But first, the importance of more biomass growth to remove CO2 from the air.

From a climate change perspective, removing CO2 from the air is a necessity, for it is true the percentage of CO2 in the atmosphere has been gradually increasing for many decades. But bear in mind this figure is a residual since vast amounts of CO2 enter the air each year, while almost all of it is withdrawn again through various natural processes. One such is plant growth. Plants need carbon to build their tissues and make various polymers, which is carbon in a dense form. They get it from CO2 gas taken out of the air. Increasing the growing vegetation is one natural way of increasing CO2 withdrawal. Humans removing CO2 from the air by 'direct capture' using ingenious means can be simply redundant. What need have we to do what nature does so readily?

Due to its high expense, removing CO2 from flue gases is even less sensible. Wherever this has been taken seriously, common sense must either have been gagged or on holiday, thus allowing politics to triumph. It is expensive because flue gases are hot and several, the CO2 being dilute among them and needing separation. This step requires energy input, expensive equipment, and a plant costly to construct. The more dilute the CO2, the greater the expense. And yet, gaseous CO2 is not the objective, so more energy is used in liquifying it for injection far below ground. This requires high pressure, a significant temperature drop, and a special pipeline able to contain the liquid CO2 on its journey, which means more cost. Still, in some cases, injection of CO2 underground may be deemed worthwhile. Even so, CO2 gas can be obtained at much less expense than from flue gases. An excellent example is making liquor, an ethanol ferment. The yeast typically used also produce CO2 as a concentrated byproduct, almost as much by weight as ethanol. So instead of spending a large amount of money 'capturing' CO2 gas from some flue, invest a tiny fraction as much in the profitable production of ethanol and obtain CO2 gas as a byproduct. This provides it much more cheaply and uses far less energy. Plus, it allows some displacing of fossil fuels in engines with ethanol. Overall, it is clear that the capture of CO2 from flue gases has yet to make sense financially.

More Vegetation Instead

Increasing the amount of vegetative growth will increase the amount of CO2 taken from the air. If year by year, total vegetative growth rises on our planet, and more areas become green and more growth per unit of space, then more carbon dioxide will be getting removed each year. A sure way to get increased growth is by irrigation. As the objective is abundant new growth, irrigation of semi·arid land or sandy desert is a good choice. Such soils are typically low in plant nutrients, but applying water and fertilizers can turn them green, removing more CO2 from the air than before.

Using water from the sea with its sodium removed can do it. Extensive projects are unnecessary, as many of modest size certainly add up. Doing so in many parts of the world is indeed indicated. Growing tall crops — sorghum, kenaf, and the like (sugarcane where appropriate) — will pull more CO2 from the air than shorter crops. Kenaf can be dual use, the outer fibre for making paper and the inner pith for biofuel production. Other crops - such as *Typha latifolia* (commonly known as bulrush or cattail), which is a perennial well suited to irrigation - would be 'energy crops' used entirely for making biofuels, mainly by fermentation.

Sunroot (*Helianthus tuberosis*) is a type of sunflower with small tubers on its roots which grows tall and has many small flowers. It may be cut more than once as forage, which means it can also be fermented. The edible flower buds may be collected then. Since it regrows the following season from its roots, even the tubers may be harvested. Sterile hybrids exist which won't propagate by seed. Of course, either confectionary or oilseed-type sunflowers could also be grown. Either can be decapitated early and the heads stored for dry down, with the stocks fermented to biofuels. Later, when the dry heads are threshed, that residue would be suitable for making furfural since both the pectin and xylans yield furfural. Maize cobs, either local or imported, would be another source of supply for the furfural maker, as can be chaff from wheat threshing. Furfural is only made from plant materials, often just maize cobs. A facility producing 5000 tons annually is usually profitable. Acetic acid is a byproduct.

Mediterranean countries grow durum wheat, yet most are also regular importers. Irrigation would provide reliable and greater output. Also, the straw and chaff from threshing can be fermented into biofuels. Part of the chaff could go instead to the furfural maker.

Tunisia

Tunisia is a small country in Africa about the size of England, with 1300 km of coast on the Mediterranean sea. Yet it has a chronic water shortage, made worse in the frequent drought years. The south of the country is an actual desert. The government has borrowed heavily to construct several desalination plants. The largest will have a daily output of 100,000 cubic metres and is being built some km from the city of Sfax on the south coast. Like most new plants anywhere, these use reverse osmosis to provide drinkable water. Priority is given to households and tourist centres, though much will go to irrigation. This is usual wherever irrigable land exists, and Tunisia has plenty. The water quality is much better than needed for this use.

Seawater is the input to these reverse osmosis plants, which convert less than half into drinkable water. The rest, now saltier, gets returned to the sea. Removing the sodium from this 'reject water' would allow it to be used for irrigation. Doing so would more than double the output of useable water from such a plant. As desalination plants are expensive, this would make a significant difference. One novel process to do it involves the use of imported potassium bicarbonate . A bit of technical detail here shows how this works. The critical thing is the low solubility of sodium's bicarbonate, which is only ~10% by weight at circa 20 °C. Having it drop out of the saltier reject water rids it of sodium. Simply mixing with enough of potassium's bicarbonate would do so, leaving a solution of the chloride of potassium (KCl), its usual fertilizer. However, there would be too much, about 12% by weight, so if possible this is best avoided. Using instead the bicarbonate of calcium should work, given a strong enough solution. According to a 2010 Australian patent, this bicarbonate may be made in good quantity from limestone, or other form of calcium carbonate, contacted with CO2, provided the material is finely ground and the water is neither alkaline nor acidic (neutral pH). Using the specified operating conditions it claims a solution of about 16% by weight calcium bicarbonate can be built up. Mixing this with 'reject water' will likewise remove its sodium as bicarbonate, while creating calcium chloride which remains in solution. This should be fine for irrigation diluted with fresh water, at least for some crops. It would be best to lower the chloride content, of course, but that is a separate issue.

Use of Irrigation Water

Large fields of durum need large equipment; smaller fields with equipment suited to them will do instead. This means more farms and more local employment to serve families. Suitable equipment for this size of farm is made in Italy, among other places — a reaper bundler for harvesting in particular. Say a farmer has 16 to 20 hectares in durum and with irrigation gets a yield of 3 t/ha. That's 48 to 60 tons of grain, and a decent income at 300 €/t.

Twenty thousand farms of this size could supply a million tons or more of durum. Tunisia currently imports at least that much and more. That is only the grain. More income could come from selling straw and chaff to those who ferment it to produce biofuels. Of course, their main supply of fermentables would come from farmers specifically growing crops for that purpose. Many biofuels would be made, for furnaces, cook stoves, heaters, grills, and particularly for external combustion engines of all sizes once they become widely available. Ethanol is not a good fuel compared with some others. The EU is a good market for biofuels. Biofuel bonds could be used to raise money.

Vine crops would also be cash crops, such things as melons and squash, mostly for export. In order to conserve irrigation water, the plants would best be rooted in raised beds while their vines are tied to linear supports over dry ground, perhaps even uphill. Harvesting requires no stooping. Each bed is separate and the ground need not be level. Since water is applied to the top of the bed and drains down, this should keep sodium salt from staying in the root zone. Such crops produce a large amount in a small area and need close attention, so the size of the farm would be a few hectares each. ONE

Cargo ships. Photo credit: pxfuel.com

Ships harness wind for voyage to a cleaner future

New sails and boat designs are set to help shipowners slash fuel costs and emissions.

GARETH WILLMER
The EU Horizon Magazine

There is no mistaking Cristina Aleixendri's enthusiasm – and competence – when it comes to talking about how wind-assisted shipping is on the verge of making a planet-changing comeback.

Aleixendri founded a company called bound4blue with two fellow Spaniards in 2014 to develop sail technology inspired by their training in aeronautical engineering.

Dream come true

'When we started, we were seen as crazy engineers for wanting to bring sails back to ships,' she said. 'But when we speak to shipowners today, they tell us we'll go back to wind and it will never be abandoned.'

It's easy to understand why. The shipping industry accounts for about 3% of global greenhouse-gas emissions and is trying to move away from heavy fuel oil, which is highly polluting. 'Wind-propulsion technology will become a standard,' said Aleixendri. 'It started as a dream of mine. Now, I see it less as a dream and more of a reality.'

Not only has Barcelona-based bound4blue attracted growing interest from shipping firms in its wind-assisted propulsion system but Aleixendri has achieved significant personal recognition for her efforts.

In 2019, she made the Forbes 30 Under 30 list for manufacturing and industry in Europe. The following year, Aleixendri won the European Institute of Innovation and Technology Woman Award recognising inspiring female entrepreneurs.

Wind in the sails

Now, bound4blue is coordinating an EU-funded sails project that borrows the company's name and runs for two years through February 2024. There's big room for growth in wind-assisted shipping.

As of September 2022, only 21 large commercial ships globally were equipped with the ability to harness wind energy, according to the International Windship Association.
Though predicted to more than double to as many as 50 vessels this year, that's still a drop in the ocean compared with the global fleet.

Wind energy is viable for a variety of vessels, including cargo carriers, tankers, ferries and cruise ships, according to Aleixendri.

'It's a massive market because there are more than 60 000 ships sailing worldwide that could benefit from such solutions,' she said. 'This is very nascent.'

As 2023 dawned, the entry into force of new regulations by the International Maritime Organization on energy efficiency and carbon emissions is also expected to spur growth.

'I think it's the right moment to invest in wind propulsion – it's a very sweet spot for us,' said Aleixendri, who is her company's chief operating officer and earned a Master of Sciences degree in aerospace engineering from the Polytechnic University of Catalonia.

Suction fan

Bound4blue has developed what's called an autonomous suction-based sail, which looks nothing like a traditional one. It has the appearance of a cylinder-shaped tower that rises from the ship's deck.

Traditional sails work by "catching the wind". The wind creates a higher-pressure area behind the sail compared to its other side. This difference in pressure generates a force that propels the ship forward, known as "lift".

By contrast, bound4blue's "eSAIL" contains a suction fan to draw air inside the tower as wind flows around it, creating stronger lift to power the boat. This results in six or seven times the lift of a conventional rigid sail and could reduce fuel consumption by up to 40% if combined with better vessel design and adjustments in routes to take advantage of prevailing winds, according to Aleixendri. The eSAIL is best suited for the types of windy conditions found in the North Atlantic and North Pacific, she said – though its use is by no means exclusive to those routes.

Emission savings will vary, depending on the general wind conditions on different routes. For example, bound4blue estimates that a merchant ship sailing the 25 000 kilometres from southern Brazil to north-eastern China could save 26% on fuel and emissions.

While it's still early days, some first movers have already reported savings of 15%. Bound4blue has also signed a range of deals with shipping firms including Japan's Marubeni and French-owned Louis Dreyfus Armateurs.

'We have more demand than we can supply today, so we're very happy about how it's going,' said Aleixendri.

While new technology has previously been seen as risky to install on ships, wind-assisted options like bound4blue's are starting to make economic sense and can pay for themselves in fuel savings within five years, she said.

'In the end, wind propulsion is providing free, renewable energy that you don't have to store or invest in infrastructure to supply,' said Aleixendri.

Vessel design

Amid the promise of wind-based options, a challenge arises: ensuring they are properly implemented to achieve their full performance potential or preventing negative knock-on effects on how a ship runs.

So another EU-funded project, Optiwise, is investigating how the overall design of vessels can be adjusted to optimise wind-assisted propulsion. Better attuning ships to the technology can help improve sailing efficiency and emission savings, according to Rogier Eggers, who leads the three-year project running through May 2025.

Design modifications could also help overcome some of the potential negative consequences of installing sails on ships. Doing so may, for instance, create an obstacle for passing under objects like cranes in ports or even affect ships in such a way that they struggle to stay on course.

'That's simply not acceptable, so it's required to look at the shape of the hull and appendages such as rudders to make sure that you get the ship in balance,' said Eggers, a senior project manager at Dutch maritime research institute Marin. Over the next couple of years, Optiwise plans to use scale models of ships several metres in length to test wind systems and the effects of technological improvements in various sea conditions.

The project also intends to employ computer-based voyage simulations and machine learning. Innovations could deliver savings of well over 30% in carbon emissions, maybe even reaching as much as 50%, if effectively delivered, according to Eggers.

Blast from the past

If wind technologies can be successfully integrated, methods like suction sails, wing sails and cylindrical spinning rotor sails being produced by partners in Optiwise could gain real traction, he said. Adoption of such rotor sails would resurrect a wind-based technology invented a century ago by Anton Flettner, a German engineer. It failed to become widely adopted as a result of the growing popularity of diesel fuel at the time.

