

# ONE

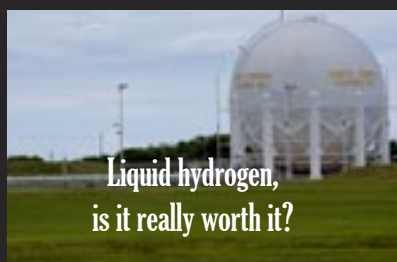
Only Natural Energy



## Progressing backwards



Soil, Fungi, Agriculture, and Climate Change



Liquid hydrogen, is it really worth it?



No Kiln in Making Soda



Beyond the Bin



CO2 Technology  
Centre of Sulcis

# SARDINIA Technology & Nature



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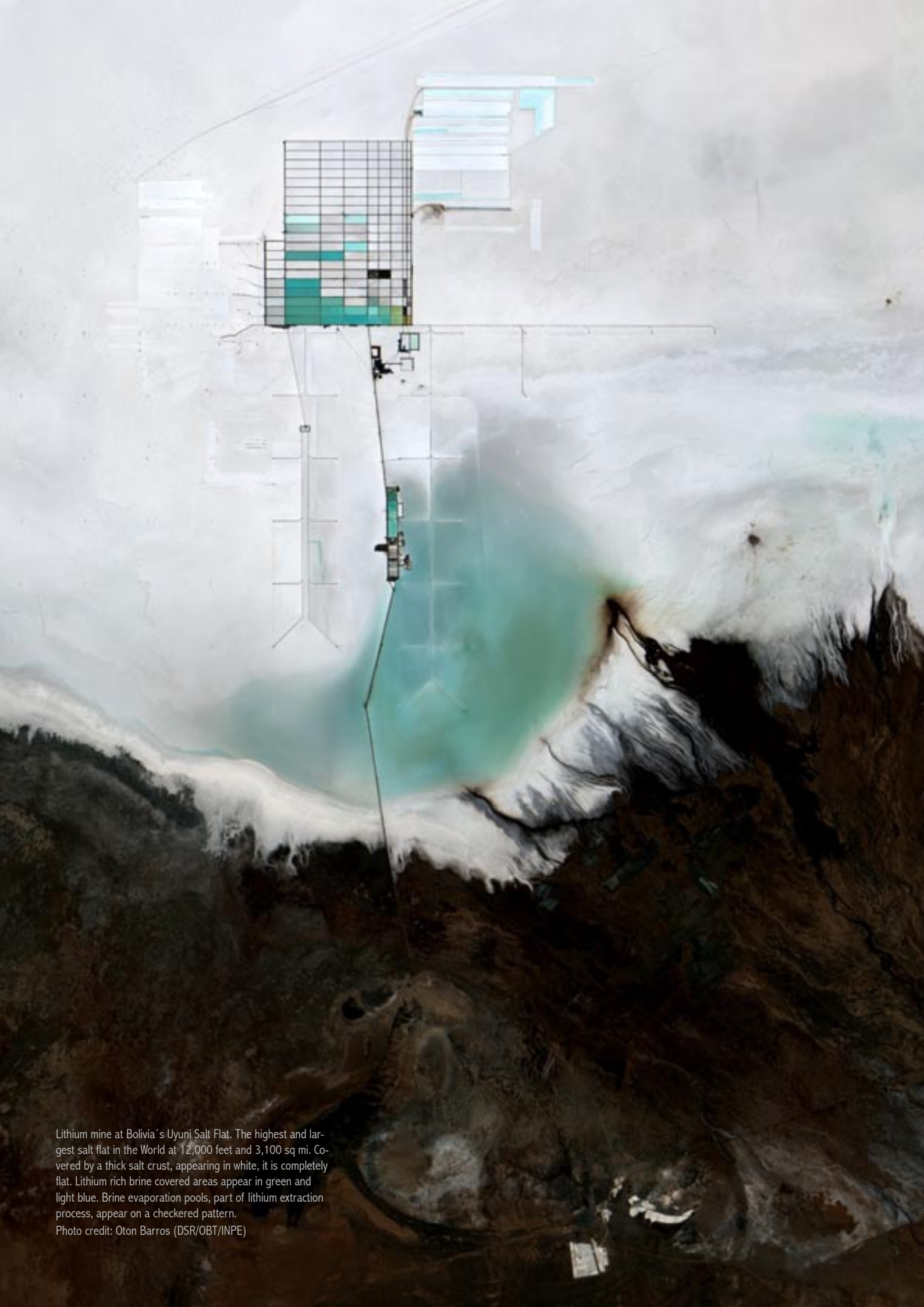
**Cover Photo:**  
 Local communities opposing lithium mining say the water is more valuable than the mineral used in batteries for smartphones and electric vehicles.  
 Photo credit: Richard Bauer/Dialogo Chino

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Lithium mine at Bolivia's Uyuni Salt Flat. The highest and largest salt flat in the World at 12,000 feet and 3,100 sq mi. Covered by a thick salt crust, appearing in white, it is completely flat. Lithium rich brine covered areas appear in green and light blue. Brine evaporation pools, part of lithium extraction process, appear on a checkered pattern.

Photo credit: Oton Barros (DSR/OBT/INPE)

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# Progressing backwards

GIANNI SERRA

ONE

"I thought fossil fuel firms could change. I was wrong." Christiana Figueres, the former Secretary of the United Nations Framework Convention on Climate Change, wrote recently for Al Jazeera. "I was convinced the global economy could not be decarbonised without their constructive participation and I was therefore willing to support the transformation of their business model. But what the industry is doing with its unprecedented profits over the past 12 months has changed my mind."

The year 2022 was a hugely gratifying period for oil companies. \$55.7bn in annual profit for Exxon; Chevron had a record \$36.5bn gain; \$27.7bn for BP and \$39.9bn for Shell - the best results of its 115-year history. In parallel, CO2 emissions kept rising. And it's difficult not to relate it to increasing investment in fossil fuels. A report released by research group Oil Change International found that French oil giant TotalEnergies used its record 2022 profits (\$36.2bn) to double its commitment to fossil fuels. No surprise. The scale of these profits are too large to stimulate a change of policy. Any company will only abandon this golden route if forced to do so.

This route might be paved with gold but only for an exclusive minority. Many more are the excluded who are paying the price for this excess. In May, the carbon dioxide levels measured at the U.S. National Oceanic and Atmospheric Administration's Mauna Loa Atmospheric Baseline Observatory peaked at 424 parts per million, an annual increase of 3.0 ppm. Two months later, on July 3, the world experienced the hottest day ever recorded, according to the United States National Center for Environmental Prediction data. This record is likely to be broken before you finish reading this article.

The supposed antidote is green tech based on renewable energy sources and increased electrification. But they are not issues-free: there is a mismatch between generation and timing of peak consumption; more land is required when less land is available; wind turbines, solar panels, and electric car batteries need the still mysterious but increasingly popular rare earths (the seventeen metallic elements essential to many high-tech devices) and other critical minerals such as copper, nickel, cobalt and lithium. According to the International Energy Agency's first annual Critical Minerals Market Review, the market for these minerals has doubled over the past five years. From 2017 to 2022, the energy sector was the main factor behind a tripling of overall lithium demand. More than 75 per cent of the world's lithium supply lies beneath Chile, Argentina, and Bolivia - the so-called 'Lithium Triangle'. Salar de Uyuni (Bolivia) or Jujuy (Argentina) are some of the targets of the race for extraction. Still, they have also become symbolic names of the unfair transition, whereby the local populations pay the price and do not have the benefits of the work and exploitation of the resources beneath their feet. A fraud scheme that has a history and goes beyond Latin America.

Africa has been the continent most deprived of its natural resources. Over two centuries of ruthless exploitation has denuded many African countries of their natural resources, leaving them among the poorest in the world and still underdeveloped. Resources alone cannot guarantee prosperity.

Namibia has significant lithium deposits but also dysprosium and terbium, rare earth minerals needed in the batteries of electric cars and wind turbines. Recently, the national government has banned the export of unprocessed lithium and other critical minerals to profit without intermediaries from the increasing global demand for metals used in clean energy technologies. Oil companies, Figueres and Namibia hint at the actual battle at the core of the energy transition: the preservation of the status quo versus a change of attitude and unprecedented policies. Retrograde versus progress, that is the game. **ONE**

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# Soil, Fungi, Agriculture, and Climate Change

LENORE HITCHLER

ONE

What do ancient Sanskrit texts, Leonardo da Vinci, Thomas Jefferson, and Franklin Roosevelt have in common? They recognized the importance of soil to humanity. Ancient Sanskrit texts from India written around 1500 BC state “Upon this handful of soil our survival depends. Husband it and it will grow our food, our fuel and our shelter and surround us with beauty. Abuse it and the soil will collapse and die, taking humanity with it.”

According to an article in Agricultural History, Leonardo da Vinci was the first soil conservation geologist. He stated, “In order to be a successful farmer one must know the nature of the soil.”

Thomas Jefferson said that “While the farmer holds the title to the land, actually it belongs to all the people because civilization itself rests upon the soil.” Franklin D. Roosevelt added that “The nation that destroys its soil destroys itself.”

Less well-known authors also stressed the importance of soil. Professor and soil scientist Wallace H. Fuller, Ph.D., stated, “A cloak of loose, soft material ... is all that lies between life and lifelessness.”

Author Wendell Berry added “The soil is the great connector of lives, the source and destination of all. Without proper care for it we can have no community, because without proper care for it we can have no life.” In other words, soil is the very foundation of life on terrestrial Earth. Terrestrial habitats are the below and above-ground areas of land masses.

Fungi help combat climate change in a variety of ways. Various fungi species contribute to the storage of carbon within soil. Soil organic matter contains more than two-thirds of the carbon stored in terrestrial ecosystems. An article in Current Biology reported that globally, plants pump an estimated 13 gigatons (a gigaton is equal to 1 billion metric tons) of carbon dioxide (CO<sub>2</sub>) into underground fungi every year. The Food and Agriculture Organization of the United Nations (FAO-UN) reported that “Keeping the carbon already contained in the soil is more effective than any other practice aiming at capturing atmospheric carbon.”

Besides helping to store carbon in soil underground, fungi help maintain plants, so they are able to directly take CO<sub>2</sub> out of the environment and store carbon within their tissues. Plants need fungi to survive, while some mycologists even say that plants need fungi to survive. Thus, by aiding plants, fungi are partially responsible for carbon storage above ground.

