ESR NEWSLETTER
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Contents

1.Global CO2 emissions in 2024

From an article by Kate Abnett, Reuters, November 13, 2024:

Year 2024 Summary

- Emissions from fossil fuels to rise nearly 1% to 37.4 bln T
- Severe wildfires fuel 13.5% surge in land-use emissions
- Emissions decrease in rich nations, rise in emerging economies
- Without urgent action, global climate goals out of reach

The Global Carbon Budget report, published during the U.N.'s COP29 climate summit in Azerbaijan, said global CO2 emissions are set to total 41.6 billion metric tons in 2024, up from 40.6 billion tons last year. The bulk of these emissions are from burning coal, oil and gas. Those emissions would total 37.4 billion tons in 2024, up by 0.8% in 2023, the report said. The rest are from land use, a category that includes deforestation and forest fires. The report by more than 80 institutions was led by the University of Exeter in Britain.

2. Climate crisis effects on Earth's water cycle

From an article by Damian Carrington, Guardian Environment editor, 6 Jan 2025

The climate crisis is "wreaking havoc" on the planet's water cycle, with ferocious floods and crippling droughts affecting billions of people, a report has found.

The 2024 Global Water Monitor Report was produced by an international team of researchers from universities in Australia, Saudi Arabia, China, Germany and elsewhere. The team used data from thousands of ground stations and satellites orbiting the Earth to assess critical water variables such as rainfall, soil moisture, river flows, and flooding.

They found rainfall records are being broken with increasing regularity. For example, record highs for monthly rainfall were set 27% more often in 2024 than in the year 2000 and daily rainfall records were set 52% more frequently. Record lows were set 38% more often. "So we are seeing worse extremes on both sides," said Prof Albert van Dijk, the report's leader.

In southern China from May to July, the Yangtze and Pearl rivers flooded cities and towns, displacing tens of thousands of people and causing hundreds of millions of dollars of damage to crops. The river floods in Bangladesh in August after heavy monsoon rains affected almost 6 million people and destroyed at least a million tonnes of rice.

Meanwhile, in Spain in October more than 500mm of rain fell in eight hours, causing deadly flash floods. The city of Porto Alegre, Brazil, was inundated with two months' worth of rain in just three days in May, transforming roads into rivers.

"Heavy rainfall events also caused widespread flash flooding in Afghanistan and Pakistan, killing more than 1,000 people," Van Dijk said. The flooding also displaced 1.5 million people.

In the Amazon, drought struck. "Wildfires driven by the hot and dry weather burned through more than 52,000 sq km in September alone, releasing vast amounts of greenhouse gases," Van Dijk said. "From historic droughts to catastrophic floods, these extreme events impact lives, livelihoods, and entire ecosystems."

"We need to prepare and adapt to inevitably more severe extreme events," said Van Dijk. "That can mean stronger flood defences, developing more drought-resilient food production and water supplies, and better early warning systems. Water is our most critical resource, and its extremes – both floods and droughts – are among the greatest threats we face."

3. US homeowners in disaster-prone states face soaring insurance costs

From an article by Oliver Milman, Guardian website, 22 Jan 2025

Homeowners in the United States are facing an enormous financial crunch due to the climate crisis, with many struggling to find insurance or even dropping premiums that are soaring due to a mounting toll of wildfires, hurricanes and other disasters, new federal government data shows.

The figures, the most comprehensive numbers ever released by the US treasury department on the issue, show insurance premiums are increasing quickly across the country, with people living amid the greatest climate-driven risks experiencing the steepest rises of all. In the four years to 2022, people living in the top 20% riskiest places for such perils paid, on average, 82% more than those in the 20% lowest climate risk zip codes.

The climate crisis is making it harder for insurance companies to operate, with many pausing or completely withdrawing from disaster-prone states such as Florida and California, which is currently being roiled by wildfires in the Los Angeles region.

"We are marching towards an uninsurable future," said David Jones, the former insurance commissioner of California. "The climate crisis is driving an insurance crisis. "This is the first such comprehensive report by government and it shows that wherever climate change is landing as more severe weather events it is causing greater insurance unavailability, higher insurance pricing and greater insurance losses."

Jones said that while the "future doesn't look very bright" on acting upon the climate crisis following Trump's election, the report makes a clear case to cut planet-heating emissions.

The US treasury report, released last week in the final days of Joe Biden's administration, is drawn from 330 insurers and the coverage offered to more than 246m homeowners. Seven states –Florida, Louisiana, Alabama, Georgia, Indiana, Montana and North Dakota – declined to take part in the study, while Texas didn't provide some data.