'Several suppliers have been pretty active with wind technology and have been getting increased interest from the shipping market for installations,' said Eggers. 'Before, there was a big reluctance to put such things on ships, but devices like Flettner rotors, suction sails and wing sails are now gradually being trusted by the industry.'

This transition promises to set the maritime sector on a course towards slashing emissions.

'We are at the start with shipping in moving towards a zero-emission future,' said Eggers. 'The number of ships equipped now with wind propulsion is still tiny compared to the world fleet, but the hope is that we will soon be seeing hundreds of ships being equipped per year.'

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March 10, 2023

The rise of green hydrogen in Latin America

The Haru Oni plant (Chile) will produce 130 tons per year of eMethanol. Photo credit: Siemens

In anticipation of future demand, several projects are underway in the region to produce this clean energy source

PABLO FONSECA
Knowable Magazine

Franklin Chang-Díaz gets into his car, turns on the radio and hears the news about another increase in the price of gasoline. But he sets off knowing that his trip won't be any more expensive: His tank is filled with hydrogen. His car takes that element and combines it with oxygen in a fuel cell that works like a small power plant, creating energy — which goes into a battery to power the car — and water vapor. Not only will Chang-Díaz's trip cost no more than it did yesterday, it will also pollute far less than a traditional gasoline-powered car would.

Chang-Díaz would like to have a public hydrogen station nearby whenever he needs to fill his tank, but that isn't possible yet, either in his native Costa Rica or in any other Latin American country. He ends up instead at the hydrogen station he built himself, as part of a project aimed at demonstrating that hydrogen generated with renewable energy sources — green hydrogen — is the present, not the future.

A physicist, former NASA astronaut and the CEO of Ad Astra Rocket Company, Chang-Díaz has a clear vision. Green hydrogen, he believes, is a fundamental player in lowering emissions from transportation and converting regions that import fossil fuels — such as his small Central American country — into exporters of clean energy, key to avoiding the catastrophic effects of global warming.

According to data from the Inter-American Development Bank, the most polluting sectors in Latin America to which clean hydrogen technology could be applied are transportation (which generates 40 percent of the region's CO_2 emissions) and electricity and energy (36 percent of emissions). And Chang-Díaz is not alone in his belief in the promise.

Large-scale hydrogen transportation will be part of the future, says Nilay Shah, a chemical engineer at Imperial College London. "By 2050, hydrogen could deliver 18 percent of the global energy supply … 28 percent of which would be destined for the transport sector," he and his colleagues note in an article on the application of hydrogen in mobility technologies in the 2022 Annual Review of Chemical and Biomolecular Engineering.

But for green hydrogen to become an important

player in the world's energy resources, the technologies for obtaining it will need to be developed on a large scale. Latin America wants to be part of this future and is already preparing, with projects throughout the region.

Not all hydrogen is the same

Hydrogen is the lightest chemical element: Its nucleus has only one proton, orbited by an electron. It's also the most common: Up to 90 percent of the atoms in the universe are believed to be hydrogen atoms. In its gaseous state (H_2), it is tasteless, colorless and odorless. In the terrestrial environment, it is usually found in more complex compounds, such as two hydrogen atoms bonded to one oxygen atom to form a water molecule (H_2O), or four hydrogen atoms bonded to one carbon atom to form methane (CH_4). If we need the hydrogen atoms alone, we must uncouple them from these compounds.

The use of hydrogen as an energy source is not new. For decades, NASA mixed H_2 gas with oxygen to generate the energy needed to lift hundreds of tons and send its shuttles into space. The US Department of Energy lists it as a safer fuel than fossil fuels because it is non-toxic and dissipates quickly in the event of a leak, since it is lighter than air.

At present, hydrogen as an energy source is mainly used in the production of petroleum derivatives, steel, ammonia and methanol. According to data from the International Energy Agency (IEA), in 2020 the world's population consumed about 90 million tons of hydrogen — equivalent to only 2.5 percent of global energy consumption. Latin America uses only 5 percent of this hydrogen, mainly in countries such as Trinidad and Tobago, Mexico, Brazil, Argentina, Venezuela, Colombia and Chile. It is mostly dirty hydrogen, which pollutes the planet due to the processes used to obtain it.

Depending on how it is derived, hydrogen can be classified as gray, blue, green — or even black. Gray hydrogen is generated using fossil fuels — natural gas especially, in the case of Latin America. In a process called steam reforming, carbon monoxide (CO) and water vapor (H_2O) are subjected to high temperatures, mo-

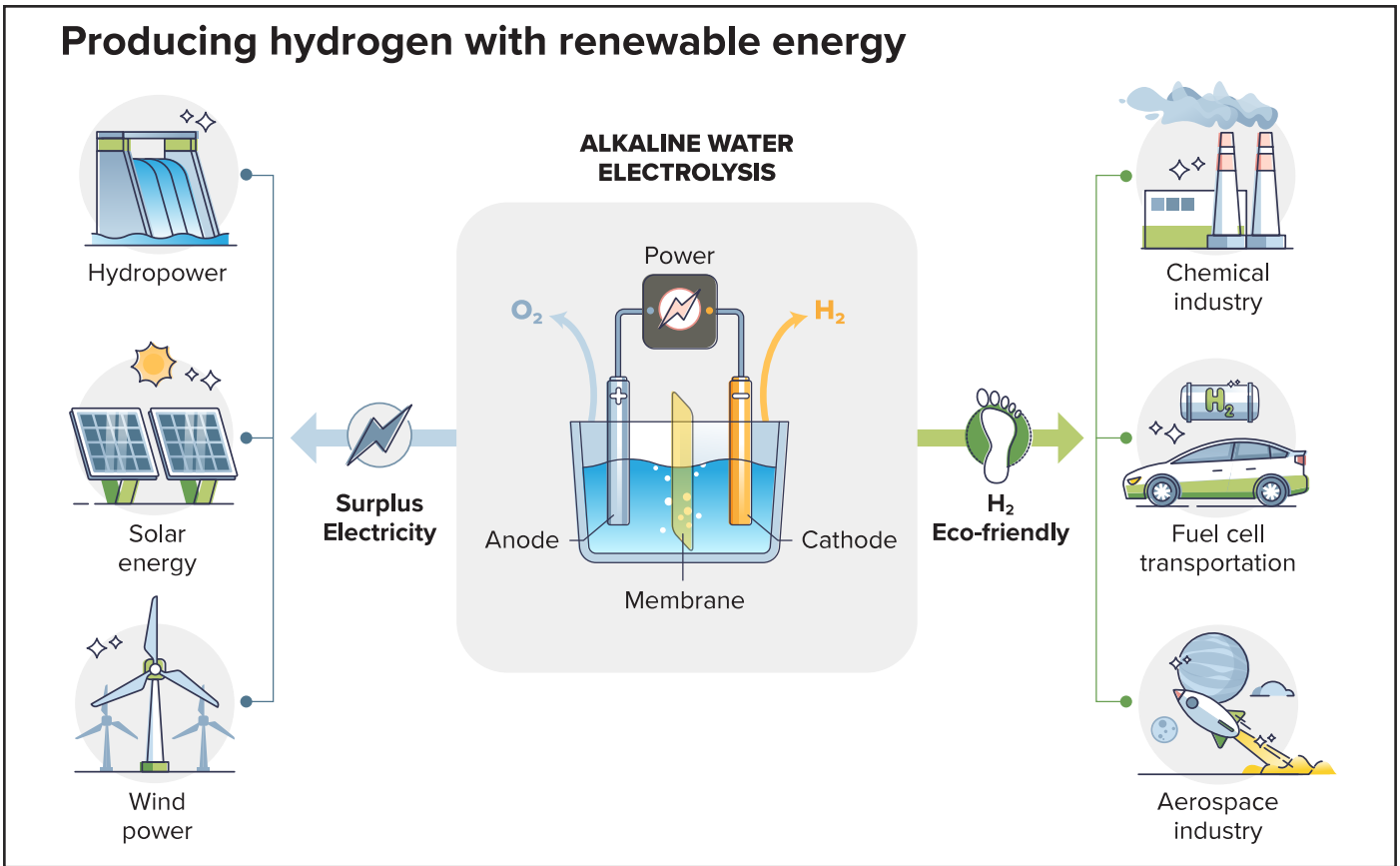

Photo credit: KNOWABLE MAGAZINE / Z CAI ET AL / journal of Materials Chemistry (2019)

derate pressure and a catalyst, producing carbon dioxide (CO2) and hydrogen (H2). If coal is used instead of gas to generate the heat necessary for steam reforming, the hydrogen is then considered black — the worst of all, from an environmental point of view.

Blue hydrogen uses gas or coal in the same steam reforming process, but in this case 80 percent to 90 percent of the carbon emissions end up underground through a process called industrial carbon capture and storage (CSS).

Finally, green hydrogen — also called clean hydrogen — uses electrical energy generated by renewable sources, such as solar and wind power, to separate the water molecule into its two elements, hydrogen and oxygen, by means of an anode and a cathode in a process called electrolysis.

Currently, less than 0.4 percent of the hydrogen utilized in Latin America is green; the rest is linked to fossil fuels.

In fact, in 2019, hydrogen production for the region required more natural gas than all of the gas consumed in Chile, a country with 19 million inhabitants.

And it generated more polluting emissions than those produced in a year by all the cars in Colombia, a nation with some 7 million vehicles.

Globally, 4 percent of hydrogen production is already the result of electrolysis, but the remaining 96 percent still requires gas, coal or petroleum derivatives.

Toward green hydrogen

With the goal of producing more and more green hydrogen, several projects on different scales are taking shape in Latin America.

The Brazilian company Unigel plans to inaugurate a $120 million plant in 2023, which will produce 10,000 tons per year of green hydrogen — the equivalent of 60 megawatts (MW) — in its first stage.
Sener Ingeniería Mexico announced in August 2022 the creation of the first of a series of small plants, of about 2.5 MW.

Chile, for its part, is already seeing some of the fruits of its National Green Hydrogen Strategy,

Projected cost of hydrogen production with renewable energy by 2050

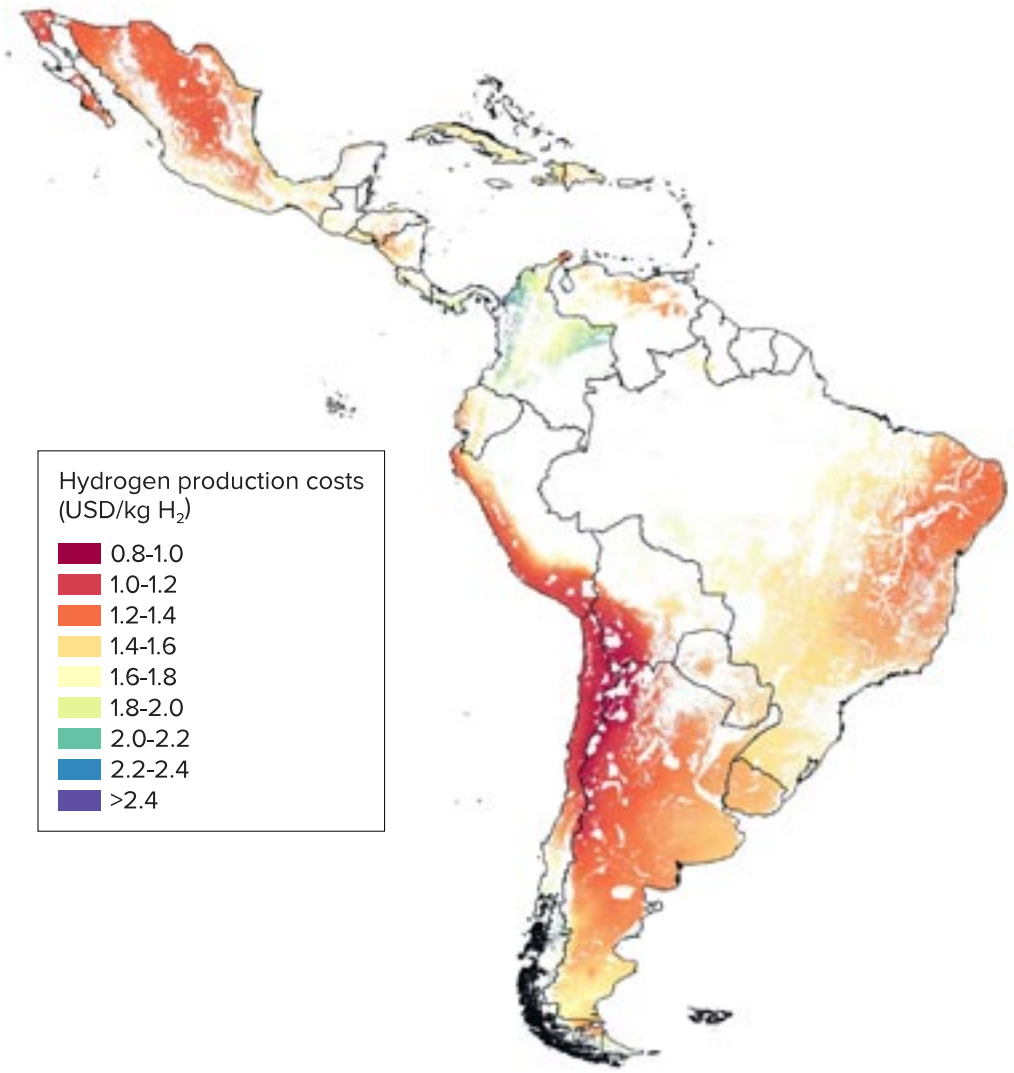

Photo credit: KNOWABLE MAGAZINE / Adaptation from HYDROGEN IN LATIN AMERICA (IEA 2021)

launched in 2020. This South American country says it plans to "conquer global markets" in 2030, mainly Europe and China, where it aims to send 72 percent of its production. The port of entry to Germany will be Hamburg. "With its great potential for green hydrogen production, Chile is on the verge of becoming an exporter of global magnitude," said the mayor of Hamburg, Peter Tschenscher, during the signing of a cooperation agreement in September 2022.