Both climate change and modern agricultural practices are lethal to many fungi. This is unfortunate as shown in an article in Nature Plants which stated that “In an era of ecosystem degradation and climate change, maximizing microbial functions in agroecosystems has become a prerequisite for the future of global agriculture.”

Katie Field, Ph.D., professor of plant-soil processes adds that “When we disrupt the ancient life support systems in the soil, we sabotage our efforts to limit global heating and undermine the ecosystems on which we depend.”

Fungi, the plural form of fungus, is a separate biological kingdom, just as plants and animals are each separate kingdoms. The fungal kingdom includes mushrooms, molds, mildews, and yeast plus the fungi found inside plants, both in and on plant roots, and in the soil.

Some species of fungi damage human health, and certain mushrooms are even fatal when ingested. Various molds and mildews are extremely destructive to health and property. Other fungal species can either severely damage or kill forests or food crops.

Despite various species of fungi being detrimental to humans, fungi are part of the circle of life. For example, biological decomposers maintain life on the planet. Without them, old plant and animal remains would pile up and there would eventually be no room for new life. There are various types of decomposers, and fungi are just one out of many. Unfortunately, decomposition releases CO<sub>2</sub>. Luckily, decomposition releases nutrients used by plants that in turn store CO<sub>2</sub>. Eventually, these plants die, and the cycle continues.

Statistics about fungi are awesome. The latest estimation is that the total number of terrestrial fungal species is between six to eight million. Fungi have existed on the planet for millions of years. Estimates of how-long fungi-plant symbiosis has existed varies. Symbiosis refers to a mutually beneficial relationship between different species.

According to an article in *Current Biology*, fungi-plant symbiosis has existed for more than 400 million years. In contrast, according to recent genetic research published in *Science*, land fungi evolved around 1,300 million years ago, and land plants evolved around 700 million years ago. Fungi gradually created the right environment to enable the survival of plants on land. Dr. Field stated that in biological weathering, fungal hyphae secrete organic acids that dissolve rocks and therefore make nutrients available to plants.

In due course, plants moved from the seas to land and then survived because of the development of fungi-plant symbiotic relationships. In turn, land plants provide food for animals, either directly by herbivores, or indirectly by carnivores. Thus, fungi hold an extremely necessary and valuable position in the global food chain. Merlin Sheldrake, Ph.D., an expert on mycorrhizal networks, went so far as to say that "Plant's relationships with mycorrhizal fungi underpin much of life on land."

The amount and extent of soil fungi are incredible. Sheldrake stated that in just one teaspoon of soil, there may be enough fungal mycelium to span approximately 6.2 miles. Mycelium is a network of fungal threads. The FAO-UN reported that there are more organisms in one tablespoon of healthy soil than the total human population of the planet. According to Paul Stamets, who has studied fungi for decades, every ounce of soil contains thousands of species of fungi. It is estimated that 25%

of Earth's species live underground, and fungi are a major part of this ecological niche.

Soil contains 80% of the carbon found in terrestrial ecosystems, according to an article in *Nature Education Knowledge*. "Soil organic matter is composed of soil microbes including bacteria and fungi, decaying material from once-living organisms such as plant and animal tissues, fecal material, and products formed from their decomposition."

Fungal mycorrhizal networks contribute to the production of soil organic matter.

Arbuscular mycorrhizal fungi produce glomalin. An arbuscular mycorrhiza is a type of mycorrhiza in which fungi penetrate the root cells of a vascular plant. According to the United States Department of Agriculture [USDA], glomalin is an arbuscular-mycorrhizal fungal soil protein. Michael Amaranthus, Ph.D., retired USDA research soil scientist, discussed the importance of glomalin in fighting climate change. He stated that "Glomalin may account for as much as one-third of the world's soil carbon and the soil contains more carbon than all plants and the atmosphere combined."

According to the USDA, glomalin "forms clumps of soil granules called aggregates. These add structure to soil and keep other stored soil carbon from escaping." Sara Wright, Ph.D., soil scientist at the USDA, stated, "Glomalin levels are maintained or raised by no-till, cover crops, reduced phosphorus inputs, and the sparing use of crops that don't have arbuscular mycorrhizal fungi associated with their roots."

Modern agricultural methods contribute to climate change by causing stored carbon in the soil to be released into the atmosphere. An article in *PNAS* (Proceedings of the National Academy of Science) estimated the total global loss of carbon from soil in the last 12,000 years of agriculture. The figure was 133 billion metric tons of carbon for the top 6.56 feet of soil, with the rate of loss increasing dramatically in the past 200 years. Dr. Fayaz Malla, assistant professor of environmental science adds that "In the first decade of the 21st century, soil degradation released between 3.3 and 3.6 billion tonnes of CO<sub>2</sub> into the atmosphere."

More discussion regarding the loss of carbon stored in soil was published by the Yale School of the Environment. The article reported that "According to Rattan Lal, director of the Ohio State University's Carbon Management and Sequestration Center, the world's cultivated soils have lost between 50 and 70 percent of their original carbon stock, much of which has oxidized upon exposure to air to become CO<sub>2</sub>. ... Lal says that restoring soils of degraded and desert ecosystems has the potential to store in world soils an additional 1 to 3 billion tons of carbon annually."

Further information on the effects of modern agriculture

on soil and fungi was published by Communications Biology. The article reported that “AMF [arbuscular mycorrhizal fungi] diversity was lower in cereal-producing farmland soils than in grassland soils.

Other studies observed similar reductions in microbial and fungal diversity in the soils of other agricultural systems, such as vineyards, orchards, and arable crops. ... Most modern crop plants have not been bred with this symbiotic relationship with AMF in mind, and thus are only inefficiently colonized by AMF.” A study reported in Science Daily reported “By altering the plants that grow across much of the Earth’s surface from those with strong soil carbon storage to weak carbon storage we have potentially further contributed to increased atmospheric CO<sub>2</sub>.”

Thus, modern agriculture damages the very fungi that produce soil. Fortunately, there are better alternatives such as increasing biodiversity. Miranda Hart, professor of biology at the University of British Columbia, Canada stated, “The single most important thing you can do is encourage biodiversity on your farm. With more plants, you get more different kinds of fungi, and these fungi bring with them different benefits.” Also, use no-till methods because plowing breaks down connections in the fungal network, reducing soil’s ability to store carbon. Cover crops should be planted because bare land results in diminished fungal growth.

Mycorrhizal fungi networks make nitrogen and phosphorus available to plants and in return receive energy in the form of carbon (carbohydrates).

According to an article in the Journal of Environmental Quality, nitrogen fertilizers have caused a net loss of native soil organic carbon. If plants are given a surplus of nitrogen, they stop relying on their fungal networks. This contributes to another negative circle in which the plants need more nitrogen fertilizers, leading to more climate change because fossil fuels are used in the production and distribution of fertilizer.

Using phosphorus fertilizers also disturbs plant-fungi symbiosis. Wendy Taheri, Ph.D. in ecology and evolutionary biology stated, “When we saturate the soil with plant-available phosphate, plants reject their symbiotic partners.” An article in Nature Ecology and Evolution added “The use of fungicides and subsequent decline in arbuscular mycorrhizal fungi richness in croplands reduced phosphorus uptake by 43%.”

Besides storing carbon, fungal networks also aid plants to resist pests. According to Scientific Reports, “There is increasing evidence that mycorrhizal networks can transmit herbivore-or pathogen-induced defense signaling compounds to warn neighbors of pest infestations.” For example, an article in Ecology Letters reported an experi-

ment that showed that warning messages from plants infested with aphids were sent through a mycelium fungus network to plants not yet afflicted. Loss of these types of fungi from climate change and agricultural methods will lead to using more pesticides. This will lead to further fungal death leading to even greater use of pesticides and then more climate change.

Climate change frequently leads to either excessive precipitation or extreme lack of precipitation. Fortunately, fungal filaments help plants deal with droughts by stretching deep into the soil, gathering water and nutrients from a volume 100 times greater than the roots could reach on their own, according to an article published at the University of Texas.

Besides droughts, soil salinity is another environmental hazard. Soil salinity is caused by several factors. For example, irrigation inevitably leads to the salinization of soil according to an article published by the University of Minnesota’s Institute on the Environment. Globally, 33% of irrigated land and over 20% of cultivated land contains soil that has become excessively saline. Also, rising sea levels on low-lying coasts due to climate change may lead to saltwater inundating the area, thus contaminating the soil, and increasing salinity.

Increased soil salinity stresses plants. An article in Plant and Soil reported that “Salt stress hinders photosynthesis resulting in an enormous loss in crop productivity.” Luckily, some mycorrhizal fungi species increase their host plant’s tolerance of salt. An article in Frontiers in Plant Science explains this by stating “Symbiotic fungi can modulate gene expression of the host plant to modify its phenotype to improve the tolerance to abiotic stress factors caused by soil salinity.”

Soil salinity reduces the amount of soil organic carbon according to an article in Environmental Science & Technology. Lower levels of carbon stored in soil result in higher levels of CO<sub>2</sub> in the atmosphere and will therefore increase climate change.

Climate change makes the planet an unhealthy environment for humanity with rising temperatures, droughts, and crop failures. Climate change, fungi, and soil are intertwined together like strands of DNA. What negatively affects one will harm the other two.

Likewise, what benefits one will also benefit the others. Since fungi help to combat climate change, it is necessary to employ agricultural methods that help soil fungi thrive. An added benefit of doing so is that less fossil fuels will be deployed, thus slowing down the greenhouse effect, and this will help combat climate change creating a healthier environment. Healthier fungi lead to healthier soil that leads to healthy plants, people, and a healthier planet. **ONE**





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# No Kiln in Making Soda

THEO HART

ONE

Sodium carbonate, known as soda or soda ash, has been made on an industrial scale since the 1790s. Annual production worldwide is well over fifty million tons, with a few plants making 500,000 tons each.

However, much of the soda comes from mining a mineral ore called trona, which consists of sodium carbonate and bicarbonate. Massive deposits in Wyoming, USA, provide about 11 million tons, the ore dug out from below ground, while five million tons are solution mined in Turkey near Ankara. Elsewhere some minor production occurs.

Even so, much soda is still made by the Solvay method, also called the ammonia-soda process, first used commercially in 1863. The temperature is a cool ten degrees or less as a strong solution of ordinary salt (NaCl) is infused with ammonia and CO<sub>2</sub>, creating ammonium chloride and sodium bicarbonate which drops out. To get soda means heating the bicarbonate to 80 degrees, releasing half its CO<sub>2</sub> for recycling. At this point, production is complete if the ammonium chloride can be sold.