States are increasingly having to set up backstop insurance options to cover residents as insurers decide to stop writing new policies or withdraw entirely from states. The Los Angeles fires, which may be the costliest fire event in California history, could push up premiums further or cause some insurers to leave the state.

In Florida, even deregulation called for by the insurance industry, leading to sky-high rates for residents, has failed to tempt back insurers that have exited that state. The climate costs to insurance are felt elsewhere, too, mostly around the hurricane-prone Gulf of Mexico coast but also in places unused to such ructions such as the midwest, which has seen an increase in damaging storms.

This all means that many Americans will increasingly face problems when buying new houses, Jones said, as insurance is required to obtain mortgages. Others will struggle to pay rising premiums or fall back on strained state-based systems that will have to be supported by taxpayers.

“Climate change is posing a systemic risk to the financial system, through insurance and housing, and it means it will get harder to get a mortgage and more people will be driven to state plans,” Jones said. “We will have to shore up these plans because they are going to face problems when there’s a catastrophic event.

4. Climate Change and Geopolitics

Excerpts from an article in the Guardian website by Oliver Milman in New York dated 13 January 2025

“Greenland has lost massive amounts of ice, making it more attractive for rare earth mining and oil drilling, while we are already seeing more traffic through the Arctic Ocean as it becomes ice free for longer,” said Alice Hill, a former climate adviser to Barack Obama and now a fellow at the Council on Foreign Relations.

“In Panama, climate change impacts how the canal operates and puts pressure on the US to find different routes or try to get priority over China for the canal itself.

“Climate change is altering the fundamental calculus of the strategic importance of the Arctic as well as the Panama canal,” Hill added. “

The impacts of a superheated planet are helping refashion geopolitics in a variety of ways, as droughts and storms cause people to migrate, conflicts erupt over resources such as water and borders are even redrawn between some countries as snow and ice dwindle.

The US isn’t the only power attempting to capitalize upon the upending of a stable climate, with China hatching plans for a “polar silk road” that will connect Chinese ports to Europe and beyond via a northern shipping route as the Arctic becomes less dominated by ice.

“Climate change is shaping geopolitics even if leaders don’t want to admit it,” said Sherri Goodman, an author and expert on the polar region at the Wilson Center. “China is clear-eyed about the climate threat and they will take advantage of that in access to resources and infrastructure.

This scramble for resources, and the rise of nationalist leaders in several countries including the US, has stoked fears of a sort of rightwing environmentalism taking hold where wealthier countries trample over those in vulnerable nations as climate disasters escalate. Jean-Noël Barrot, France’s foreign minister, warned last week: “We have entered an era that is seeing the return of the law of the strongest.”

5. EU's electricity mix in 2024

From an article by Susanna Twidale

Jan 23 (Reuters) - Solar power overtook coal in the European Union's electricity mix for the first time last year, while wind power's share plateaued, data from energy think tank Ember showed on Thursday. The EU is seeking to increase its renewable power generation as part of efforts to cut emissions and reach its climate targets as well as cutting its reliance on fossil fuel imports to help boost energy security.

Solar generation provided 11% of the EU's electricity mix in 2024, up from 9.3% in 2023 and overtaking coal which fell to less than 10% for the first time since Ember began collating the figures in 2011, the data showed.

"For the past two years we have seen sharp declines in both coal and gas in the EU power system and fossil fuels are now at an historic low," Chris Rosslowe, senior analyst and lead author of the report said in an interview.

Gas-fired power production fell to a 15.7% share from 16.9% in 2023 while wind power was almost flat at 17.4%. Although some 13 gigawatts (GW) of new wind capacity was added in 2024, wind conditions were less favourable than in 2023, leading to lower than expected generation.

The EU wants wind power to make up around 34% of its electricity mix by 2030 and more action is needed, particularly around making permitting for new projects easier, to meet the goal, Rosslowe said.

Nuclear remained the dominant electricity provider in the EU, rising to 23.7% from 23% in 2023.

6. Toxic PFAS pollution in UK and Europe

From an article by Leana Hosea and Rachel Salvidge, Guardian website, 14 Jan 2025

The cost of cleaning up toxic PFA pollution could reach more than £1.6tn across the UK and Europe over a 20-year period, an annual bill of £84bn, research has found.

PFAS (per- and polyfluoroalkyl substances), commonly referred to as "forever chemicals" are a family of more than 10,000 human-made substances. Manufactured by a handful of companies, they are widely used in consumer products and industrial processes.

They can be found in nonstick pans, pizza boxes, cosmetics, waterproof clothing, firefighting foam and pharmaceuticals, among other places. The properties that make them so useful – heatproof, greaseproof and waterproof – also have fateful downsides. Almost indestructible without human intervention and persistent in living organisms, PFAS have been linked to infertility, cancers, immune and hormone disruption, and other illnesses.