Uruguay launched the Green Hydrogen Sector Fund, with $10 million non-reimbursable funding from the government to finance projects. In August 2022, nine companies won a spot, some with names such as "Green H2 Production for Forest Transport" and "Palos Blancos Project: green hydrogen, ammonia and fertilizer production plant with wind and solar photovoltaic renewable energy."

And in Costa Rica, Chang-Díaz is helping lead the way to add green hydrogen to the country's portfolio of clean energy sources (about 99 percent of electricity in Costa Rica is generated through sources such as the sun, wind and water from dams). In July 2022, Chang-Díaz demonstrated on social media how he fueled his car, at a prototype station, with green hydrogen produced in his own country. While some Latin American countries may benefit from the production of green hydrogen, others will benefit from large-scale consumption of the clean energy source. For example, Trinidad and Tobago, which consumes 40 percent of the region's hydrogen for its oil refining processes, emits 12.3 metric tons of carbon per person per year (by comparison, Costa Rica emits 1.6 metric tons per capita per year, according to 2019 World Bank data).

If Trinidad and Tobago used green hydrogen in its processes instead of gray hydrogen, its carbon footprint would be significantly reduced. Other countries are being creative and are not yet focusing on either production or consumption of green hydrogen. Panama, for example, seeks to become a storage and commercialization node for the element, like the air and maritime transport hub it already is. As part of this national energy transformation plan, called *Green Hydrogen Roadmap*, the authorities of this country signed a memorandum of understanding with Siemens Energy. Panama also has plans to produce some of its own green hydrogen eventually: The Ciudad Dorada Biorefinery, expected to begin construction this year, will have the capacity to generate 405,000 metric tons. "Green hydrogen technology is developing worldwide and by 2030 Latin America will be the third region in the world with the most projects, after Europe and Australia," says José Miguel Bermúdez, chemical engineer and energy technology analyst at the IEA. For Shah, the reason for this growing interest is clear: Many Latin American countries have the potential to generate more clean energy than they need. "Let's take Chile, for example," he says. "The amount of potential for renewable electricity is probably 10 times more than the amount of electricity you need in the country."

Exporting that clean energy from Chile or Costa Rica in the form of electricity over long distances is complicated and expensive. But using it to create hydrogen and transport it in tanks to practically any place in the world is realistic, he says, although it will require investments — just as investments in oil tankers and gas pipelines were once needed. But, Shah adds, green hydrogen could also be transported with existing infrastructure if it is used to create popular products, such as ammonia (NH_3, a nitrogen atom bonded to three hydrogen atoms, a compound widely used in agriculture) or synthetic fuels.

Challenges to be solved

After the production and distribution of green hydrogen comes its myriad uses. To power car batteries, it's combined with oxygen in a fuel cell and generates water vapor and energy. To manufacture iron, hydrogen is used to transform one molecule of iron oxide (Fe_2O_3) into two molecules of iron (Fe) and three molecules of water (H_2O) at high temperatures — fossil fuels are currently used for this purpose. Processing this iron further, with more energy, produces steel. The manufacture of cement also requires high temperatures, currently generated

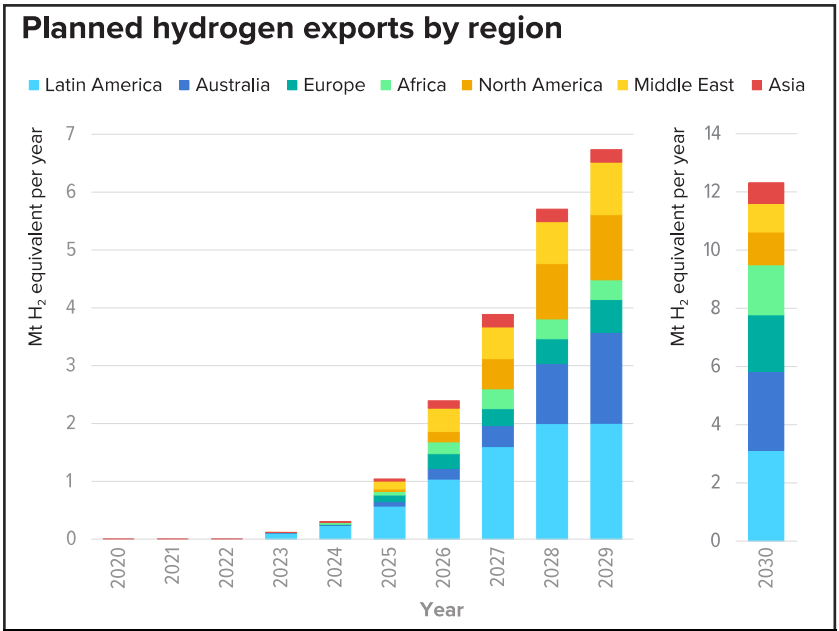

Photo credit: KNOWABLE MAGAZINE / Adaptation from Global Hydrogen Review (IEA 2022)

with fossil fuels: The IEA indicates that as much as 67 percent of hydrogen demand in 2030 could come from this industry. In addition, hydrogen combined with carbon in the Fischer-Tropsch process generates synthetic fuels, which are cleaner than traditional fossil fuels. Aircraft are already allowed to fly on up to 50 percent synthetic kerosene. Some 50,000 hydrogen vehicles are already on the road worldwide, Bermúdez adds.

Projections are that the number will soon skyrocket — China alone expects to have 1 million on its streets by 2035 — but experts agree that, in the short or medium term, hydrogen will not completely replace the most polluting fuels; instead, it will be one alternative in a matrix of different options, such as traditional electric cars or solar-powered airplanes. However, the experts also agree that it will be a significant option, not a marginal one.

"There will be a series of technologies and areas of opportunity that do not have to be specifically the same in all the countries of our region," says Andrés González Garay, a process engineer at the chemical company BASF and a coauthor of the article on hydrogen production and its applications to mobility in the Annual Review of Chemical and Biomolecular Engineering. "It is also true that hydrogen, although it can be applied in a lot of areas, will not make sense in all of them, and it will depend a lot on our political, social and economic systems."

To arrive at the more environmentally friendly scenario that green hydrogen offers, its production should be increased as soon as possible and, at the same time, its consumption needs to be encouraged, Shah says. "Global hydrogen production is expected to grow six to 10 times between now and 2050," González Garay says, and the increase is projected to be mainly in clean hydrogen. The role of governments will be pivotal, the scientists say. "If governments become the first users of hydrogen — for their buildings, for their vehicle fleets, for their other operations, for power generation — they become the customer. Then they can create the supply chain of hydrogen and give confidence to the producers that there is a market," Shah says.

Adds Bermúdez: "The public sector needs to put the regulations and support programs in place to accelerate the private sector. Public policies are needed to force demand for green hydrogen.... If Latin America does not position itself well and start producing and closing agreements, it runs the risk of being left behind."

Chang-Díaz, for his part, fears that countries like Costa Rica, despite producing almost all its electricity through clean renewable sources, risk moving too late to take advantage of the wave of green hydrogen that is already beginning to rise. In December 2022 he participated as a speaker at an international meeting held in San José, the capital of his country. But at the same time, a few kilometers away, the bill to support the green hydrogen sector, which has been under discussion for months, has not advanced in the Legislative Assembly.

So, at least for now, Chang-Díaz will remain the only one in his country who can travel in a car that uses green hydrogen as fuel.

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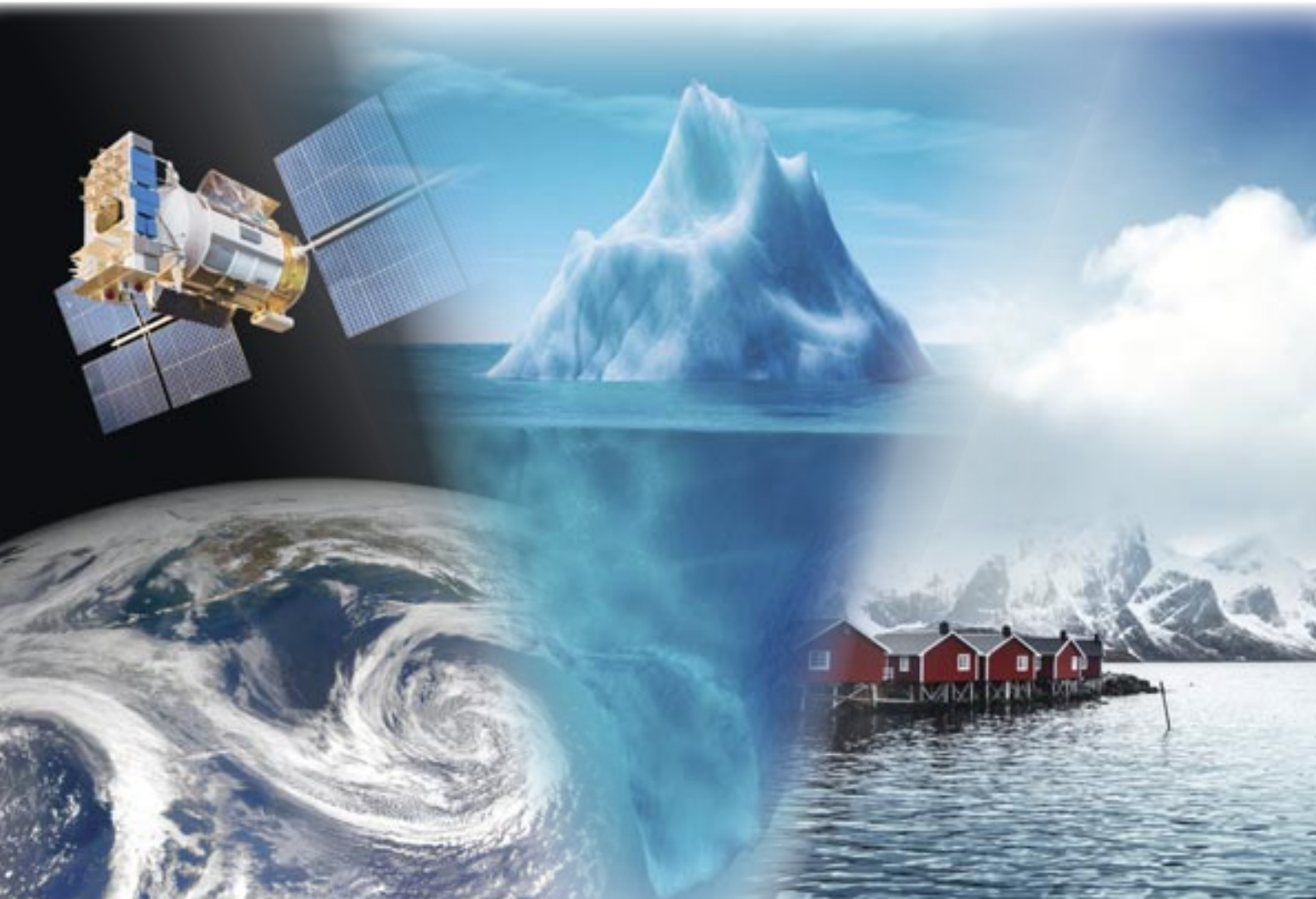
Fire and Ice – Space for Climate Action



Three small steps for mankind, one giant leap for the climate

A new report proposes a set of three policy interventions by governments that could help parts of the global economy rapidly decarbonize. Among the potential policy interventions, the report says a mandate on zero-emission vehicles could cut battery costs; supporting green ammonia in fertilizers could widen hydrogen use; and purchasing alternative proteins for food served in public institutions could reduce land pressures and cut agricultural emissions.