In China, since 1933, it has been used as nitrogen fertiliser, though most other places don't want it. Instead, ammonia gets recycled. The ammonia is freed by lime, with the resulting calcium chloride disposed of as a waste product, usually in the sea. The lime is made in a kiln by roasting limestone at over 900 degrees. This also supplies the CO<sub>2</sub> for the process. The mismatch in temperatures is startlingly huge.

Coal is the usual fuel burnt to supply the heat, making large CO<sub>2</sub> emissions into the air. With the advent of a tax on these in the EU, the Solvay

company has decided to switch to renewable fuels, including pelleted wood, waste papers, and some crop residues such as seed hulls. However, Solvay-style soda production by anyone elsewhere still has a lime kiln and usually burns coal.

But is there an alternative to lime? Suppose instead that at some temperature between 50 and 90 degrees, calcium acetate is added. Any ammonium acetate formed will decompose, with gaseous ammonia emitted, leaving acetic acid and calcium chloride behind.

An absorbant for the acetic acid could be useful. Then running the released acid into crushed limestone would provide CO<sub>2</sub> and calcium acetate. An approach like this would still turn limestone into CO<sub>2</sub> and have as waste calcium chloride, but with no lime kiln and its significant need for fuel.

## **Soda at smaller scale**

Another way of making soda using its bicarbonate is well-known though only a little used. Electrolysis of aqueous NaCl yields a lye solution (sodium hydroxide), hydrogen gas at the cathodes, and chlorine gas at the anodes. These two gases may be combined to provide hydrochloric acid. The lye plus CO<sub>2</sub> can yield soda directly, but this is rarely done because lye is worth more. The scale of soda production would shrink were potassium bicarbonate available at a reasonable price.

Soda production would become a mere matter of mixing it with ordinary salt (NaCl), causing sodium bicarbonate to drop out and creating potassium chloride, the usual form of fertiliser. Soda here comes from heating the bicarbonate. All this can



Photo credit: Pxfuel

match the soda needed by a none-too-large manufacturer, who could make it and sell the fertiliser co-product.

A local maker should have a marketing advantage for a consumer product such as washing soda. It is heavy due to each crystal including ten water molecules, so a modest output could succeed.

### **Making Potassium Bicarbonate**

Potassium bicarbonate is too soluble for the ammonia-soda process to work. Instead, the usual method is electrolysis of the chloride salt, which tends to be pricey due to the electricity needed. Regardless, electrolysis has a key role as part of a new way to work a solution potash mine, though the salt involved is not potassium chloride.

Today's solution mining involves evaporating quite a lot of water to crystallise the potassium chloride salt brought to the surface. This consumes much fuel. Upwelled salts are mostly ordinary sodium salt, as even a rich deposit will be but 20-30% potassium chloride. A new alternative, called the 'acetate method', avoids this crystallisation by separating the potassium as its acetate salt, which is soluble in certain solvents that neither chloride is nor sodium acetate only slightly.

So when sodium acetate is added to the upwell, potassium may be extracted as its acetate, using ethanol, methanol or both as solvent. The potassium acetate is then contacted with a suitable amine and with CO<sub>2</sub>, which causes the formation and deposi-

tion of potassium bicarbonate, the amine attracting the acetate. After the removal of the bicarbonate, sodium hydroxide is added to strip the amine of acetate, and the sodium acetate needed in the first step is created.

As earlier depicted, sodium hydroxide (lye) may be made by electrolysis of ordinary salt, and it might have only lye and hydrochloric acid as outputs, the acid being sold. Alternatively, the electrolyser may have three sections: the anode section is fed potassium acetate resulting in potassium hydroxide being formed and H<sub>2</sub> gas emitted, while acetate goes into the middle part; the cathode section is fed salt, chlorine gas is formed, and Na ions go into the middle part to create sodium acetate, which accumulates.

Potassium bicarbonate is made as above, as can be hydrochloric acid. In broad outline, that is the Acetate Method of potassium solution mining. In avoiding crystallisation, far less water evaporation is involved, and much less fuel is consumed. Of course, much more electricity is used, but taken together with the production of potassium bicarbonate, it is financially better, particularly for smaller-scale mines, especially where potassium is a small part of the upwell. While mines in Saskatchewan usually have 25% or so potassium in the upwell, deposits elsewhere might be less than half that.

The Acetate Method is the best option for those. Also, some deposits, too low in potassium to be mined profitably any other way, could now be brought into production. **ONE**

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# UN Provides Blueprint for 80% Cut to Global Plastic Pollution by 2040

"If we follow this roadmap, including in negotiations on the plastic pollution deal, we can deliver major economic, social, and environmental wins," said the director of the U.N. Environment Program.

KENNY STANCIL

Common Dreams

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Global plastic pollution can be reduced by 80% by 2040 if countries and companies make far-reaching changes using existing technologies, according to a report published Tuesday by the United Nations Environment Program.

Turning Off the Tap: How the World Can End Plastic Pollution and Create a Circular Economy comes less than two weeks before the start of a second round of negotiations in Paris on a legally binding global plastics treaty. While the required shifts outlined in the report are significant, UNEP stresses that they are practical, relatively inexpensive, and would yield benefits valued at more than \$4.5 trillion.

Research has shown that plastic pollution is a life-threatening crisis poised to grow worse unless governments intervene to prevent fossil fuel and petrochemical corporations from expanding the production of single-use items.

"The way we produce, use, and dispose of plastics is polluting ecosystems, creating risks for human health, and destabilizing the climate," UNEP executive director Inger Andersen said in a statement. "This UNEP report lays out a roadmap to dramatically reduce these risks through adopting a circular approach that keeps plastics out of ecosystems, out of our bodies, and in the economy."

"If we follow this roadmap, including in negotiations on the plastic pollution deal," said Andersen, "we can deliver major economic, social, and environmental wins."

The report proposes a four-fold "systems change" to address "the causes of plastic pollution, rather than just the

symptoms."

As UNEP summarizes, it consists of the following:

**Reduce:** By first eliminating problematic and unnecessary plastics, policymakers can reduce the size of the problem.

**Reuse:** Promoting reuse options—including refillable bottles, bulk dispensers, deposit-return schemes, packaging take-back schemes, etc.—can reduce 30% of plastic pollution by 2040. To realize its potential, governments must help build a stronger business case for reusable items.

**Recycle:** Reducing plastic pollution by an additional 20% by 2040 can be achieved if recycling becomes a more stable and profitable venture. Removing fossil fuels subsidies, enforcing design guidelines to enhance recyclability, and other measures would increase the share of economically recyclable plastics from 21 to 50%.

**Reorient and Diversify:** Careful replacement of products such as plastic wrappers, sachets, and takeaway items with products made from alternative materials (such as paper or compostable materials) can deliver an additional 17% decrease in plastic pollution. "Even with the measures above, 100 million metric tons of plastics from single-use and short-lived products will still need to be safely dealt with annually by 2040—together with a significant legacy of existing plastic pollution," UNEP explains. "This can be addressed by setting and implementing design and safety standards for disposing of non-recyclable plastic waste, and by making manufacturers responsible for products shed-

ding microplastics, among others."

According to the agency: "The shift to a circular economy would result in \$1.27 trillion in savings, considering costs and recycling revenues. A further \$3.25 trillion would be saved from avoided externalities such as health, climate, air pollution, marine ecosystem degradation, and litigation-related costs. This shift could also result in a net increase of 700,000 jobs by 2040, mostly in low-income countries, significantly improving the livelihoods of millions of workers in informal settings."

Although UNEP's recommendations necessitate a substantial investment, it is "below the spending without this systemic change: \$65 billion per year as opposed to \$113 billion per year," the agency notes. "Much of this can be mobilized by shifting planned investments for new production facilities—no longer needed through reduction in material needs—or a levy on virgin plastic production into the necessary circular infrastructure. Yet time is of the essence: a five-year delay may lead to an increase of 80 million metric tons of plastic pollution by 2040."

While many progressive advocacy groups are likely to welcome UNEP's overall message that readily available solutions, backed by strong regulatory instruments, can help bring about a transformation from a "throwaway" society to a "reuse" society, the agency is facing criticism for its promotion of burning plastic waste in cement kilns.

"Burning plastic waste in cement kilns is a 'get out of jail free card' for the plastic industry to keep ramping up plastic production by claiming that the plastic problem can be simply burned away," Neil Tangri, science and policy director at the Global Alliance for Incinerator Alternatives (GAIA), said in a statement. "Not only does this pose a grave climate and public health threat, it also undermines the primary goal of the global plastic treaty—putting a cap on plastic production."

Larisa de Orbe of the Mexican environmental justice groups Red de Acción Ecológica and Colectiva Malditos Plásticos echoed Tangri's argument. "To tackle the plastic crisis, waste should not be burned, but its production should be drastically reduced, and single-use plastics should be banned," said Orbe. "Environmental authorities in Mexico and the [U.N.] Human Rights Rapporteur on Toxic Substances have recognized that the burning of waste in cement kilns has caused environmental disaster and the violation of human rights in the territories and communities near these activities."

Imports of plastic waste into Mexico grew by 121% between 2018 and 2021. As GAIA noted, a large portion of that "is suspected to be burned in cement kilns, which ope-

rate with few controls or emissions monitoring systems." Linda Birnbaum, former director of the National Institute of Environmental Health Sciences and National Toxicology Program, called the U.N.'s promotion of burning of plastic waste in cement kilns "an irresponsible choice that has significant health implications for the communities living nearby."

"Burning plastic waste releases dioxins that stay in the environment forever, and are linked to cancers, reproductive, and developmental impairments," said Birnbaum. "These are the very same chemicals that are threatening the residents of East Palestine, Ohio."

Ahead of the first round of global plastic treaty negotiations in December, civil society organizations, scientists, and other advocates demanded robust rules to confront the full lifecycle impacts of the plastic pollution crisis. After talks opened, the Break Free From Plastic (BFFP) alliance, comprised of more than 100 groups, emphasized the need to limit the ever-growing production and consumption of plastic and hold corporations accountable for the ecological and public health harms caused by manufacturing an endless stream of toxic single-use items. The coalition launched a petition outlining what it described as the "essential elements" of a multilateral environmental agreement capable of "reversing the tide of plastic pollution and contributing to the end of the triple planetary crises of climate change, biodiversity loss, and pollution." According to experts associated with BFFP, an effective pact must include:

- Significant, progressive, and mandatory targets to cap and dramatically reduce virgin plastic production:
- Legally binding, time-bound, and ambitious targets to implement and scale up reuse, refill, and alternative product delivery systems;
- A just transition to safer and more sustainable livelihoods for workers and communities across the plastics supply chain;
- and Provisions that hold polluting corporations and plastic-producing countries accountable.