PFAS are ubiquitous and have been detected in drinking water and surface waters across the UK, which makes the task of remediation huge and complex. Hotspots of contamination include landfills, airports, military sites, sewage outfalls, sewage sludge, manufacturers and industrial users of PFAS, and places where large amounts of firefighting foams have been used.

Just to clean up existing legacy pollution in the UK, analysis has found it will cost an estimated £428m every year for the next 20 years, based on existing cost data. This would cover remediating contaminated soils, landfill leachate and to treat 5% of the drinking water in large water supply zones for just the two regulated PFAS compounds, PFOS and PFOA. These costs are conservative, as they only include decontamination costs, not socioeconomic costs or potential costs to the health system. It also assumes that PFAS emissions stop immediately.

“Current remediation of PFAS-contaminated samples is predominantly through high temperature incineration, which is very expensive,” said Dave Megson, a PFAS expert at Manchester Metropolitan University. “Our recent research on landfill wastewater treatment plants shows that some facilities actually create banned PFAS, rather than destroy them. More funding towards developing effective lower cost remediation options is desperately needed to tackle this issue.”

A YouGov survey commissioned by the Royal Society of Chemistry (RSC) found more than three-quarters of respondents said the use of PFAS known to be toxic should be stopped immediately or subject to more effective controls. The most popular control measure the UK public would accept is increased regulation on industries using PFAS, requiring them to reduce and reverse the contamination caused by their processes.

The RSC is calling for public protections from toxic PFAS to be enshrined in the recent water special measures bill, which is now at the committee stage. “No one chooses the water that comes out of their tap. This bill is a crucial first step, and we also urge government and industry to build upon this change by creating a national inventory of PFAS and enforcing stricter limits on industrial discharges,” said Stephanie Metzger, the RSC’s chemistry policy adviser.

7. Flatulence tax: Denmark agrees deal for livestock emissions levy

From an article by Hafsa Khalil, BBC News, 18 November 2024

Denmark has agreed on how to implement the world’s first tax on agricultural emissions, including flatulence by livestock. This comes after months of negotiations between the country’s major parties, farmers, the industry, trade unions and environmental groups. The Green Tripartite agreement was first announced in June.

From 2030, farmers will have to pay a levy of 300 kroner (72 NZ$) per tonne of methane (as per carbon dioxide equivalent) on emissions from livestock including cows and pigs, which will rise to 750 kroner (181 NZ$) in 2035.

The Green Tripartite minister said they will "do what it takes to reach our climate goals" after receiving a "broad majority" in parliament. "[It is a] huge, huge task that is now underway: to transform large parts of our land from agricultural production to forestry, to natural spaces, to ensure that we can bring life back to our fjords," Jeppe Bruus said.

Part of the Green Tripartite agreement between the government, the agriculture industry and environmental organisations is to also reduce nitrogen pollution in an effort to restore the coasts and fjords. Nitrogen emissions could be reduced by 13,780 tonnes annually from 2027, AFP news agency reported.

A concerted effort will also be made to improve the country's biodiversity. According to Danish daily The Copenhagen Post, 250,000 hectares of new forest will be planted, and 140,000 hectares of peatlands that are currently being cultivated will be restored to natural habitat. Peatlands are wetlands characterised by waterlogged conditions and are known carbon stores.

8. Sites without sound: Oslo leads in quiet, low-emission electric construction

From an article by Ajit Niranjan in Oslo, Guardian website, Fri 10 Jan 2025

The peaceful streets of Oslo are growing even calmer as the city drives noisy machines off municipal building sites. For locals and builders, the drop in decibels is a welcome side-effect of a goal to keep city-managed construction projects free from toxic emissions. The mandate, which is the first of its kind in the world, came into effect on 1 January.

"I don't think we're going to get to 100%, because not all [electric] machines are available on the market," said Ingrid Kiær Salmi, an engineer from Oslo's urban environment agency, speaking to the Guardian at a building site in the city centre last year. "But I think we're going to get pretty close."

Construction is one of the biggest sources of urban air pollution, but even forward-thinking cities such as Oslo have struggled to clean it up. The Norwegian capital has led the way in replacing the petrol and diesel that powers its construction equipment with biofuels, which do little to heat the planet but still foul the local air. It is now moving to battery-powered machines.

The latest data shows Oslo's municipal building sites were 98% free from fossil fuels in 2023; three-quarters were powered by biofuels and less than one-quarter by electricity. For projects run by the urban environment agency, which has more recent data through

to October 2024, two-thirds of machine hours were powered by electricity and one-third by biodiesel.