JULIETTE PORTALA
Mongabay

From rising sea levels to scorching heat waves, the planet has one foot in the climate grave. But a new report says three targeted policy interventions could lead to positive tipping points, helping pull us back from the brink.

The report — produced by Systemiq, a company that advocates for "systems change" in the global economy, along with the University of Exeter in the U.K. and the Bezos Earth Fund — focuses on areas that could trigger "a cascade of decarbonization" in sectors representing 70% of global greenhouse gas emissions. It was released at the annual World Economic Forum meeting in Davos, Switzerland, in January. These positive or "desirable tipping points" can help humankind "transition to net zero greenhouse gas emissions as fast as we can," Tim Lenton, chair in climate change and Earth system science at the University of Exeter and a contributor to the report, told Mongabay.

The report, titled "The Breakthrough Effect," identifies three credible "super-leverage points" that have the potential to cut carbon emissions not just in one sector, but to snowball into a series of tipping points and support faster decarbonization returns across numerous industries. Such positive tipping points occur where "reinforcing feedback within a system is able to get strong enough to become self-propelling," according to Lenton.

The first recommendation is for a mandate on zero-emission vehicles; the second a mandate to employ green ammonia as fertilizer; and the third is public procurement of non-meat proteins.

All three of these sectors are connected to other industries, the report's authors point out, so channeling money into any of them would have knock-on effects on difficult-to-abate emissions. A zero-emission vehicle mandate would make battery production cheaper and accelerate the development of renewable energies, according to the researchers, while carbon-free fertilizers would boost hydrogen growth, and procuring plant-based proteins would greatly reduce pressures on agricultural land.

Erik Faassen, an expert at the Institute for European Energy and Climate Policy (IEECP), who was not involved in the report, said these possible actions were "signs change is about to come."

Governments have long focused on the optimal rate of warming to tolerate before reacting, which in Lenton's view was "built on a crazy idea that we actually knew the consequences of our actions." But tipping points work both ways. Scientists have warned that failing to cap the average global temperature rise at 1.5° Celsius (2.7° Fahrenheit) above pre-industrial levels will precipi-

Interactions between wind turbines and birds.
Photo copyright: CC BY-NC-SA 2.0

tate irreversible damage to the Earth's life-support systems, also known as tipping points.

Whether it's the dieback of the Amazon Rainforest, the collapse of the Greenland ice sheet, or a shift in the West African monsoon, these critical thresholds, if crossed, risk "locking us into self-perpetuating climate change," the report's authors warn. They say the positive tipping points are needed to keep these cataclysmic ones at bay.

Driving away from fuel

The report's first of three "super-leverage points" is for governments to mandate zero-emission vehicles (ZEVs) in light road transport by requiring carmakers to ensure that ZEVs make up for a rising share of car sales. The report notes that this would push ZEV prices down and hike demand, thereby "reinforcing feedback loops as a dominant market force."

"Versions of this policy have proved highly effective in California, China, and the Canadian provinces of Quebec and British Columbia," its authors say, adding that the ZEV mandate involves no government expenditure, but relies on the reallocation of industrial capital.

ZEVs are electric vehicles that run on rechargeable batteries or cars that run on hydrogen fuel instead of petroleum (although the latter have not gone mainstream yet). By mandating ZEVs, governments could cause a tipping point in battery production, according to the report.

The researchers say that boosting the adoption of electric vehicles to 60% of total car sales by 2030 would lead to a tenfold increase in the volume of battery production from current levels and, as a result, a 60% decline in battery costs by that date. This, they add, would in turn reduce the cost of solar and wind deployment and power storage solutions.

"By rapidly increasing the production of batteries, prompting technological and cost improvements, electric vehicles could support the transition to clean power, and the decarbonization of other sectors that need cheap and clean electricity," the authors write. They add that other types of support will also be vital, including investments in charging infrastructure.
In heavy road transport, cheaper and better-performing batteries could also increase the competitiveness of electric trucks, the report adds, "bringing forward the

point where they outcompete petrol or diesel trucks."

Lenton, nonetheless, said a mandate could face a lot of political opposition. He cited an attempt by Republican lawmakers in the U.S. state of Wyoming to pass a resolution to phase out the sale of all new EVs by 2035. The resolution failed.

"You can get backlash from incumbents in particular sectors and some governments can be weak," he said. "That often also stems back to what's the dominant political ideology: is it laissez-faire — basically, let the market decide everything, in which case we're doomed — or are we actually going to exercise considerable public purse for our collective good?"

Green ammonia mon amour

A compound of nitrogen and hydrogen, ammonia is most commonly used in fertilizer production. It's typically produced from fossil fuels, and hence has garnered interest as a climate solution. If produced from green hydrogen — which is generated by splitting water molecules into hydrogen and oxygen using renewable energy — it could become, in its turn, green. The report says that if governments mandate the use of this green ammonia in the production of agricultural fertilizers, it could kick-start the growth of the hydrogen economy by bringing down costs and widening its use in storing energy and powering ships.

"For example, implementing a 25% green ammonia blending mandate in fertilizer manufacturing could create demand for almost 100 GW [gigawatts] of hydrogen electrolyzers, which would reduce capital costs by ~70% given current learning rates," the report's authors say, particularly as agricultural products must meet the needs of a growing population. Hydrogen electrolyzers are the machines that split water into oxygen and hydrogen. Green ammonia can be shipped at a relatively low cost, so it can be produced where hydrogen costs are the lowest.

"Further, there is no end-sector conversion required since fertilizer plants already consume ammonia," the report adds. Its authors, however, are not as confident here as they are for the ZEV mandate, citing hydrogen production as "a nascent industry with limited historical data across its use cases."

"It would make economic sense anyway to try," Lenton said, especially when the price of conventional fossil fuel fertilizer is so high. "It's encouraging that there are governments that have seen this is a logical first niche for green hydrogen," he said, calling for a more "risk-opportunity analysis approach to the climate situation."

India's draft hydrogen strategy, for instance, requires 5% minimum green ammonia production for the domestic fertilizer sector by 2023-2024, and 20% by 2027-2028, according to the report. Its authors say that mandating green ammonia should also be combined with appropriate financing mechanisms to avoid higher crop prices that "would disproportionally affect the most vulnerable populations."

We won't meat again

The third tipping point? Taking fake meat public. The report says governments should publicly procure alternative proteins for food served in public institutions such as hospitals, prisons, schools and government offices. It notes that introducing more consumers to rich-protein products from plants, algae or lab-grown meat would rapidly increase demand and reduce costs, helping producers achieve economies of scale while shifting social norms around meat consumption.

Growth in global meat consumption is expected to increase by 14% by the end of this decade, according to the Food and Agriculture Organization's 2021-2030 Outlook report, driving up GHG emissions. To counter this, the researchers estimate that putting non-meat proteins into public institutions could double its projected market share to 20% in 2035 and beat animal proteins on cost.

"This would free up an estimated ~400-800 million hectares of land from use for meat production, equivalent to 7-15% of total land currently dedicated to agriculture," the report says. This would leave more land available for natural carbon storage, easing pressure to clear forests for crop plantations and livestock pasture, and lowering emissions from methane-heavy livestock farming.

In Faassen's view, alternatives that "make it harder for 'the old,' tried and proven polluting technologies and processes to exist [will] create room for new, more fit-for-purpose processes to emerge."

The higher uptake in alternative proteins would require matching animal proteins on flavor and texture, the report says. But plant-based proteins, an industry valued at about $30 billion annually, are already well advanced technologically, the report adds.

To Lenton, this mandate is partly in the hands of governments. In countries like the U.K., he said, politicians "as a rule wouldn't go anywhere near telling people what they could or couldn't eat." But this isn't a lost cause, he added, as schools are proactively turning to plant-based foods. "We can make a clear evidence-based case in the

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)

health sector that eating less red meat is better for your health, let alone the planet," he said.

But like hydrogen, the fake meat market is only emerging.

"The general unpredictability of the underlying innovations these 'super-leverage points' ought to bring are the main challenges," Faassen said. "The issue with disruptive change is that, by its very nature, it is very difficult to … plan for."

'The super-super-leverage point'

Lenton, who calls himself "a mixture of an optimist and a pragmatist," said he was upbeat on the renewables transition, since low-carbon power sources have started to shut down fossil fuel power stations even before their lifetimes are up.

For example, wind and solar accounted for a record one-fifth of the European Union's electricity in 2022, overtaking gas for the first time, according to a study published in January by the think tank Ember.

Lenton said the report's co-contributor, Simon Sharpe from the Climate Champions team, described the clean energy leverage option "as Sisyphus, who in the Greek mythology, has to push the boulder up the hill. When you're trying to change an energy source, you have to do some pushing the boulder up the slope, but at some point, you're going to get to the top of the hill where the boulder starts rolling down the other side into this new renewable energy world."

Then, as costs go down, incentives for further renewable electrification are bolstered. One straightforward idea: Lenton said public money for fossil fuel extraction subsidies and tax credits could be shifted "more decisively" toward renewables.

"That's perhaps the 'super-super-leverage point': private and public movements of capital just to push the renewables transition ever quicker," he said.

"Change is going to be messy and chaotic," Faassen said, "and we're definitely not going to do it right. This doesn't mean, however, that it is impossible and not going to happen."

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Direct Air Capture: Is it finally gaining momentum?

ALICE MASILI
ONE

Climate change caused by greenhouse gas (GHG) emissions, mainly carbon dioxide (CO2), is progressing rapidly and has reached dangerous levels. The latest Intergovernmental Panel on Climate Change (IPCC) report reminds us that "multiple, feasible and effective options to reduce greenhouse gas emissions and adapt to human-caused climate change" are available now.

Negative emission technologies (NETs) can no longer be a last resort. They are crucial to offsetting sectors that are hard to decarbonize.

CO2 emissions can be captured from point sources such as the exhaust of conventional power plants or cement factories. Some plants are too old to be retrofitted, and in any case, average capture rates range from 50% to 94%. Also, emissions, such as long-haul aviation and shipping, cannot be captured. Large amounts of small emitters, such as those from the transportation sector, which account for 50% of global greenhouse gas emissions, cannot be neutralized with conventional CO2 capture applications. This is why we must find other solutions capable of capturing CO2, regardless of origin or location.

Capturing CO2 directly from the atmosphere is one. What plants naturally do. However, they need to catch up with growing anthropogenic emissions. Afforestation, bioenergy with carbon capture and storage (BECCS), and enhanced rock weathering have been introduced to reduce atmospheric CO2 concentrations. However, their potential impact on fixing the problem is limited. BECCS and large-scale reforestation threaten biodiversity, water and food security, as both require large amounts of land. Increased weathering of rocks raises the pH in rivers and alters ocean chemistry.

Direct air capture (DAC) is a relatively new technology still at an early commercial stage. Capturing CO2 from the air is very energy and cost-intensive, given the extreme dilution of this gas in the air. But it can help humanity control and mitigate climate change in the long term, along with conventional technologies.

DAC extract CO2 from ambient air anywhere on Earth. This is possible because CO2 is almost uniformly distributed in outdoor air worldwide, with a current average concentration of 405.5 parts per million and rising (World Meteorological Organization, 2019).

Today, Direct Air Capture technologies remove thousands of tons of CO2 annually. However, reaching the required scale by 2050 will take annual growth rates of nearly 50%. Unfortunately, capturing CO2 from the air is very energy and cost-intensive, given the extreme dilution of this gas in the air.

Only a few companies develop and deploy different direct air capture technologies with a solid commercial view.


Photo credit: Climeworks

Carbon Engineering is the first commercial company to pursue solvent DAC technology. The approach is based on a potassium hydroxide solvent combined with a calcium leach recovery loop. In 2015, Carbon Engineering built the first pilot-scale DAC plant in Canada. Between 2019 and 2021, a demonstration plant in Canada was designed and built.

Carbon Engineering plans to work with Oxy Low Carbon Ventures to finalize design plans for a plant in the Permian Basin. This project would capture and store up to 1 million tons of CO2 annually. In addition, Carbon Engineering is working with Pale Blue Dot in the United Kingdom.