While the U.N.'s Intergovernmental Negotiating Committee meetings in December (INC-1) and those scheduled to begin later this month (INC-2) mark the first time that governments have met to develop global regulations to restrict plastic production, the United States and the United Kingdom—the world's biggest per-capita plastic polluters—have so far refused to join a worldwide treaty aimed at curbing the amount of plastic waste destined for landfills and habitats, though both countries are reportedly now open to the idea.

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# The challenges and promises of climate lawsuits

**Lawsuits against emissions-spewing governments and fossil fuel companies have established themselves as a key tool in the battle against climate change, but they aren't always successful.**

KATARINA ZIMMER

Knowable Magazine

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Even the temperate, mountainous country of Switzerland isn't immune to climate change. Sizzling heat waves are melting alpine glaciers, killing trees and fish and, in the cities, likely causing an uptick in human deaths.

Rosmarie Wydler-Wälti, who lives in Basel, is acutely aware of this. A woman in her 70s, she belongs to the demographic most vulnerable to heat-related death. To her, the government's response to recent heat waves — cautioning seniors to stay in the shade during hot days, for instance — seemed like a Band-Aid. She wanted to see people tackling the problem's root cause: countries like Switzerland not doing enough to curb emissions of planet-warming greenhouse gases.

With support from Greenpeace Switzerland, Wydler-Wälti and other members of a group of senior women climate activists filed a lawsuit against the Swiss government in 2016, demanding that the state curb emissions more quickly. They argued that the government, by not sticking to policies consistent with the worldwide goal of limiting warming to less than 2 degrees Celsius above pre-industrial temperatures, was threatening senior women's fundamental human right to life. Indeed, many of the women involved ultimately reported having experienced heart palpitations, vomiting, swollen arms and legs and breathlessness during recent heat waves, and some reported having fainted.

Hundreds of lawsuits like these have been filed around the world in recent years, as activists, frustrated by the slow

pace at which nations are acting to cut greenhouse gas emissions, have turned to the courts for help.

The success rate has surprised many experts. Of those cases filed outside the United States — the focus of one analysis — dozens had outcomes that encouraged more aggressive climate action, according to a 2022 report from the Grantham Research Institute on Climate Change and the Environment at the London School of Economics and Political Science. In one landmark case that concluded in 2019, for example, Dutch courts ordered the government to set more ambitious climate targets.

But such cases don't always succeed. To Wydler-Wälti's disappointment, after a series of courts dismissed the case, the Swiss Supreme Court concluded in 2020 that the women's rights hadn't been violated severely enough to merit a case. "We would have to be half dead for them to believe that we're particularly affected," Wydler-Wälti says angrily.

Examining why some cases succeed while others don't is key to understanding the future of this rapidly growing field of litigation. Experts say that success hinges on many factors — not only on the plaintiffs' arguments, but also on the design of a country's legal system, its political environment and the apparent willingness and/or ability of judges to interpret the scientific evidence around climate change.

"One of the reasons it's so important to look closely at these cases and the impact they're having is because their impact



Climate Strike in Pittsburgh on 9/24/21. Photo credit: Mark Dixon

is likely to only grow in the years to come, as people increasingly see litigation as an important way to address the problems of climate change,” says Hari Osofsky, a human rights law expert now at Northwestern University’s Pritzker School of Law, who in 2020 coauthored an overview of climate change litigation in the *Annual Review of Law and Social Science*.

That said, “litigation by itself is not going to close the emissions gap,” Osofsky adds. “Solutions to climate change require a lot of different kinds of action.”

### **Climate change as a human rights problem**

Taking governments to court over climate change was once considered a long shot, says César Rodríguez-Garavito, an international human rights and environmental law expert who heads New York University’s Climate Litigation Accelerator, which studies and advocates for climate litigation, and

edited the 2022 book *Litigating the Climate Emergency*. Climate change is, after all, a tricky issue for courts to address. For one thing, there’s the question of whether individual governments can be held accountable for the climate crisis when no single actor is responsible. For another, courts are typically designed to react to harms that have already been inflicted, whereas the bulk of climate-related damage will unfold in the future.

The Dutch courts’ decisions, the last of which was reached in 2019, were groundbreaking in how they handled both questions.

The courts rigorously applied the latest scientific evidence on how countries’ policies contribute to climate change, concluding that the Netherlands must do its fair share regardless of what other countries do. The courts also agreed with the plaintiffs — the Urgenda Foundation, a Dutch non-profit, and 886 Dutch citizens — that the government has

a duty to reduce not only current harms of climate change to its citizens, but also future risks. The Dutch courts ordered the state to raise its existing goal of reducing emissions from 17 percent below 1990 levels by 2020 to 25 percent below.

The state complied that year, and later announced that it would greatly reduce the capacity of coal-fueled power stations, among other measures. It was a “Big Bang moment” in climate litigation in Europe, says human rights researcher Corina Heri of the University of Zürich in Switzerland. “That really changed the idea of what could be possible legally.”

The decision inspired a wave of like-minded lawsuits, some of which saw similar success. In 2021, Germany’s constitutional court decided a lawsuit brought by nine young people against the German government that claimed insufficient climate goals. The court ordered the government to set clearer emissions targets for 2031 onward. Soon after, the government passed a bill containing faster emissions reduc-

tions and announced plans to become carbon-neutral by 2045 — faster than its previous goal of reaching climate neutrality by 2050.

Like the Urgenda case, the German lawsuit invoked human rights — fundamentally arguing that the worsening hazards driven by climate change threaten the very rights to life and dignity, particularly for future generations. This is legally, as well as symbolically, a powerful argument, because many regions have specific legal pathways and courts dedicated to dealing with human rights cases, and such arguments center and individualize the suffering of people.

In recent years, the argument has gained traction in courtrooms and international law, Rodríguez-Garavito says, and on the whole, “it has been much more consequential and much more effective than any of us would have thought.” However, while such successful cases create an impetus for action, actually changing and implementing new policies is often a longer-term project, Heri notes.

Photo credit: Florin (Wikimedia Commons)





For instance, some courts, such as the German one, have stopped short of mandating specific targets for reducing emissions and instead leave that up to legislators. Some youth activists argue that the governments' new climate policies aren't aggressive enough and are still in violation of human rights.

And, as Wydler-Wälti's experience illustrates, this argument hasn't worked everywhere. In her case, the courts rejected the argument that the senior women were disproportionately affected by climate change compared to the general public — an argument adapted to a Swiss legal system that largely doesn't allow public interest lawsuits, Heri says. In another case, a lawsuit against the Norwegian government by two activist groups over new oil drilling licenses in the Barents Sea in the Arctic was rejected.

Those plaintiffs had argued that by exacerbating climate change, the licenses infringed on the human right to a healthy environment, which is enshrined in Norway's constitution. After years of litigation in domestic courts, the country's Supreme Court ruled that the youths' rights weren't violated, in part because it was uncertain at that time how much the licenses would actually end up contributing to climate change.

Part of the reason the Urgenda case succeeded while these two didn't could lie in the design of the Dutch legal system, which makes it easier for environmental groups to bring collective claims of this kind. "What works is very jurisdictionally specific," Osofsky says. "European jurisdictions that are legally similar to the Netherlands are going to be the most promising jurisdictions for a successful Urgenda-style case."

To Heri, it also comes down to the willingness of courts to engage with and understand the scientific evidence around climate change and its impacts, which they were with Urgenda, she says. The fact that the case was heard by judges who understood the need for urgent climate action and the evidence before them "in the end made all the difference," she says.

Far from giving up, the plaintiffs in Switzerland and Norway have since taken their cases to higher powers: the European Court of Human Rights in Strasbourg, France, which can order states to change policies it deems unlawful. The Swiss

case and two others are among the first climate cases the Strasbourg Court is reviewing, and its decisions could influence climate policy across Europe, Heri says.

Lasse Eriksen Bjørn, a plaintiff in the new Norway case and a member of the Saami Indigenous community, whose way of life is threatened by Arctic warming, is optimistic that the Strasbourg Court may decide more favorably than Norwegian courts, which have closer ties to the oil industry. In late March, the Strasbourg Court held an official public hearing for the Swiss case and for a French lawsuit. "If we win," Wydler-Wälti says, "I think I will see it as a feminist win for older women, who usually come last in society."

## Other legal strategies

Invoking human rights may be a promising legal strategy in places like Europe and Latin America, where 25 youths recently won a lawsuit against the Colombian government over deforestation in the Amazon. Latin America also has a regional human rights court. But the strategy is less useful in jurisdictions like the United States, whose legal system doesn't recognize human rights in the same way.

"I think that's actually been one of the main reasons that we haven't seen the same sorts of major victories when it comes to strategic climate litigation that we have seen in some other countries, particularly in Europe," says Jessica Wentz, a climate law expert at Columbia Law School's Sabin Center for Climate Change Law.

The US Constitution doesn't recognize the human right to health, for example. But some states, like Montana, do acknowledge the right to a healthy environment, and youth plaintiffs are now using that right to sue the state of Montana over climate change. At the federal level, plaintiffs can bring cases based on the political human rights the Constitution does contain, like the rights to liberty and property, and indirectly argue that having a stable climate is essential to exercising these. Still, this strategy is neither particularly successful nor common; only a tiny fraction of the more than 1,100 climate cases filed in the United States have invoked constitutional rights.

One of the most famous of these was the Juliana case, named after one of the youth plaintiffs who sued the federal government in 2015 over causing harmful levels of greenhouse gases. Although the Ninth US Circuit Court of Appeals

acknowledged that the government is obligated to address climate change, it still ultimately dismissed the case, arguing that decisions over climate policy should be left to the elected branches of government, not the courts.

US courts have often reached this conclusion in cases that have pursued emissions reductions, Wentz says. It's possible, she adds, "that the reason this has become such a prominent thing in US climate cases is linked to how climate change itself has been politicized in our public discourse."

A more popular and effective legal strategy in the US has involved targeting government decisions over specific infrastructure projects, such as permitting new gas pipelines or extracting fossil fuels from public lands, and forcing federal agencies to consider the climate impacts, notes Michael Burger, the Sabin Center's executive director. Such cases often draw on the National Environmental Policy Act, which mandates that federal agencies assess the full scale of the environmental impact of proposed projects, including the greenhouse gas emissions they cause.

Courts may not necessarily put a stop to such projects, but in forcing government agencies to redo their environmental analyses to take carbon emissions into account, Osofsky says, these lawsuits often raise the cost and time required for such projects. Wentz adds that the impact can be seen in trends in government decision-making. "We have seen a big shift, where the federal government is, in fact, thinking through the climate implications of its actions in much greater detail than it did before," she says. "I think litigation has helped drive that."

Like some other regions, the United States has also seen an uptick in cases brought against fossil fuel companies. The US doesn't have strong laws requiring that corporate entities limit the global environmental damage they cause.

In Europe, Friends of the Earth Netherlands recently argued in its lawsuit against the Dutch oil giant Shell that companies, like states, had such obligations. Instead, US plaintiffs often claim that oil and gas companies are deliberately misleading the public by underplaying the harms of climate change in order to deepen their profits, in a similar vein to suing tobacco companies over downplaying the health risks of smoking.

"We know that a very small [number] of companies are responsible for half the world's emissions. So we really need

to hold companies accountable," says Sam Cossar-Gilbert, who coordinates Friends of the Earth International's economic justice program. However, he adds that this strategy has drawbacks. Since some companies — like some governments — have deep pockets, they "can delay a lot of these decisions for a very long time." In the case against Shell, the company has appealed the decision and the process is still ongoing three years after the judgment.

## **Suing over damages**

Most climate lawsuits aim to get big emitters like governments to more rapidly reduce emissions in order to reduce future harm. But as climate change is increasingly making its mark in the present, many of the plaintiffs suing fossil fuel companies are testing another approach — suing for compensation for damages already caused or for the costs to prevent future ones.

Several US cities, states and counties are suing such companies for the damages incurred during hurricanes and for the costs of relocating infrastructure away from shorelines due to rising sea levels. While it's still early days, some experts note that such cases could be strengthened by a growing body of evidence on how climate change fuels specific extreme weather events and connecting specific damages to the emissions of fossil fuel producers.

Suing for damages or compensation to prevent future damage may become an especially important approach in developing countries in hotter parts of the world where the worst climate impacts are being felt, Rodríguez-Garavito says. There's long been a scarcity of climate lawsuits in many pockets of the developing world where people lack access to courts or the financial means to sustain the legal process, notes Lisa Vanhala, a political scientist at University College London who published an overview of how law is being used to prevent environmental degradation in the 2022 Annual Review of Law and Social Science. But cases in South America, Asia and Africa are growing in number, and some of them are targeting entities in wealthier, high-emitting countries.

One such case has been ongoing since 2015, when the Peruvian farmer Saúl Luciano Lliuya, whose city is threatened by flooding from a melting glacier, filed a lawsuit against the German energy company RWE, demanding that it pay for local flood protections. Such cases can be challenging, because corporations aren't always legally respon-

sible for the environmental damage they cause overseas — it depends on the jurisdiction, Rodríguez-Garavito says.

Developing countries may even consider taking legal action against high-emitting countries — something they've long been reluctant to do as they're often geopolitically dependent on wealthier countries and have prioritized international negotiations over climate targets, Rodríguez-Garavito says. But, he adds, "after 30 years, a lot of people have lost patience, and the effects are also much more urgent and serious. So that perception is changing."

For instance, the Pacific island nation of Vanuatu, which is under threat from rising seas, recently spearheaded a United Nations request to the International Court of Justice — which handles disputes between countries — for an official opinion on whether states have an obligation under international law to ensure a safe and livable climate for everyone. The opinion could then set the stage for lawsuits brought by individual countries.

Rodríguez-Garavito predicts that the coming years will see a rise in cases between developing nations and wealthy ones. There may also be lawsuits against other high-emitting entities like carmakers and cement companies, and even banks for financing fossil fuels as plaintiffs continue to explore new strategies, the Grantham Institute report notes. Their success remains to be seen — but many experts stress that even where lawsuits fail in the actual courts, they can still win in the court of public opinion, and raise awareness around climate change as a justice issue.

Bjørn, of the Saami community in the Arctic, says he witnessed this after Norwegian courts rejected the oil drilling case. "The way oil drilling in the Arctic was talked about in northern Norway had completely changed," he observes. "The feeling was that we had succeeded in many ways, no matter what the result was.

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# Beyond the bin: giving biowaste a second life



Cities across Europe are working with researchers to turn organic waste such as coffee grounds into valuable goods.

PIETER DEVUYST

HORIZON - THE EU RESEARCH AND INNOVATION MAGAZINE

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Coffee Grounds. Photo credit: Pixabay

It's hard to imagine a world without coffee given how many people enjoy kick-starting their day with a freshly brewed cup. Once the coffee beans are roasted and brewed, the leftover powder – coffee grounds – is often thrown away. Millions of tonnes of the powder end up every year in landfills, where its decomposition worsens the climate crisis by emitting methane.

## Old matter, new goods

But coffee grounds can be recycled into a wide range of products. The EU-funded WaysTUP! project is coming up with different ways to give coffee and other organic waste from European cities a second life. 'We are trying to open the gates for products that were unthinkable before,' said Amadeo Semper, who works for SAV – Agricultores de la Vega, a Spanish waste-management company that coordinates the project.

Valencia-based SAV collects coffee grounds from local coffee shops, which sort the waste in a separate bin stockpiled along a "smart" collection route that prevents the material from rotting. Through a series of chemical and extraction processes, the company then transforms this waste into a range of high-quality food ingredients. These includes carotenoids, which are natural pigments that can be used for their orange colour, and

polyphenols – antioxidants that can help protect against various diseases. Carotenoids are usually made synthetically, but we have developed a process to do this in a natural way,' said Semper. The four-year project, which ends in August this year, also works with 25 other partners to collect, process and refine more bio-based products.

## Beans to bioplastics

Among the partners is a UK-based company called bio-bean, which turns coffee grounds into coffee oil or upscales it into high-value products such as barbecue charcoal, heating logs and natural flavours. While bio-bean already had experience extracting coffee oil to make renewable biofuels, the EU's research funding allowed the company to expand to a new application: bioplastics.

**«We are trying to open the gates for products that were unthinkable before».**

AMADEO SEMPER, WAYS TUP!

'Coffee oil is an exciting area where we could deliver a clean technology and promote sustainability,' said Ben Mills-Lampthey, chief technology officer at bio-bean. Like SAV, bio-bean collects coffee grounds from large chains such as Costa and Starbucks, which store the

waste in a separate container, and from factories that produce instant coffee. With the help of urban waste-management companies, bio-bean receives tens of thousands of tonnes of coffee grounds every year. After the removal of anything that isn't coffee, the powder is dried and coffee oil is extracted. Ultimately, the coffee oil is sent to other WaysTUP! partners. It is first fermented to create bio-degradable polyesters, which are then turned into bioplastic. 'There is nothing like waste,' said Mills-Lamprey. 'We should all change our minds towards that and use the resources that we have more efficiently.'

### **Range of uses**

Bio-bean is now extracting the coffee oil at a factory while creating other goods from used coffee that are sold commercially. Its dried coffee grounds product, "Infical", has a range of applications including in cars and in home, shop and restaurant interiors. 'It can be used in brake pads or to make kitchen cabinets,' Mills-Lamprey said. 'And most of the backgrounds at Costa or McDonald's are now made with spent coffee grounds.'

But the potential of biowaste isn't limited to coffee. Back in Valencia, SAV also uses the leftovers from meat and fish to create new types of food. It collects the fish and meat by-products from the city's Central Market, one of the biggest food markets in Europe. With the help of the municipality, it gives back value to hundreds of kilos of animal leftovers that would otherwise be costly to discard. SAV developed a way to turn fish waste into collagen, a protein used both to feed animals and to make food such as jelly desserts as well as pharmaceutical pills. It also found a way to reuse animal blood from slaughterhouses as a component in bio-fertilisers.

### **Network of cities**

'The range of products and applications that we can get from urban biowaste is huge,' said Martin Soriano, an environmental scientist at CETENMA, a private non-profit technology centre in Spain. The products span proteins for food and animal feed, compost, bio-ferti-

zers, construction materials and cosmetics ingredients. Soriano is using his academic background in biowaste applications to manage HOOP, an EU-funded project that was inspired by WaysTUP! and other research initiatives in the field.

**«The range of products and applications that we can get from urban biowaste is huge».**

MARTIN SORIANO, HOOP

HOOP, which began in 2020 and runs through September 2024, is helping European cities and regions use technologies developed in those other initiatives to recycle biowaste into valuable products. Soriano's team focuses on recovering solid biowaste and wastewater sludge in eight so-called lighthouse cities and regions in Finland, Germany, Greece, Italy, the Netherlands, Norway, Portugal and Spain. Coordinated by CETENMA, HOOP is building the legal, financial and technical expertise in these areas for biowaste investments. HOOP also includes 44 other members committed to replicating the practices and the aim is to have a network of 100 cities and regions in total. Recycling urban biowaste and wastewater on a large scale would reduce the strain on landfills, help tackle global warming and generate green jobs in urban areas.

### **Spreading the word**

To promote the circular economy further, WaysTUP! and HOOP are speaking with people across Europe to increase their awareness and acceptance of bio-based products. The message is being spread at public events, in interactive exhibitions, on regional television and radio and even at local food markets. By sharing the results of their work, the two projects aim to highlight the safety and environmental benefits of bio-recycled products. 'The best way to convince consumers is to show them the benefits,' said Mills-Lamprey of bio-bean.

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# Liquid hydrogen, is it really worth it?

ALICE MASILI

ONE

One of the pillars of the energy transition will be hydrogen produced from renewable sources. However, for the green hydrogen economy to take off and become a sustainable alternative, the problem of storage and long-distance transportation must be fixed.

Long-distance marine transportation is one of the biggest challenges to developing a genuinely global green hydrogen trade.

As an industrial fuel, hydrogen can be produced in a decentralised manner in many countries around the world. It is also a flexible source of electricity and can use existing natural gas infrastructure.

However, the hydrogen trade differs significantly from the current international trade in fossil fuels, including natural gas.

Countries with cheap electricity from renewable energy sources can develop an economic advantage in producing green hydrogen in a net-zero economy.

Import costs must be lower than domestic production costs to be a globally traded commodity. But transporting hydrogen over long distances has its issues.

While waiting for the development and improvement of chemical storage of H<sub>2</sub> by third-party substances or materials, the most practical solution at the technological level is to liquefy it.

Liquefaction is a relatively expensive alternative with prohibitive energy consumption. In existing processes, the specific energy consumption is between 12 and 15 kWh/kg per 1 kg of liquefied hydrogen, which means that the liquefaction of hydrogen is about 60% efficient.

New processes under development can reduce energy consumption to 6 kWh of electricity per kg of hydrogen.