Global Thermostat (GT) is a company based in the United States. Founded in 2010, GT currently has two DAC pilot plants with the potential to capture 3000-4000 tons of CO2 per year. Global Thermostat has partnered with ExxonMobil to develop its technology into a plant capable of capturing one million tons of CO2 annually.

Their process focuses on using process heat to regenerate the sorbent after capture. The capture process is followed by a CO2 capture system for various potential applications: reliable geological sequestration, biofuels, or non-combustible products such as fertilizers or building materials.

Climeworks was founded in Switzerland in 2009 and developed the first working prototype of its DAC technology in 2013. Climeworks' technology is based on an adsorption/desorption process on alkaline functionalized adsorbents. Depending on environmental conditions, especially relative humidity, the current process can also recover H2O as a by-product from the air. In 2017, the first commercial DAC plant kicked off. Two years later, Climeworks opened its first carbon removal service for individual customers. The Suisse company has publicly set a goal of removing 225 million metric tons of CO2 from the atmosphere by 2025, or about 1% of total global emissions.

The first and largest direct airborne carbon capture and storage facility started operation in 2021. Orca, as it is called, consists of eight collection tanks, each with an annual intake capacity of 500 tons. The Hellisheidi geothermal power plant in Iceland supplies the required heat and electricity.

CarbonCapture Inc is an American company that plans to build an air pollution control plant. Project Bison will be the world's largest carbon dioxide removal facility, aiming to remove 5 million tons of CO2 from the atmosphere annually by 2030, surpassing Iceland's Orca facility.

Project Bison is being developed in Wyoming, which produces the most significant amount of CO2 nationwide due to the coal-fired power plants' emissions.

When atmospheric capture begins in late 2023, the CO2 will be injected into wells for permanent storage in deep saline aquifers.

Conditionality mechanisms and the green transition: the case of EU funding for Poland

The dispute over the rule of law between Poland's government and the European Commission culminated in a recent announcement by EU officials to block funds for Poland. The country's authorities must take the Commission's reservations seriously and address them immediately. Meanwhile, they must start implementing investments planned in the cohesion policy programmes as soon as possible to better address the challenges posed by the climate and energy crises.

KRZYSZTOF MROZEK

Bankwatch.org

The current EU budget for 2021 to 2027 is unique not only because it has been boosted by the NextGenerationEU facility, which aims to speed up the post-pandemic recovery of EU economies in a sustainable and just way. For the first time, this funding structure also includes conditionality mechanisms designed to ensure compliance with the rule of law as applied by the European Commission.

For years, experts and media have claimed that this could lead to the suspension or even removal of EU funds for countries such as Poland and Hungary, a prophecy that has indeed been fulfilled in both cases. Let us look at the Polish example – has Poland definitively lost hundreds of billions of euros from the cohesion policy? And if so, can programmes aimed at scaling up the green transition still be implemented in spite of this?

Stories about EU funds have flooded Polish media in recent months. The public is slowly getting used to headlines like 'There will be no recovery money!' and 'EU funds will not come to Poland!', although decision makers in Warsaw and Brussels aren't happy about this messaging.

This is a topic of conversation not only for politicians, journalists and local government officials, but also for many concerned citizens who either want to apply for EU co-financing for their planned activities or want to see investments implemented in their neighbourhood. The conflict between the Polish government and EU institutions over the country's violation of the rule of law is escalating, hence the emergence of theories about how this will affect EU payments to Poland.

The most important question remains: will the flagship FEnIKS (European Funds for Infrastructure, Climate, Environment) programme rise from the ashes like its mythical namesake and make sure investments go where they should?

Suspension of funds

In the eyes of the European Commission and the EU courts, Poland has violated EU treaties by undermining the judiciary's independence in several reforms adopted since 2015.1 This has significant consequences, and not only in terms of fines that the Polish government has to pay for not respecting the European Court of Justice's rulings, although these fines al-

The Berlaymont building, headquarters of the European commission (Brussels, Belgium). Photo credit: Nuno Nogueira

ready amount to nearly EUR 400 million. This amount could fund 100 new windmills or 35,000 heat pumps to replace old coal boilers.2 But this is still a tiny percentage of the money Poland could lose if it does not comply with the rulings.

Independent courts are crucial for protecting investments and competitiveness. It's especially important for them to remain independent to ensure that EU funds are spent properly. The national recovery and resilience plan and structural funds from the Cohesion Policy amount to almost EUR 112 billion (an additional EUR 22.7 billion can still be requested from the loan part of the recovery plan, with the chance of an extra EUR 2.76 billion in grants under the REPowerEU programme).

Conflict around the judiciary structure was one of the reasons why the European Commission delayed approving the recovery plan. Once it was finally greenlighted, the president of the European Commission, Ursula von der Leyen, assured the concerned European Parliament that no funds from the recovery fund would flow to Poland until the rule of law milestones were fulfilled.

Soon after the approval of the recovery plan, the European Commission and Poland agreed on the country's Partnership Agreement – a roadmap for spending over EUR 76 billion in funding under the cohesion policy. However, in early October, Marc Lemaitre, director general for regional policy at the European Commission, announced that Poland would not yet receive these funds either. This is because Poland failed to meet the horizontal enabling condition regarding the efficient application and implementation of the Charter of Fundamental Rights. Enabling conditions are critical features of the legal and policy environment in each Member State that must be fulfilled before any disbursement can be made.3 Among them are those concerning fundamental rights, as well as the adoption of sectoral strategies, such as building renovation. The wi-

The EU programmes for Poland have been approved; the money is ready to flow, but will only do so once the government meets the required conditions.

thholding of all cohesion policy funding (except for a small pre-financing figure of around one per cent) is unprecedented in Poland's time as a member of the EU.

Is the alarm pure exaggeration?

The current situation, however, does not necessarily imply that funds allocated to Poland have been irreversibly lost, nor that the planned investments must be thrown away. Both recovery and cohesion funding rely on refinancing expenditures that investors must make first. The beneficiaries receive funding from the Polish administration, then the government requests refinancing from the European Commission, which is conditional upon fulfilment of the previously agreed-upon criteria (milestones and targets for recovery funding, enabling conditions for the cohesion policy). To date, Poland has received only a pre-payment for administration and technical assistance purposes.

Considering the rules of settling expenses from EU funds and the government's declarations that 'work on meeting the enabling conditions is ongoing, and the matter will be settled quickly', alarmist critiques saying that these funds have already disappeared are exaggerations. The EU programmes for Poland have been approved; the money is ready to flow, but will only do so once the government meets the required conditions.

All formal steps related to implementing the programmes should now be carried out. First and foremost, monitoring committees should be appointed in line with the partnership principle. They should include representatives of independent non-governmental organisations, which will prepare the first calls for proposals alongside the authorities and other stakeholders. This partnership framework is one of the safeguards in place to ensure the funds are not misused.

The appointing procedure of the monitoring committees guarantees the representation of at least one environmental organisation on each committee. To date, most of the committees of national programmes have been appointed in a transparent and inclusive process, with only minor violations reported. However, significant violations of the partnership principle have been observed at the regional level, where as of January 2023, the selection procedure remains ongoing. Work on calls for proposals must begin shortly so that the implementation of investments financed from the EU budget for 2021 to 2027 can start in full in 2023.

'All quiet on the Western Front'?

While the problem is by no means unsolvable, there are multiple reasons why the messages from the European Commission about withholding EU funds for Poland shouldn't be underestimated.

First, the trajectory of reforms in the Polish judiciary suggests a significant risk that the enabling conditions won't be met in the next few years. Although the government's recent actions offer some hope that violations of the rule of law will be at least partially remedied, Poland's failure to apply the Charter of Fundamental Rights is broader and goes beyond the judiciary (it also concerns the discrimination against minorities). Tensions within the ruling right-wing coalition raise concerns about whether the issue can be resolved.

If the government fails to meet the conditions, expenditures have already been incurred from cohesion policy programmes and the recovery plan may not be reimbursed. And if the EU doesn't pay, then those funds will come from the state budget, which is funded by Polish taxpayers.

Second, there are concerns of a 'chilling effect' among potential beneficiaries. Confidence in the stability and predictability of EU funding has been undermined. Some potential beneficiaries who would like to implement projects with EU funding may withdraw from these plans for fear that they will not be reimbursed. Another issue is that banks that offer cheap bridge loans for EU funding beneficiaries (which allow beneficiaries to cover expenditures until they're eligible for reimbursement) may become stricter due to the increased risks. Therefore, some investors may be unable to gather sufficient funding for their investments.

Third, focusing on the public debate around European funds by asking whether there will be EU funding shifts attention

away from an equally important question: what will be financed? What will Poland spend over EUR 110 billion on?

What is at stake?

Cohesion policy funds, with their required climate allocation of no less than 30 or 37 per cent (depending on the source) are vital for Poland's green transition. Billions of euros have been earmarked for increasing energy efficiency, deploying renewables and adapting to climate change.

From the beginning, Polish Green Network has been involved in preparing the EU's largest operational programme, FEnIKS, in which the EUR 24.2 billion budget focuses on the green transition. The first drafts of the programme raised many objections: transformative ambition was low, and the business-as-usual approach prevailed (spend a lot and quickly, preferably on large infrastructural projects). Huge sums were earmarked for highways and fossil gas investments, with very little dedicated to biodiversity protection.

However, the programme was significantly improved thanks to the involvement of civil society partners in the programming process. Polish Green Network and Fridays for Future Poland jointly submitted nearly 50 comments to FEnIKS as part of official public consultation process, with dozens more submitted within the working group and sent directly to the Ministry of Funds and the European Commission. As a result, the allocation for biodiversity protection and restoration was doubled and support for energy communities and climate educational measures was included in the programme.

In the latest version of FEnIKS approved by the European Commission, over EUR 2 billion has been allocated to increasing energy efficiency, mainly through the flagship Clean Air programme. Alongside this, almost EUR 540 million has been earmarked for renewable energy sources and EUR 310 million for the protection of biodiversity. Further billions for the green transition have been reserved in 16 regional programmes prepared by provincial governments.

What needs to be improved?

However, improvements to FEnIKS and other cohesion policy programmes are still needed. Support for any investments harmful to the climate and the environment should be dropped entirely. These include river regulation (up to EUR 200 million earmarked) and gasification of the energy and heating sector (district and individual heating), with over EUR 900 million planned for gas investments.

Even if this is improved, assessing the impact of Poland's main programme for EU funds on its contribution to meeting EU climate objectives would be difficult due to poor indicators. There is, for example, no indicator for the overall reduction of greenhouse gas emissions as a result of the programme's implementation. More specific output and result indicators also need to show improvements in energy efficiency, adaptation to climate change and biodiversity protection. Those currently included in the programme4 do not allow for a thorough assessment of the quality of climate-related spending.

The 2021 to 2027 budget – fortified with the recovery funding – is likely to be the last that of its size, especially if EU economies do not improve their sustainability and resilience. As such, it should be spent responsibly and efficiently. The challenges posed by the worsening climate and energy crises require a change in how public investment priorities are considered.

Poland desperately needs EU funding. Without reducing the demand for energy in the building sector, installing new renewable energy sources and climate education activities included in FEnIKS projects, the distance between Poland and western Europe will increase. Vast emissions of greenhouse gases will also deepen the impacts of the climate crisis on human health and biodiversity, as well as negatively impacting several economic sectors, making Poland a pariah among developed countries and forcing citizens to pay horrendous energy bills.

This is why the flow of EU funds to Poland and ambitious climate spending must be ensured. It is a challenging but not impossible task.

Withholding EU funds for Poland serves as a lesson for the entire EU. We already know that conditionality mechanisms work and that the European Commission is determined to apply them when deemed necessary. But we still need to learn how they will affect the green transition in one of the largest and most delayed EU Member States.

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Wanted (by Scientists): Dead Birds and Bats, Felled by Renewables

Collecting, studying, and storing the carcasses from wind and solar facilities, scientists say, can unlock new insights.

EMMA FOEHRINGER MERCHANT

Undark

"This is one of the least smelly carcasses," said Todd Katzner, peering over his lab manager's shoulder as she sliced a bit of flesh from a dead pigeon lying on a steel lab table. The specimens that arrive at this facility in Boise, Idaho, are often long dead, and the bodies smell, he said, like "nothing that you can easily describe, other than yuck."

A wildlife biologist with the U.S. Geological Survey, a government agency dedicated to environmental science, Katzner watched as his lab manager rooted around for the pigeon's liver and then placed a glossy maroon piece of it in a small plastic bag labeled with a biohazard symbol. The pigeon is a demonstration specimen, but samples, including flesh and liver, are ordi-

Interactions between wind turbines and birds.

narily frozen, catalogued, and stored in freezers. The feathers get tucked in paper envelopes and organized in filing boxes; the rest of the carcass is discarded. When needed for research, the stored samples can be processed and sent to other labs that test for toxicants or conduct genetic analysis.

Most of the bird carcasses that arrive at the Boise lab have been shipped from renewable energy facilities, where hundreds of thousands of winged creatures die each year in collisions with turbine blades and other equipment. Clean energy projects are essential for confronting climate change, said Mark Davis, a conservation biologist at the University of Illinois at Urbana-Champaign. But he also emphasized the importance of mitigating their effects on wildlife. "I'm supportive of renewable energy developments. I'm also supportive of doing our best to conserve biodiversity," Davis said. "And I think the two things can very much coexist."

To this end, Katzner, Davis, and other biologists are working with the renewable energy industry to create a nationwide repository of dead birds and bats killed at wind and solar facilities. The bodies hold clues about how the animals lived and died, and could help scientists and project operators understand how to reduce the environmental impact of clean energy installations, Davis said.

The repository needs sustained funding and support from industry partners to supply the specimens. But the collection's wider potential is vast, Davis added. He, Katzner, and other stakeholders hope the carcasses will offer a wide array of wildlife biologists access to the animal samples they need for their work, and perhaps even provide insights into future scientific questions that researchers haven't thought yet to ask.

In 1980, California laid the groundwork for one of the world's first large-scale wind projects when it designated more than 30,000 acres east of San Francisco for wind development, on a stretch of land called the Altamont Pass. Within two decades, companies had installed thousands of wind turbines there. But there was a downside: While the sea breeze made Altamont ideal for wind energy, the area was also well-used by nesting birds. Research suggested they were colliding with the turbines' rotating blades, leading to hundreds of deaths among red-tailed hawks, kestrels, and golden eagles.

"It's a great place for a wind farm, but it's also a really bad place for a wind farm," said Albert Lopez, planning director for Alameda County, where many of the projects are located. A 2004 report prepared for the state estimated deaths and offered recommendations that the authors said could add up to mortality reductions of anywhere from 20 to 50 percent. The most effective solution, the authors argued, involved replacing Altamont's many small turbines with fewer larger

For the last decade, Katzner has also researched how birds interact with energy installations like wind and solar projects. During this time, studies have estimated that hundreds of thousands of birds die each year at such facilities in the United States.

turbines. But, the authors wrote, many measures to reduce deaths would be experimental, "due to the degree of uncertainty in their likely effectiveness." More than a decade of research, tensions, and litigation followed, focused on how to reduce fatalities while still producing clean electricity to help California meet its increasingly ambitious climate goals.

While all this was happening, Katzner was earning his Ph.D. by studying eagles and other birds — and beginning to amass a feather collection halfway around the world. In Kazakhstan, where he has returned nearly every summer since 1997 to conduct field research, Katzner noticed piles of feathers underneath the birds' nests. Carrying information about a bird's age, sex, diet, and more, they were too valuable a resource to just leave behind, he thought, so he collected them. It was the start of what he describes as a compulsion to store and archive potentially useful scientific material.

Katzner went on to co-publish a paper in 2007, in which the researchers conducted a genetic analysis of naturally shed feathers, a technique that could allow scientists to match feather samples with the correct bird species when visual identifications are difficult. He later towed deer carcasses across the East Coast to lure and trap golden eagles in order to track their migration patterns. And today, part of his research involves testing carcasses for lead and other chemicals to understand whether birds are coming in contact with toxicants.

For the last decade, Katzner has also researched how birds interact with energy installations like wind and solar projects. During this time, studies have estimated that hundreds of thousands of birds die each year at such facilities in the United States. Thats's still a small fraction of the millions of birds that at least one paper estimated are killed annually due to habitat destruction, downstream climate change, and other impacts of fossil fuel and nuclear power plants. But renewable energy is growing rapidly, and researchers are trying to determine how that continued growth might affect wildlife. Bats seem attracted to spinning wind turbines, sometimes being struck by the blades while attempting to roost in the towers. Birds sometimes swoop down and crash into photovoltaic solar panels — possibly thinking the glass is water that is safe for landing. A separate, less common solar technology that uses mirrors to concentrate the sun's rays into heat energy is known to singe birds that fly too close — a factor that has drawn opposition to such facilities from bird activists. But scientists still don't fully understand these many interactions or their impacts on bird and bat populations, which makes it harder to prevent them.

In 2015, by then on staff at the USGS, Katzner and a team of other scientists secured $1 million from the California Energy Commission to study the impacts of renewable energy on wildlife — using hundreds of carcasses from the Altamont Pass. NextEra Energy, one of the largest project owners there, chipped in a donation of approximately 1,200 carcasses collected from their facilities in Altamont.

The team analyzed 411 birds collected over a decade at Altamont and another 515 picked up during a four-year period at California solar projects. They found that the birds originated from across the U.S., suggesting renewable facilities could affect far away bird populations during their migrations. In early 2021, Katzner and a team of other scientists published a paper examining specimens collected at wind facilities in Southern California. Their results suggested that replacing old turbines with fewer, newer models did not necessarily reduce wildlife mortality. Where a project is sited and the amount of energy it produces are likely stronger determinants of fatality rates, the authors said.

In the Altamont, scientists are still working to understand impacts for birds and bats, with a technical committee created to oversee the work. Ongoing efforts to replace old turbines with newer ones are meant to

reduce the number of birds killed there, but whether it's working remains an open question, said Lopez. Installing fewer turbines that produce more energy per unit than earlier models was expected to provide fewer collision points for birds and more space for habitat. And when new turbines are put in, scientists can recommend spots within a project site where birds may be less likely to run into them. But other variables influence mortality aside from turbine size and spacing, according to the 2021 paper authored by Katzner and other scientists, like season, weather, and bird behavior in the area.

On a small road in the Altamont, a white sign marks an entrance to NextEra's Golden Hills wind project, where the company recently replaced decades-old turbines with new, larger models. Not far away, another wind project sits dormant — a relic from another time. Its old turbines stand motionless, stocky, and gray next to their graceful, modern successors on the horizon. The hills are quiet except for the static buzz of power cables.

Some conservationists are still concerned about the area. In 2021, the National Audubon Society, which says it strongly supports renewable energy, sued over the approval of a new wind project in the Altamont, asserting that the county didn't do enough environmental review or mitigation for bird fatalities.
Katzner attributes his work in California with the beginnings of the repository, which he's dubbed the Renewables-Wildlife Solutions Initiative. Amy Fesnock, a Bureau of Land Management wildlife biologist who collaborates with Katzner, simply calls it the "dead body file."

In Idaho, Katzner has already amassed more than 80,000 samples — many drawn from the feather collection he's kept for decades, and thousands more recently shipped in by renewable energy companies and their partners. Ultimately, Katzner would like to see a group of repository locations, all connected by a database. This would allow other scientists to access the bird and bat samples and use them in a variety of ways, extracting their DNA, for example, or running toxicology tests.

"Every time we get an animal carcass, it has value to research," said Katzner. "If I think about it from a scientific perspective, if you leave that carcass out there in the field, you're wasting data."

That data is important to people like Amanda Hale, a biologist who helped build the repository while at Texas Christian University. She is now a senior research biologist at Western Ecosystems Technology, a consulting company that, along with providing other services, surveys for dead wildlife at renewable energy sites. Part of her new role involves liaising with clean energy companies and the government agencies that regulate them, making sure decision makers have the most current science to inform projects. Better data could assist clients in putting together more accurate conservation plans and help agencies know what to look for, she said, making regulation more straightforward.

"Once we can understand patterns of mortality, I think you can be better in designing and implementing mitigation strategies," said Hale.

The initiative is not without its skeptics, though. John Anderson, executive director of the Energy and Wildlife Action Coalition, a clean energy membership group, sees merit in the effort but worries that the program could be "used to characterize renewable energy impacts in a very unfavorable light" without recognizing its benefits. The wind industry has long been sensitive to suggestions that it's killing birds.

Several renewable energy companies that Undark contacted for this story did not respond to inquiries about wildlife monitoring at their sites or stopped responding to interview requests. Other industry groups, including the American Clean Power Association and the Renewable Energy Wildlife Institute, declined interview requests. But many companies appear to be participating — in Idaho, Katzner has received birds from 42 states.

William Voelker, a member of the Comanche Nation who has led a bird and feather repository called Sia for decades, says he's frustrated at the lack of consideration for tribes from these types of U.S. government initiatives. Indigenous people, he said, have first right to "species of Indigenous concern." His repository catalogs and sends bird carcasses and feathers to Indigenous people for ceremonial and religious purposes, and Voelker also cares for eagles.

"At this point we just don't have any voice in the ring, and it's unfortunate," said Voelker.

Katzner, for his part, says he wants the project to be collaborative. The Renewable-Wildlife Solutions Initiative has sent some samples to a repository in Arizona

that provides feathers for religious and ceremonial purposes, he said, and the RWSI archive could ship out other materials that it does not archive, but it has not yet contacted other locations to do so.

"It's a shame if those parts of birds are not being used," he said. "I'd like to see them get used for science or cultural purposes."

Many U.S. wind farms already monitor and collect downed wildlife. At a California wind facility an hour north of Altamont, the Sacramento Municipal Utility District tries to clear out its freezers at least once per year — before the bodies start to smell, said Ammon Rice, a supervisor in the government-owned utility's environmental services department. The specimens that companies accumulate are often kept until they're thrown out. Until recently, samples had been available to government and academic researchers on only a piecemeal basis.

Photo credit: Dennis Schroeder (National Renewable Energy Laboratory - NREL)

There are many reasons why a clean energy company might employ people to pick up dead animals at its facility: Some states require companies to survey sites during certain stages of their development and keep track of how many birds and bats are found dead. Removing the carcasses can also deter scavengers, such as coyotes, foxes, and vultures. And the federal government has set voluntary conservation guidelines for wind projects; for some companies, complying with the recommendations is part of maintaining good political relationships.

Most of the time, human searchers canvas a project, walking transects under turbines or through solar fields. It's "enormously labor intensive," said Trevor Peterson, a senior biologist at Stantec, one of the consulting firms often hired to conduct those surveys.

On some sites, trained dogs sniff out the dead bodies. For years, conservation biologists have wanted to find a use for the creatures languishing in freezers at clean energy sites around the country. To get a nationwide project off the ground, Katzner started working with two other researchers: Davis, the conservation biologist at University of Illinois, and Amanda Hale, then a biology professor at Texas Christian University. They were part of a small community of people "who pick up dead stuff," said Katzner. The three started meeting, joined by scientists at the Bureau of Land Management and the U.S. Fish and Wildlife Service, who helped connect the initiative with additional industry partners willing to send carcasses.

Building on Katzner's existing samples, the repository has grown from an idea to a small program. In the last two years, it received about $650,000 from the Bureau of Land Management and earned a mention in the agency's recent report to Congress about its progress towards renewable energy growth.

Davis had already been accepting samples from wind facilities when he started working on the repository. Often the bodies are mailed to his laboratory, but he prefers to organize hand-to-hand deliveries when possible, after one ill-fated incident in which a colleague received a shipped box of "bat soup." To receive deliveries in person, Davis often winds up loitering in the university parking lot, waiting for the other party to arrive so they can offload the cargo.

"It sounds a lot like an illicit drug deal," said Davis. "It looks a lot like an illicit drug deal — I assure you it is not."

Recently, Ricky Gieser, a field technician who works with Davis, drove two and a half hours from Illinois

to central Indiana to meet an Ohio wildlife official in the parking lot of a Cracker Barrel. Davis arranged for Undark to witness the exchange through Zoom. With latex-gloved hands, Gieser transferred bags of more than 300 frozen birds and bats — lifting them from state-owned coolers and then gingerly placing them into coolers owned by his university. The entire transaction was over in under 15 minutes, but coordinating it took weeks.

Davis studies bats and other "organisms that people don't like," with a focus on genetics. He grew up in Iowa chasing spiders and snakes and now stores a jar of pickled rattlesnakes — a souvenir from his doctoral research — on a shelf behind his desk. Protecting these creatures, he said, is of extreme importance. Bats provide significant economic benefit, eating up bugs that harm crops. And their populations are declining at an alarming rate: A disease called white-nose syndrome has wiped out more than 90 percent of the population of three North American bat species in the last decade. In late November of 2022, the U.S. Fish and Wildlife Service listed Davis's favorite species, the northern long-eared bat, as endangered.

For certain species, deaths at wind facilities are another stressor on populations. Scientists expect climate change to make the situation worse for bats and overall biodiversity. "Because of this confluence of factors, it's just really tough for bats right now," said Davis. "We need to work a lot harder than we are to make life better for them."