One example is active magnetic refrigeration (Amr), in which a compact bed of magnetic material particles is passed through a series of magnetic fields to achieve the cooling effect.

The Amr system has shown promise as a technology for H<sub>2</sub> liquefaction because it offers high cooling performance and efficiency.

A group of researchers from Austria's Institute for Applied Systems Analysis (Iiasa) has proposed to couple the liquefaction of H<sub>2</sub> with the solidification of air. Specifically, the team investigated the possibility of using nitrogen or solid oxygen to recover cooling energy during the regasification of the liquid carrier.

Liquid air to recover cooling energy recovery is already well established. At standard temperatures and pressures, air is a gas, but under certain conditions, it can become liquid or solid. In this process, called

Solid Air Hydrogen Liquefaction, the cooling energy from the regasification of hydrogen is stored, and the air is solidified to transport it to the location where the hydrogen was liquefied.

The solidified air is then used to reduce the energy consumed to liquefy the hydrogen. The process includes 4 phases: hydrogen regasification, transport of solid nitrogen or oxygen, liquefaction of hydrogen, and transport of liquid hydrogen.

The first step removes the cooling potential from liquid H<sub>2</sub> to solidify nitrogen and oxygen.

Liquid nitrogen or oxygen is sprayed into a cryogenic tank.

Upon contact with liquid hydrogen, N<sub>2</sub> or O<sub>2</sub> solidifies and collects at the bottom of the tank, causing the temperature to drop to 20 Kelvin. As a result, H<sub>2</sub> goes into the gaseous state.

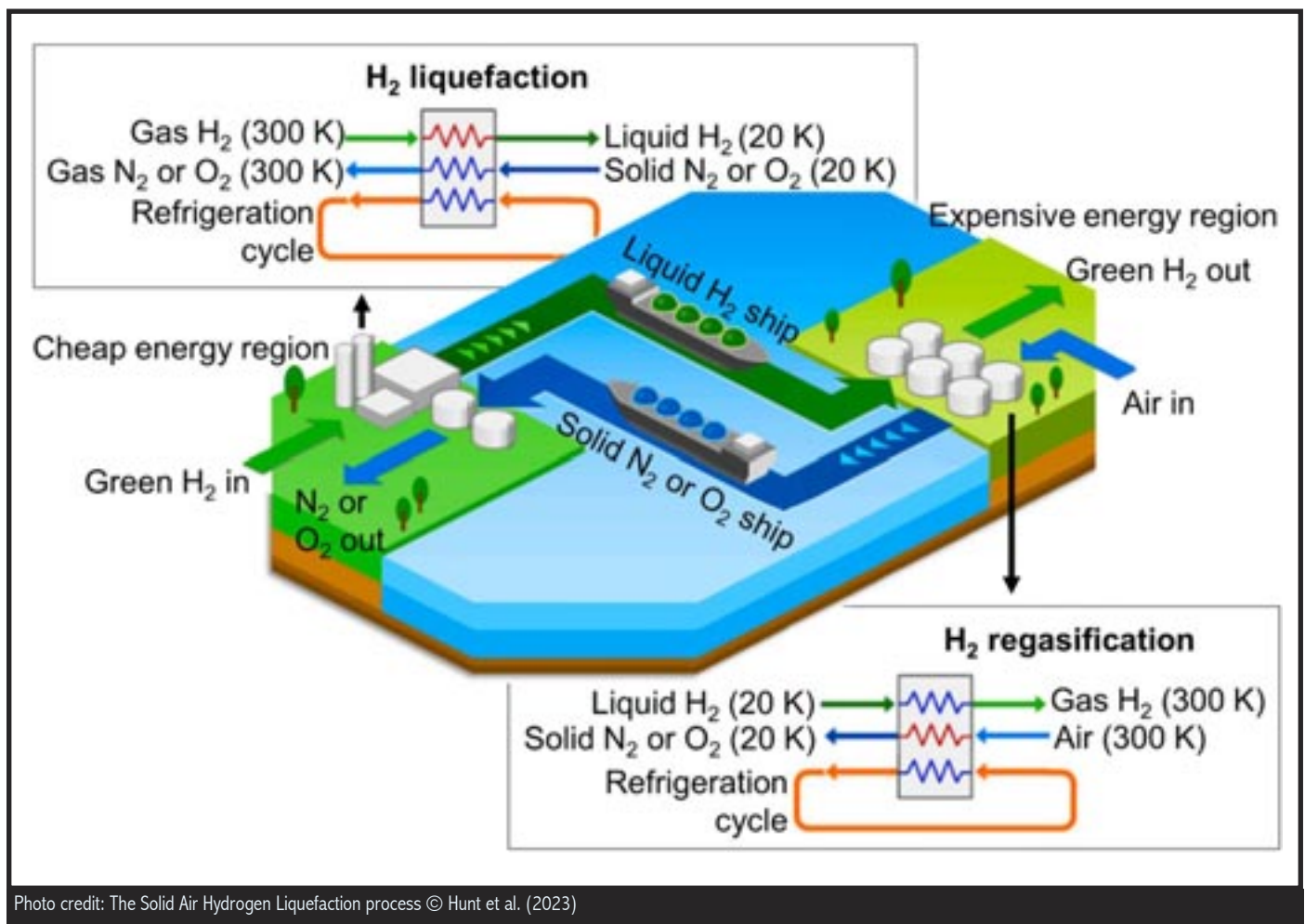
At this point, the solid nitrogen or oxygen is returned

to the original location where the liquid H<sub>2</sub> was generated to utilise the cooling capacity of the solid N<sub>2</sub> or O<sub>2</sub> and cool the hydrogen gas as much as possible. The hydrogen gas enters the tank as it cools, while the N<sub>2</sub> or O<sub>2</sub> returns to the liquid state and is gradually removed to cool the H<sub>2</sub> outside the tank through heat exchangers.

The H<sub>2</sub> is cooled down to about 30 Kelvin. An additional refrigeration system provides the further cooling required to liquefy the H<sub>2</sub>.

After liquefaction, the hydrogen is loaded into an empty tank and transported to the regasification plant, where the cycle begins again.

According to this study, this process can reduce the energy required to liquefy hydrogen by 25,4% when using N<sub>2</sub> and 27,3% when using O<sub>2</sub>. Lower energy consumption and lower costs for transporting hydrogen between continents would increase the viability of a global hydrogen market and hydrogen suppliers for countries with high energy demand. **ONE**



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# ‘EU climate bank’ keeps back door open for fossil fuel giants

The European Investment Bank (EIB) made history with its decision to stop financing fossil fuel energy from 2022 onwards. By adopting the PATH Framework in October 2021, it seemed the EIB had finally set the conditions requiring its clients to disclose information on their corporate-level emissions, as well as decarbonisation plans. But a year later, it made a U-turn.

ANNA ROGGENBUCK  
Bankwatch.org

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The European Investment Bank (EIB) made history with its decision to stop financing fossil fuel energy from 2022 onwards. By adopting the PATH Framework in October 2021, it seemed the EIB had finally set the conditions requiring its clients to disclose information on their corporate-level emissions, as well as decarbonisation plans. But a year later, it made a U-turn.

The EIB’s move to adopt the framework followed criticism that it had failed to take concrete measures to restrict its financing of high-carbon companies.

Research that we conducted in 2018 showed that despite eliminating direct financing for coal projects (both in the mining sector and in energy pro-

duction), the EIB was still indirectly financing the coal sector. Between 2013 and 2017, the EIB provided EUR 3.9 billion to several companies that either had a high share of coal in their power and heat generation portfolios or planned to develop new coal power capacity.

The PATH Framework was supposed to revolutionise the EIB’s approach to financing corporations whose climate impacts go beyond EIB-financed projects due to their operations in high-emission sectors, such as oil and gas extraction or steel and fertiliser production.

It acknowledged its support of companies that continue to engage in activities at odds with the long-term goals of the Paris Agreement, and that





the Bank must therefore ‘address legitimate concerns from stakeholders around the risk of “greenwashing”’.

But the Framework had yet to be even fully implemented when the EIB suddenly announced it would relax the rules for companies involved in the most polluting activities incompatible with the Paris Agreement, such as fresh investments in new high-carbon oil production techniques, thermal coal mines or coal-fired power plants.

Originally, these companies were restricted by the Framework and could only, in exceptional cases, access financing for innovative low-carbon projects involving carbon capture, utilisation and storage, renewable hydrogen, advanced biofuels, deep geothermal energy or floating offshore wind. Now they are off the hook, free to access financing for

all renewable energy projects as well as electric vehicle charging stations.

The EIB’s recent loans to energy companies Polska Grupa Energetyczna (PGE, Poland) and Repsol (Spain) show that the sieve-like PATH Framework has done nothing to stop major oil, coal and gas corporates from continuing their dirty business of polluting the planet.

Effectively given carte blanche, they are now able to run their environmentally- and climate-damaging operations while simultaneously accessing attractive public loans.

## **The case of PGE**

The EIB is a long-term financier of Poland’s state-owned utility PGE. In 2022, PGE received EUR 725 million from the Bank to modernise its electri-

city distribution infrastructure, supplementing the three other existing EIB loans on its balance sheet. PGE is Poland's biggest coal-heavy energy utility, responsible for approximately 40 per cent of the country's electricity generation. It produces energy on a vast scale. Based on 2021 figures, 89 per cent is produced from burning hard coal and brown coal (lignite) and 6 per cent from gas, but a measly 4.4 per cent of the company's energy production comes from renewable energy sources.

In 2021, PGE's production of electricity from lignite increased by 25 per cent in comparison to 2020, while its production of electricity from hard coal also increased by 20 per cent. Over the same period, renewable electricity production remained at the same minimal level. PGE operates two open-pit mines (Belchatów and Turów), which delivered almost 47.2 million tonnes of lignite in 2021, increasing extraction by 18 per cent in comparison to 2020. The company is also a shareholder in hard coal mining group Polska Grupa Górnicza (PGG).

PGE, which owns and operates the notorious 5.3 GW brown coal-fuelled power plant in Belchatów (the largest in Europe), remains one of the biggest carbon dioxide emitters in Europe. In 2022, PGE started selling coal and lignite for heating purposes to external institutions and individual consumers. The use of lignite for home heating had been illegal before the latest legislative changes to address coal shortages were introduced in 2022. Despite knowing that combustion of lignite is extremely toxic, especially when used by individuals to heat their homes, PGE continues to sell it to consumers regardless.