Like other wildlife researchers, Davis has sometimes struggled to get his hands on the specimens he needs to track species and understand their behaviors. Many spend time in the field, but that's costly. Depending on the target species, acquiring enough animals can take years, said Davis. He used museum collections for his doctoral dissertation, and still views them as an "untapped font of research potential." But museums often focus on keeping samples intact for preservation and future research, so they may not work for every project.

That leaves salvage. Frozen bird and bat carcasses are "invaluable" to scientists, said Fesnock, the BLM wildlife biologist. So far, samples collected as part of the Renewables-Wildlife Solutions Initiative have led to about 10 scientific papers, according to Katzner. Davis says the collection could reduce research costs for some scientists by making a large number of samples available, particularly for species that are hard to collect. It's difficult for scientists to catch migratory bats that fly high in the air with nets, making it challenging to estimate population levels. Bat biologists say there's much we still don't know about their behaviors, range, and number.

As scientists work to compile better data, a few companies are experimenting with mechanization as a possible way to reduce fatalities at their facilities. At a wind farm in Wyoming, utility Duke Energy has installed a rotating camera that resembles R2D2 on stilts. The technology, called IdentiFlight, is designed to use artificial intelligence to identify birds and shut turbines down in seconds to avoid collisions.

Prior to IdentiFlight, technicians used to set up lawn chairs amid the 17,000-acre site and look skyward, sometimes eight hours a day, to track eagles. It was an inefficient system prone to human error, said Tim Hayes, who recently retired as the utility's environmental development director. IdentiFlight has reduced eagle fatalities there by 80 percent, he added. "It can see 360 degrees, where humans can't, and it never gets tired, never blinks, and never has to go to the bathroom."

Biologists say there are still unknowns around the efficacy of these types of technologies, in part because of incomplete data on the population size and spread of winged wildlife.

Katzner and his colleagues want the repository to help change this, but first they will need long term funding to help recruit more partners and staff. Davis estimated he needs between $1 and $2 million to build a sustainable repository at his university alone. Ideally, the USGS portion of the project in Boise would have its own building. For now, Katzner stores feathers in a space that doubles as a USGS conference room. Next door, in a room punctuated with a dull hum, the walls are lined with freezers. Some carry samples already cataloged. Others hold black trash bags filled with bird and bat bodies just waiting to be processed.

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Trailblazing Hydrogen Plant Could 'Cannibalize' Green Power from Nova Scotia Grid

CHRISTOPHER BONASIA

The Energy Mix

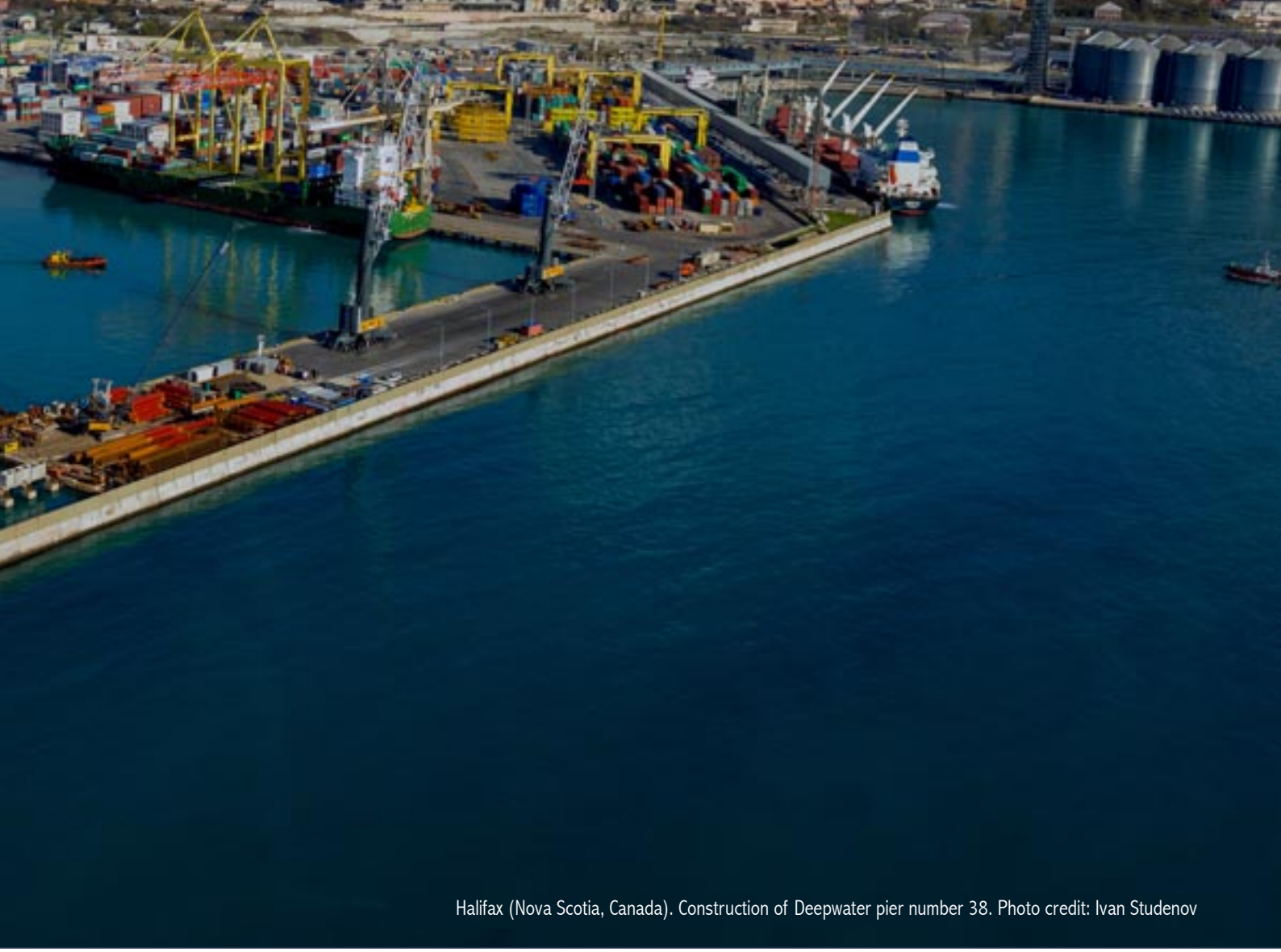
Nova Scotia has approved plans for what could be North America's first commercial-scale green hydrogen facility, amid lingering concerns that powering the plant could cannibalize renewable energy that's vital to meeting the province's climate goals.

Early in February, Nova Scotia Environment and Climate Change (ECC) Minister Timothy Halman conditionally approved EverWind Fuels LLC's environmental assessment for its Point Tupper green hydrogen project. The facility will produce and export 200,000 tonnes of hydrogen per year to the European Union by 2025, according to proposals for the first phase of the project. Construction is set to begin this spring.

"I am satisfied that any adverse effects or significant environmental effects of the undertaking can be adequately mitigated through compliance with the attached terms and conditions," Halman wrote in his decision. The project remains subject to any other approvals required by statute or regulation, including those outlined in the province's Environment Act.

New EU green hydrogen certification rules that prominently feature "additionality" requirements will also apply to Canadian exporters like EverWind, which intends to draw energy from the local grid to power its facilities. The EU regulations are meant to ensure that any clean energy used to produce green hydrogen does not cause a net increase in emissions by diverting renewable resources from other sectors. Fuels can only be produced from "additional" renewable electricity generated at the same time and in the same area as their own production, but a transitory phase loosens these requirements for facilities producing hydrogen before 2028, drawing criticism from some advocates.

"Without additionality, hydrogen is a back door for coal and fossil gas," *Euractiv* wrote in 2021, when the European Commission first approached the issue.



Halifax (Nova Scotia, Canada). Construction of Deepwater pier number 38. Photo credit: Ivan Studenov

EverWind's facility is one of several emerging projects in Nova Scotia, including another green hydrogen development at Point Tupper proposed by Bear Head Energy. With the fuel take its place as an important element of Nova Scotia's clean energy strategy, how the producers meet EU additionality requirements will have a bearing on the province's progress toward decarbonizing its grid.

Power Sources in Question

EverWind says it will rely on power purchase agreements (PPAs) to supply energy for the plant during the project's first phase. The company has not yet applied for an environmental assessment for the second phase, in which hydrogen production will increase to one million tonnes per year, but EverWind says it plans to have new wind farms in operation by then. In December, EverWind announced a memorandum of understanding (MOU) to lease 137,000 acres (55,440 hectares) of Crown land to install a two-gigawatt onshore wind farm in Guysborough, NS. None of that land had been set aside for new renewable energy sources for Nova Scotia's grid, Patricia Jreige, Communications Advisor for Nova Scotia's Department of Natural Resources and Renewables, confirmed for The Energy Mix.

But the feasibility of EverWind's plans to source sufficient clean energy has raised questions. EverWind contested a reporting collaboration between *The Mix* and *Halifax Examiner* last fall, maintaining that it would source electricity from new wind and solar projects. The company fielded a similar inquiry by The Chronicle Herald on the feasibility of building a plant and raising an immense network of wind power within three years. "It is certainly very doable based on the windfarms we've got lined up to provide that," replied CEO Trent Vichie.

"We have risked a tremendous amount of money to put Nova Scotia in a first-mover position in the market," he added.

"Yes, we are probably moving a lot faster than we normally would, but we're doing it with a purpose."

EverWind's Point Tupper hydrogen project. Rendering credit: 3D Wave

But EverWind has not yet identified any specific sources of solar, wind, or other renewables for its first phase.

"Nova Scotia Power has confirmed the ability to verify/certify the origination of renewable energy sources, and is in advanced stages of sourcing specific wind renewable energy sources to power its first phase," Lynn Hammond, the company's vice president of corporate affairs, told *The Mix*. While procuring clean energy is critical to determining whether the hydrogen produced at the facility is "green," the province does not evaluate power supply in its environmental assessment process. That's because ECC's mandate is to work with industries and companies to ensure impacts on the environment are minimized, but not to "have a role with any company's business focus or scope," a departmental spokesperson said.

"The purpose of an environmental assessment is for companies to identify and address any potential impacts of its construction and operations on the environment."

'Certified Green' Hydrogen

The EU released an official legal definition of renewable hydrogen last month in a delegated act, a non-legislated measure mean to amend or update legislation quickly. The new definition will provide a basis for certifying renewable fuels of non-biological origin (RFNBOs) like hydrogen as green. While it may seem clear-cut to link a project's operations to clean energy sources, the specifics are important to make sure that "green hydrogen production does not cannibalize existing renewable energy generation, and instead operates under newly installed capacity," explains RenewEconomy.

The EU's additionality requirements cover two points. A facility producing an RFNBO must use power from a clean energy installation that came into operation no more than three years prior. And the clean energy source must not have received any form of operating or investment aid, with some exceptions.

But the EU definition allows exemptions for producers that start operation before January 1, 2028, a provision that has led to different interpretations from advocates and stakeholders. EverWind's Hammond said EU rules "do not

allow RFNBO producers to use power under PPAs with gas or coal power producers, even during the initial period in which slightly wider tests apply." She added that RFNBO producers will need to source all their power through renewables PPAs with energy suppliers, as opposed to local wind or solar farms, when the power is transmitted through the grid.

But Brussels-based Transport & Environment says the exemption allows "projects starting before 2028 to use electricity produced from coal and gas" if the vast amount of electricity needed to produce the fuel would divert renewables from local grids. Interpretations along this line hold that slack additionality requirements would result in hydrogen projects being powered by fossil fuels. A project may be certified green—with its independent operations powered by clean energy—but adding it to a grid could result in more fossil fuels being burned.

Nova Scotia's Decarbonization Plan

While the province is paving the way "for the production and use of green hydrogen as a clean energy source in Nova Scotia," it is also committed to reducing overall emissions and fuel consumption under the 2021 Environmental Goals and Climate Change Reduction Act.

The act outlines statutory obligations to cut emissions by 53% below 2005 levels, phase out all coal-fired electricity generation, and supply 80% of electricity from renewable sources by 2030.

Wind power will be an important part of the province's transition, but "there is limited land in Nova Scotia, much of which is already degraded, so we will have to be intentional about where wind power is generated," said Brenna Walsh, energy coordinator for the Ecology Action Centre.

That means wind resources must be prioritized for use in the province's current electricity system to replace coal and other fossil fuels, and to support the increase in grid capacity that will be needed as the province electrifies other sectors, Walsh said. She called on the province to undertake a comprehensive Crown land use planning process for wind farm construction, to avoid costs to Nova Scotia's ecosystems and biodiversity. "If these needs can be met without the other impacts, then uses for hydrogen generation could make sense to consider."

The role of hydrogen in Nova Scotia's energy strategy also raised questions for Ralph Torrie, research director at Corporate Knights, who co-authored two recent reports on how the province can accelerate its phaseout of coal, reduce its greenhouse gas emissions to tackle the climate emergency, and reach net-zero by 2050. In an interview last fall, he said moving the provincial grid off fossil fuels will mean "moving very heavily into wind power."

Rather than going all-in on hydrogen, Torrie continued, "it seems clear to me that the higher priority should be to use Nova Scotia wind to make affordable electricity for Nova Scotians. And it's going to be a very tight passage for Nova Scotia to get to a carbon-free system."

In a climate plan released last December, ECC notes that "having a reliable and clean source of electricity is important to help Nova Scotia respond to the demand for alternative sources of energy like green hydrogen."

The plan calls for the province to develop a green hydrogen action plan by 2023 and set aside five gigawatts of offshore wind by 2030 to support production of the fuel, with a call for bids in 2025.

"We will all need to hold the government accountable to these goals," said Walsh.

"As this transition occurs, working with government and other stakeholders to ensure that Nova Scotia transitions to a clean, reliable and affordable energy system will be key in our work, and is something that all Nova Scotians can push for."

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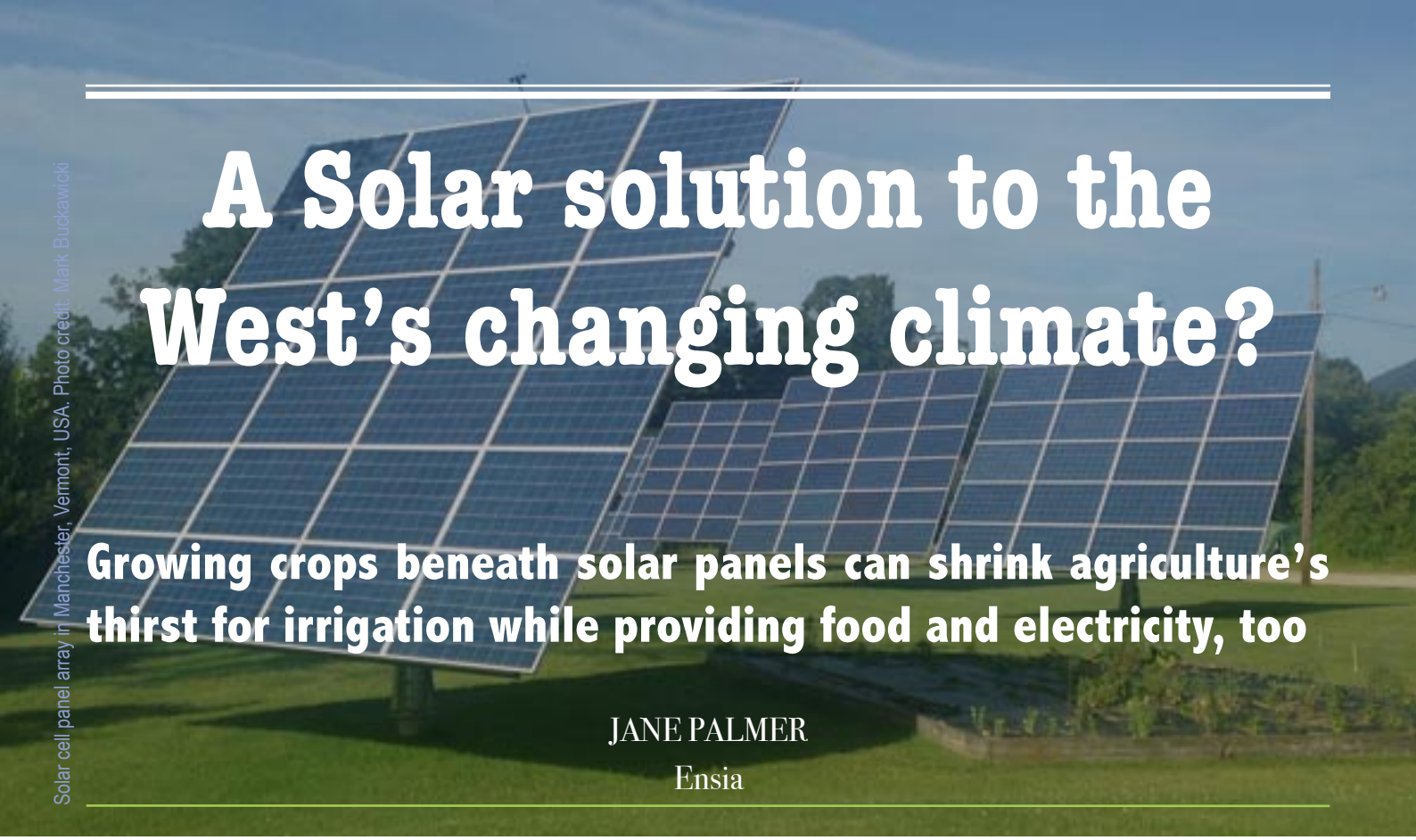

Solar cell panel array in Manchester, Vermont, USA. Photo credit: Mark Buckawicki

A Solar solution to the West's changing climate?

Growing crops beneath solar panels can shrink agriculture's thirst for irrigation while providing food and electricity, too

JANE PALMER
Ensia

The summer of 2022 was tough for farmers in the American West: Hot, dry conditions led snow to melt early, reservoirs to run low and streams to pare down to mere trickles. For many, that meant less water to grow crops and reduced yields. But Byron Kominek, a farm manager near Longmont, Colorado, enjoyed an abundant harvest of peppers, tomatoes, squash and lettuces.

When his family farm stopped making a profit, Kominek installed solar panels on the plot and invited Sprout City Farms to grow crops beneath them. It's a setup known as agrivoltaics — where solar panels and agriculture occupy the same land — and the duo effectively harvests the sun twice, for both food and electricity.

Protected from the high midday sun, plants under panels become mini swamp coolers: As they open their pores to photosynthesize, water escapes from their leaves — creating a cooler microclimate. This reduction in heat increases the efficiency of the panels — even as the panels are sheltering the crops beneath from overexposure to the hot sun. Consequently, agrivoltaics can provide benefits to both farmers and electricity producers. In the past few years another possible advantage has come to the fore: crops grown under panels need less water.

"If you spilled your water in the shade versus the sun, where would it stay wet longer?" asks Greg Barron-Gafford, a University of Arizona professor who has helped set up the site as well as experimental agrivoltaic plots in Arizona, Africa and Israel.

At one such site, Biosphere 2 near Oracle, Arizona, Barron-Gafford has found that some crops beneath solar panels only need watering every couple of days, compared to every few hours for those grown in direct sunlight. Agrivoltaic cherry tomatoes proved 65% more water efficient than those grown under an open sky, for example, and the total fruit production doubled. Researchers are now scrutinizing how different spacings of panels are impacting the water needs of a range of crops in the hot, dry climate of the Sonoran Desert.

Meanwhile, at Kominek's farm, now called Jack's Solar Garden and the largest commercially active agrivoltaics system in the United States, the same scientists are testing which crops thrive under panels in the varied seasons of Colorado.

Barron-Gafford believes agrivoltaics could be help farmers in the West who want to keep farming in the face of climate change. "We want to adapt our food system to survive through periods of drought and warmer temperature changes, and that comes down to easing our dependence on irrigation," he says.

Harvest Hacking

Against the backdrop of Sonoran Desert scrub on a sunny but chilly November morning, Nesrine Rouini tends to seedlings under a canopy of solar panels at the Biosphere 2 site. A mere 9- by 18-meter (30- by 59-foot) garden, the experimental agrivoltaics site resembles an intensive care unit for plants — stakes bearing barcodes identify each new sprout, and a network of cables and wires runs along each seedbed to a centralized data logger. This Gordian knot of leads and controls transmits real-time data of a

plant's living environment — soil moisture, temperature, solar radiation and a host of other variables — hour by hour to the research group in Tucson. Simultaneously, cameras track its growth from seedling to sprouting to flowering. A plant can't so much as open a stoma without its actions being spotted, relayed and recorded. Once a week, Rouini, an agrivoltaics researcher on Barron-Gafford's team, visits the site and a control plot, which is not under panels. Using a handheld gas exchange device, she takes the pulse of each plant and checks how well it's coping with the shade or open sky. "This is how we found out that plants in the control plot experience midday depression and don't photosynthesize," Rouini says. "While the ones under the panels keep trucking along."

Irrigation on both plots starts at 7 a.m. By 9 a.m. the control plot soil already appears drier to the naked eye than earth under the panels. "Without shade the water just evaporates so much quicker," Rouini says.

Basic physics dictates that crops grown under panels need less water, but scientists still don't know how each crop will fare in each location and exactly how much water will be saved. Consequently, in Arizona, Colorado and a network of nearly 30 sites around the country, groups of researchers are trying to close that data gap. Although scientists have studied the interaction between light and plants for decades, the novel shading regime of solar panels presents many unknowns, says Jordan Macknick, the lead energy-water-land analyst for the National Renewable Energy Laboratory and the principal investigator of the Innovative Solar Practices Integrated with Rural Economies and Ecosystems (InSPIRE) network of agrivoltaic sites. "The Holy Grail would be for any farmer to be able to pick a point on a United States map and retrieve information about what crops they could grow, the best configuration of panels and how much water they need," he says.

Focusing on Feasibility

In Colorado, Liza McConnell, Jack's solar research farm manager with Sprout City Farms, observed that the lettuces grown with half the amount of water administered to a control plot were only a little smaller and significantly sweeter than their sun-exposed equivalents.

Celery, typically a high-water-use crop, also fared well under a reduced watering regime, as did smaller peppers, but the larger Anaheim peppers under panels didn't produce as much fruit as hoped. With the West in a prolonged drought and climate change taking its toll, people might have to adapt to not getting the exact type of pepper they want all year round McConnell says.
"In the face of climate change we need all options on the table," she says. "Agrivoltaics is not the only solution, but it is going to be one of the things that will help keep our communities safe and resilient."

Despite its many benefits, agrivoltaics may not be feasible for large-scale, single-crop farms that grow corn and soybeans and rely on using heavy machinery. Farming under solar panels is even challenging for farmers on their feet: McConnell equates it to farming on an obstacle course. On the flip side, the panels provide much needed shade for farmers on hot days.

"We're producing energy, we're producing food, we're conserving water, and we're building soil health that further conserves water and nutrients," McConnell says. "And then we're also protecting necessary human labor and quality of life for farmworkers."

The yield of certain crops, specifically warm-season peppers and tomatoes, might also be less under panels in Colorado, McConnell says. But these fruits only ripen at certain temperatures; if it's too hot, they won't ripen at all. "So a reduced yield is still better than having no tomatoes in the face of climate change," she says. Macknick points out that the revenue that farmers can make by selling solar-generated power will more than compensate for any reductions in farm produce and that agrivoltaics could help farmers in the West and the Colorado River Basin be more financially resilient to droughts and climate change. Another potential benefit of agrivoltaics is that it could open more land to farming, including Indigenous lands where food security and energy access have been issues. In hot and dry desert lands, for example, growing crops under panels can reduce the need for scarce water and increase productivity and feasibility for farming efforts. "Can some of these places now produce food because we've taken off that harsh edge of the environment?" Macknick poses.

Agrivoltaics also offers the potential to harvest and store rain so it can be used for irrigation. Gutters attached to the bottom of solar panels can capture rain and channel it into small reservoirs. But challenges exist in the execution. In Tucson, for example, water simply flows off water panels and gets wasted. "It would be good to think about how to set up guttering on panels to collect water intentionally and do it the right way," Barron-Gafford says.

Large-scale agrivoltaics endeavors will face plenty of challenges, and they won't be right for every farmer, Macknick says. But there's potential to improve yields of some crops while enhancing soil health, reducing water needs and producing power, too. "It is certainly going to play a growing role in farming," Macknick says. "I think we are going to see more and more of this."

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LAST STAND

Photo credit: Drissbkd

Ahouli is an abandoned mining village in the remote Atlas mountain in Morocco. This lead mine is located on a valley along the Moulouya river. From 1928 Ahouli was one of the most important lead deposits in Morocco. The French company Penarroya ran the site until the 1960s, employing hundreds of Moroccan workers and producing tens of thousands of tons of lead annually. The mine exported its production to France until its closure in the 80s. ONE

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