In 2020, PGE announced a new strategy aimed at achieving climate neutrality by 2050. However, the EIB failed to ensure that the company submit its strategy under the PATH Framework criteria. Instead, it granted the company a one-year period to update its strategy. In 2020, Greenpeace filed a lawsuit against PGE – the largest ever filed in Poland – demanding it halt all fossil fuel investments.

During the court proceedings, PGE refused to deliver a decarbonisation plan for its part in producing electricity from coal. Serious doubts remain as to whether the company ever plans to deliver a sound decarbonisation strategy in line with the PATH Framework, which requires the strategy to address all activities, including lignite mining and fossil fuel-based electricity production. For now, PGE's current preference is to rely on the indulgence of its lender.

Shortly after announcing its climate neutrality strategy, the company added 2.3 gigawatts (GW) in brand new coal capacity to be used for at least the next 30 to 40 years: 900 megawatts (MW) each for two new hard-coal-fired units in Opole; and approximately 500 MW for a new lignite-powered unit in Turów. And if the pattern of the company's capital expenditure is anything to go by, PGE is only going to follow one path – in the last six years, the PGE group has spent a meagre 3.5 per cent of its investments on renewable energy sources (4 per cent in 2021).

In early 2022, PGE along with other Polish energy utilities launched a controversial anti-EU 'light bulb campaign'. Huge billboards displayed across the country pushed the misleading narrative that EU climate policies equate to expensive energy costs and high prices. The campaign cost PLN 12 million.

The Polish Advertising Council stated that the campaign breached standards of reliable advertising by falsely claiming 60 per cent of energy production costs were directly caused by the EU's climate policy.

The Council concluded that the campaign's real aim was to reduce the responsibility of the energy companies for the increase in energy prices.

In its response to the campaign, the European Commission rejected the idea that EU climate policy is responsible for 60 per cent of consumer electricity bills, claiming it to be inaccurate.

## The case of Repsol

Repsol, a fossil energy multinational and Spain's top greenhouse gas emitter, is also benefiting from EIB financial support. In December 2022, the Bank signed a EUR 120 million loan for Repsol's first biofuels plant, enabled by a newly introduced 'exception' under the PATH Framework.

Located in Cartagena, Spain, the plant is intended to produce fuels for transport 'from different types of waste primarily from the agri-food industry, such as used cooking oils', according to the EIB. But these so-called innovative fuels are also deeply problematic. One of the plant's products, hydro-treated vegetable oil (HVO), is often synthesised from palm oil, the exploitation of which has led to extensive deforestation and human rights violations. In 2016, the European Commission designated palm-oil-based biofuels as a high-risk indirect land use change (ILUC) biofuel and, in 2019, decided to initiate a complete phase-out given its catastrophic environmental and social implications. Producing HVO from palm oil can hardly be considered sustainable by any yardstick, let alone a legitimate use of EU public money.

In justifying its loan for the project, the EIB claims it is 'supporting Repsol's decarbonisation strategy'. But even if this project were ever to be deemed environmentally sound, it's only a drop in the dirty bucket that is Repsol's fossil fuel business. Even the EIB has acknowledged that Repsol, which is also engaged in shale and oil production, pursues 'activities that are considered incompatible with the Paris Agreement in the PATH framework'. Yet the Bank has sought to legitimise its support for Repsol by focusing on the 'innovative nature' of the project while ignoring the multinational's core business.

Apart from being a repeat climate offender, Repsol also has a dismal human rights and environmental track record. In January 2022, a Repsol-owned re-

finery was behind a major oil spill on the coast of Peru. Nearly 12,000 barrels of oil contaminated the ocean and coasts, dealing a devastating blow to approximately 3,000 families, many of whom depend on fishing and tourism for their livelihoods. In their report on the spill, UN agencies UNEP and OCHA state: 'Vulnerable communities who rely on the sea are facing uncertain futures amid beach closure, safety concerns and limited options.'

In late February, activists from the environmental group *Ecologistas en Acción* staged a protest in Madrid in solidarity with the Peruvian fisherfolk affected, demanding Repsol be held accountable for the vast damage wrought by the spill.

As a result of its role in the environmental catastrophe, Repsol has thus far been issued with over EUR 16 million in fines by the Peruvian authorities. With local ecosystems not expected to recover for many years, farmers who depend on them for their livelihoods are now demanding just reparation.

Quite apart from the environmental and humanitarian consequences of Repsol's actions, it is morally unacceptable that EU public funds should be used to support a major, discredited energy multinational that raked in a net income of EUR 3.2 billion within the first nine months of 2022 alone.

It is ludicrous for the self-styled 'EU climate bank' to be channelling public money into fossil fuel companies such as PGE and Repsol. By financing their so-called 'sustainable energy projects', the EIB has not only turned a blind eye to the core business of companies that have made fortunes on the back of a historic energy crisis, but has also made itself complicit in their brazen attempts at greenwashing.

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# As Shell, Eni quit Niger Delta, state-backed report describes legacy of carnage

**A new report commissioned by the governor of Bayelsa state in Nigeria said that over the course of 50 years, oil companies spilled 10-15 times as much oil as the Exxon Valdez disaster in the small riverine state.**

ASHOKA MUKPO

Mongabay

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Oil and gas companies, led by Shell, Eni, Chevron, Total and ExxonMobil, spilled 110,000 barrels of oil into Nigeria's Bayelsa state over the past 50 years, a new report says. The report, released by a commission of experts set up by the state government in 2019, also reported finding levels of heavy metals associated with oil production in human tissue in the state that are far higher than safe levels.

The commission, the first of its kind to be directly appointed by a state government in Nigeria's notoriously polluted Niger Delta, called for Shell and others to set up a \$12 billion cleanup fund to address the environmental and health impacts of the oil industry in Bayelsa.

Bayelsa state lies on Nigeria's coastline and once included parts of Africa's largest mangrove forest. Its mangroves, coastal barrier islands and freshwater and lowland rainforests are home to a wide variety of wildlife, including threatened red colobus monkeys (*Piliocolobus epieni*). Bayelsa was also once home to robust populations of chimpanzees (*Pan troglodytes ellioti*) and pygmy hippos (*Choeropsis liberiensis*), but these have now all but vanished.

Long years of exploitation of the area's resources by transnational companies, beginning with palm oil for the Royal Niger Company in the 17th century and continuing into the present with unregulated logging and, since the late 1950s, the petroleum industry, have taken a terrible toll on the environment and fishing and farming communities of the delta.

According to official Nigerian government data cited in the

report, at least 234 oil spills happen every year in the small state, which covers just 3,500 square kilometers (1,350 square miles). Between 2006 and 2020, at least 110,000 barrels of oil were spilled into its rivers, swamps, and forests — 90% of which came from facilities owned by just five oil companies: Shell, Eni, Chevron, Total and ExxonMobil.

"For people living in Bayelsa, the air they breathe, the water they drink, the fish that they rely on, and the lands that they farm are all thick with oil," said Kathryn Nwajaku-Dahou, a program manager at the UK think tank, the Overseas Development Institute and chair of the Bayelsa State Oil and Environmental Commission's expert working group.

As dramatic as the figures are, the commission says they're almost certainly an underestimate. Most statistics on oil spills in the Niger Delta come from the Nigerian Oil Spill Detection and Response Agency (NOSDRA), an arm of the federal government. But the agency is reliant on oil companies themselves to transport inspectors to remote areas where oil spills take place, and their figures are as much as three times lower than the number of lost barrels recorded by other parts of the Nigerian government that are responsible for monitoring production.

"There's a whole political economy around how spills are identified, who designates them as oil company fault or third-party sabotage, and the consequences of that," Nwajaku-Dahou said.



A boy with a fishing net stands on the oil-soaked bank of a creek area in the Niger Delta: children are particularly susceptible to environmental pollutants, absorbing it into their tissue more rapidly than adults. Photo credit: Milieudéfense/Flickr

“All of that means there’s a tendency to underestimate. And it’s not just a tendency, it’s a kind of deliberate skewing of the way we describe and ascertain spills that’s built into the system.”

In one eye-opening estimate, the report said that as much as 10-15 times the amount of oil lost in the Exxon Valdez disaster may have been spilled in Bayelsa over 50 years of production.

The commission also worked with forensic scientists and medical researchers to collect and test samples of water, sediments, plants and animals in the food chain in 17 sites in Bayelsa. They found that surface water in the test sites showed concentrations of “total petroleum hydrocarbons” — chemical compounds present in crude oil that are associated with health risks — that were at least 300 times the maximum safe value in every sample they took. At one site, the concentration was more than 700,000 times the safe limit.

Researchers also took blood and tissue samples from 1,600 people living across the state. According to their analysis, the amount of dangerous heavy metals like lead and cadmium from oil pollution was as much as six times higher in people living in Bayelsa than is safe.

Both metals have been associated with higher cancer risks,

and can cause birth defects, neurological damage and other serious health risks.

In testimonies published in the report, Bayelsa residents described ongoing health issues, poisoned waterways and a byzantine system of legal and corporate requirements for assessing spills that made it nearly impossible for them to get compensation for damages.

“I live within 500 meters [0.3 miles] of a multibillion-dollar oil facility, flaring toxic gas into the air every day,” said Bubaraye Dakolo, traditional ruler of the Ekpetiama Kingdom and chair of the Bayelsa State Council of Chiefs. “I am a traditional ruler in Bayelsa state. The enormous suffering caused by oil pollution in my kingdom pokes me, chokes me, and stares me in the face every day.”

Representatives of the Bayelsa State Oil and Environmental Commission told Mongabay that while the extent of the damage in the region has been well-known for decades, they hope the official stamp of a local government will help spur action.

“It’s important that the Bayelsa state government commissioned this, because it’s a signal to Nigeria and the federal government — but also the world at large — of the seriousness of the accumulated crises, what our report refers to as an ecocide,” said Michael C. Watts, professor emeritus



A typical landscape in Niger Delta. Photo credit: SteadyWins

at the University of California, Berkeley, and one of the lead researchers. “We’re at a tipping point that really needs massive international and national resources and attention.”

The commission was critical of Nigeria’s regulatory and monitoring framework, including the recently passed Petroleum Industry Act, saying it failed to grant adequate powers to environmental agencies, instead placing oversight in the hands of government bodies more closely tied to the business side of the oil industry.

Environmental activists in the region said the report’s findings tracked what they’d seen during decades of oil production in Bayelsa.

“Bayelsa state has been pronounced by [NOSDRA] as the most polluted in Nigeria, and there has never been any proper cleanup,” said Alagoa Morris of the Bayelsa-based Niger Delta Resource Centre.

The report comes amid an accelerating strategy by companies like Shell to withdraw from the Niger Delta, moving their operations to deep-water wells offshore in an attempt to meet their climate commitments and avoid bad publicity. Shell is facing lawsuits in multiple countries over the impact of its operations in Nigeria, and activists in Bayelsa say they worry that along with the other oil majors, it will leave the region without cleaning up the mess it left behind.

“Shell should do the proper cleanup before they sell and divest, and the same goes for any company operating in the Niger Delta and Bayelsa state,” Morris said.

The commission wants Shell, Eni and the other oil majors to capitalize a \$12 billion fund that they say is necessary to address the damage done to ecosystems and communities in Bayelsa over the past five decades. In 2022, Shell made a record \$40 billion in profits, and Eni posted its own record with \$14 billion.

A chunk of those profits, the report’s authors say, should be directed to Bayelsa, which has suffered not just under the oil and gas regime of the past 75 years, but under extractive pressures for centuries.

“This is the area where in the 16th century you had slaves taken in the trans-Atlantic slave trade, then the mass palm oil trade replaced slavery, and now petroleum and oil and gas extraction has followed the same path, essentially destroying not just the environment, but the source of life and livelihood for most people in the Delta,” Nwajaku-Dahou said.

“It’s not just a tragedy, it’s criminal.”

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# Urgent action needed in food sector to curb warming: study

LENA BECK

Coastal Review

A study recently published in *Nature Climate Change* found that the global food sector alone, the way it is now, could add nearly 1 degree Celsius to global climate warming by the year 2100. But over half of this anticipated warming could be avoided if there were simultaneous changes made to production and food waste systems, the energy sector, as well as universal diet changes.

It is exceedingly hard to estimate warming associated with agriculture at the global level. One of the biggest reasons for this is that the agricultural sector emits multiple climate pollutants, things like carbon dioxide, methane and nitrous oxide. Often, to make it easier to estimate emissions, a strategy is used called “carbon dioxide equivalents.” This puts all emissions on the same comparable scale, making it easier to measure aggregate impact.

The downside of this method is that different pollutants spend varying amounts of time in the atmosphere and trap different amounts of heat. So when you only look at these emissions through the lens of carbon dioxide, you risk blurring the picture of what agricultural emissions actually look like, and what can be done to address them. This study aimed to paint a clearer image.

Previous research has shown that one of the biggest pollutants from the agriculture sector is methane, which stays in the atmosphere for a far shorter amount of time than carbon dioxide but has a stronger warming effect on the atmosphere per mass. So looking at a long-term timescale in carbon dioxide equivalents would really downplay the role of methane emissions in the agriculture industry.

In order to get a better idea of how different pollutants could impact warming by the year 2100, the researchers had to look at the emissions individually, not as an aggregate.

“It just made it very apparent that when people are doing lifecycle assessments and when they’re doing this kind of work, the need to report those emissions in the explicit gas emission rather than an aggregate it is really essential,” said Catherine Ivanovich, a doctoral candidate in the Department of Earth and Environmental Sciences at Columbia University and lead author on this study. “And the more that people can do this type of work can reduce future uncertainty.”

The researchers analyzed literature on the food sector including agriculture, fisheries, ranching and more. One of the findings of this study was that consumption of meat and dairy will be responsible for more than half of food-associated warming by the year 2030, and continuing through 2100.

The researchers explored four different possible arenas in which to mitigate anticipated warming: production, consumption, the energy sector and food loss/waste.

Optimizing agricultural production practices could contribute 25% of possible reductions by 2100. Decarbonizing the energy sector by 2050 would decrease the anticipated warming from the food sector by 17% by the end of the century.

A global diet shift based on health recommendations could decrease projected warming by 21%. Finally, if the world were able to cut consumer and retail food waste in half by the end of the century, it would de-





crease anticipated warming by 9%.

Changes to production, the energy sector and food loss/waste would all be largely structural or systemic changes, while changing the ways in which people consume food through diet is more of a behavioral shift. The limitation of this method is that making any kind of change on a global scale is very difficult and maybe unlikely. But the benefit is that taking a simplified approach allows people to see the full extent of what could be possible with these kinds of shifts.

“We can really just think of it as a very theoretical test of the rough magnitude these storyline scenarios might be expected to trigger,” Ivanovich said.

Regardless, Ivanovich says that both supply-side and consumer-side interventions, at multiple scales, are going to be critical to reduce anticipated warming in the food sector.

Questions about how to advance in the food sector are made even more complicated when moving beyond consideration of greenhouse gases. Other important factors to consider are how different food production techniques impact the environment and space use on the land and in the ocean.

“In order to make meaningful change in this sector, which is a really essential aspect of human life — supporting people, ensuring that we’re pursuing global food security and also sustaining economic livelihood for people who are producing our foods — we really need a multi-angle approach,” Ivanovich said. “We can really work towards increased food security, and pro-

viding people with nutritious diets, all the while working towards a more climate-safe future.”

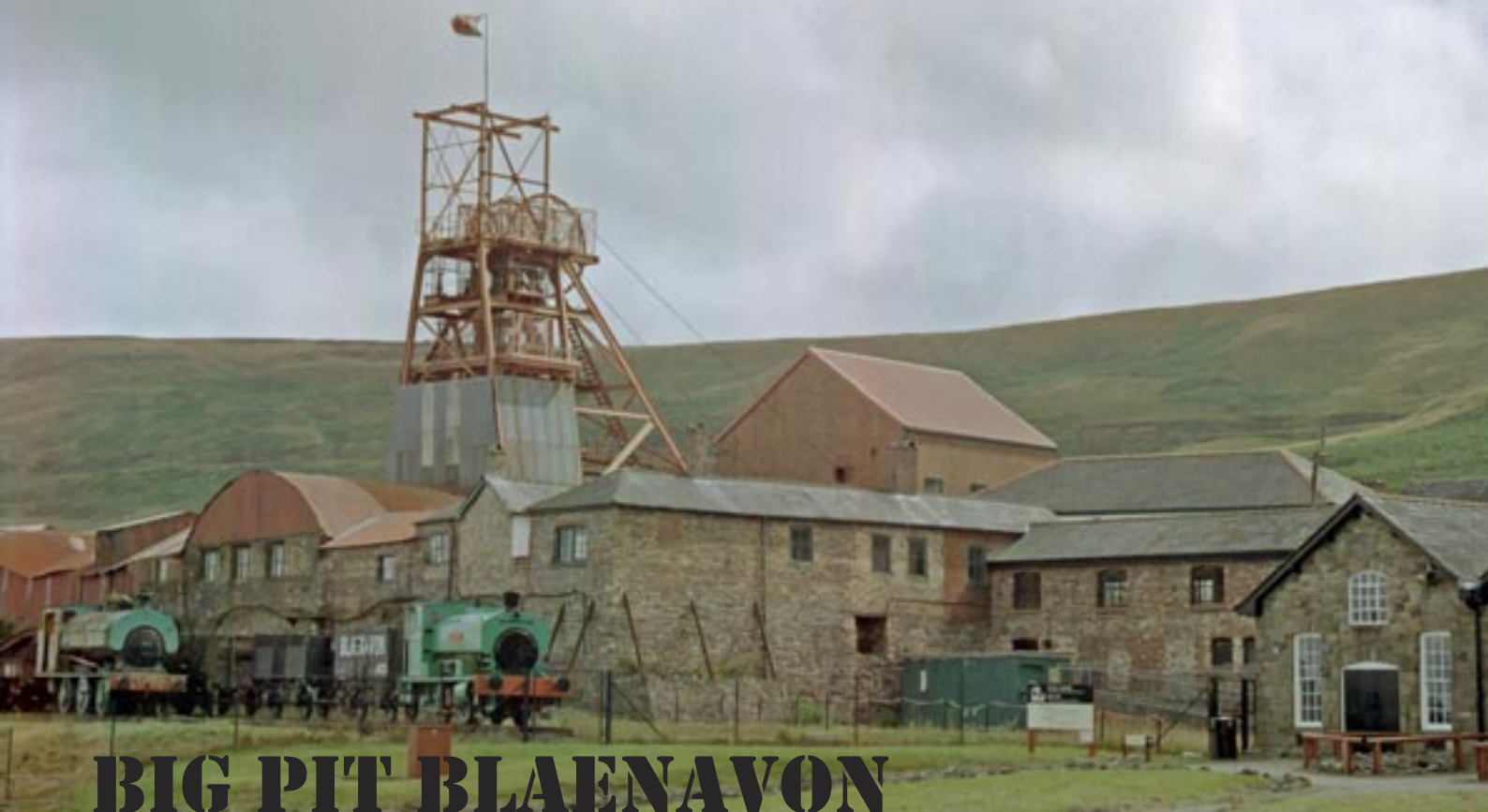
According to the North Carolina Local Food Council, climate change poses a notable threat to the state’s food system. But a more resilient local food system focused on food waste recovery, local food infrastructure, better support for cultivators and addressing racial inequities in the food sector, among other things, would make the state less vulnerable in the face of pressures like climate change. There are resources on the Local Food Council’s website toward that end.

There are also reasons to be optimistic, said Ivanovich. When you separate the different pollutants, you can see that nearly 60% of the warming by the end of the century is because of methane. And since methane is a short-lived emission, making rapid changes in that sector now could make a big difference in slowing down the rate of warming associated with the food sector.

It also underscores the urgency for action, according to Ivanovich.

“Everyone has to eat,” Ivanovich said. “We have to ensure that we can sustain our global population with nutritious food that supports people at a local scale. This is the problem that we can’t really shy away from.”

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## BIG PIT BLAENAVON

Big Pit National Coal Museum is an industrial heritage museum in Blaenavon, Wales (United Kingdom). The Big Pit is part of a network of coal workings established in the first half of the nineteenth century by the Blaenavon Iron and Coal Company as part of the development of the Blaenavon Ironworks, which means it has some of the oldest large scale industrial coal mining developments in the South Wales Coalfield. The shaft at the present colliery was sunk around 1860 and deepened in 1880. The pit was operated in connection with Blaenavon Ironworks Company until nationalisation in 1947.

Most surface buildings are still on the site except the washery, which has been demolished. The facilities are the most comprehensive overground and underground layout surviving in Wales; the pit bank and steel headframe date from 1921, the tram circuit and electric winding engine date from 1952, the fan house dates from 1910, and there are also workshops and offices. The baths and canteen were built in 1939 and are an excellent example of the International Modernist style. Coal production ceased in 1980, and the site is now the Welsh Mining Museum and open to the public with underground access. **ONE**

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