The signal Oslo sent has helped the industry develop electric machines from which other cities can also benefit, said Salmi. “We’ve used a lot of demo editions and customised machines, so the technology is developing and becoming more suitable for these kinds of projects.”

Electric vehicles are nothing new to Norwegians, who are more likely to drive a car with a big battery than one with a combustion engine, but the market for clean diggers and wheel loaders still has a way to go. The building industry has pushed back on Oslo’s pioneering plans for moving too fast, and has called for a more flexible approach that looks at a construction project’s total emissions rather than regulating its equipment.

The requirement that all machinery on building sites must be emission-free is “at this point, neither effective nor cost-efficient”, said Stine Marie Haugen, from the Norwegian construction and civil engineering contractors’ association. “Currently, very few countries in Europe have a strong focus on emission-free machinery, which means that access to such equipment is somewhat limited,” she said. “Only a few countries bear the development costs of bringing these machines to market.”

As the volume of vehicles increases, costs will come down – but “like with all new technology, there is a green premium”, said Tora Leifland, the head of public affairs at Volvo Construction Equipment. A battery-powered machine can cost twice as much as a diesel one, she said.

There are also benefits that are harder to capture, such as quieter working conditions on-site and reduced disruptions to local communities and businesses.

Oslo is not the only city in which officials are encouraging the shift to cleaner construction machines. In Stockholm, authorities redeveloping a former meatpacking district have raised the minimum requirement for electric machines from 10% to 50%, and are running the rest on biofuels. In the Netherlands, a water board’s project to strengthen a dyke is using more than 40 heavy-duty electric machines, and has led to the construction of the world’s first fast-charging station for large vehicles and machines.

9. Report says blue hydrogen gives false hope for green steel

From Energy Source and Distribution Magazine, January 21, 2025

Steelmakers considering using ‘blue hydrogen’ to decarbonise production will not significantly reduce their emissions, according to the Institute for Energy Economics and Financial Analysis (IEEFA).

Applications for hydrogen have narrowed to a few key areas, including iron and steel, where electrification may not be able to decarbonise the sector completely. While

green hydrogen (produced using renewable energy and electrolysis) has emerged as the primary pathway for green steel, its costs remain higher than anticipated.

As an alternative, a number of countries and corporates are considering 'blue hydrogen'— produced from fossil gas coupled with carbon capture and storage (CCS) technology.

Companies like POSCO, Thyssenkrupp and Salzgitter have been exploring the use of blue hydrogen in ironmaking. Woodside's involvement in the NeoSmelt collaboration (focusing on a low-emissions ironmaking pilot plant) in Australia further highlights the future possibility of using fossil-based hydrogen in this initiative. Additionally, the German government is advocating for a less strict definition of clean hydrogen within the EU, aiming to facilitate the use of blue hydrogen for end users.

However, a new briefing note from IEEFA—Blue hydrogen: A false hope for steel decarbonisation—critically assesses the role that blue hydrogen might play, and identifies a range of problems that severely hamper its potential for decarbonising steel production.

"As the hydrogen landscape becomes more pragmatic, choosing the right 'colour' of hydrogen becomes crucial to maximising its impact on decarbonisation," IEEFA energy finance analyst, global steel, Soroush Basirat explains. "Any investment in fossil fuel-based hydrogen production risks trapping investors, as they may find themselves committed to a long-standing technology likely to become obsolete in the coming years."

One of the primary issues facing blue hydrogen is its reliance on carbon capture. Over a period of nearly five decades, CCS has amassed a track record of significant underperformance, with projects consistently falling short of achieving their targets for capturing carbon dioxide (CO2).

IEEFA's research indicates capture rates of the operating blue hydrogen plants fall well below the 95% often claimed by CCS proponents.

IEEFA's research shows that it will be extremely challenging for blue hydrogen to meet the emissions intensity targets of key markets such as the US, the EU, Japan and South Korea. Major oil and gas companies like Shell and Equinor have abandoned their blue hydrogen projects, citing the challenges of meeting the EU's strict carbon emissions regulations and lack of demand. Stricter regulations will come into effect in the coming years, making it increasingly difficult for blue hydrogen to attract end-users including steelmakers.

In the direct reduction (DR) ironmaking process, replacing gas with hydrogen produced from gas (grey hydrogen) does not lead to a reduction in gas consumption or carbon emission. The DR technology provider Tenova has emphasised that "... direct use of fossil gas followed by green hydrogen will be the efficient and economical approach versus blue hydrogen for carbon reduction."

Meanwhile, the cost advantage for blue hydrogen appears likely to be short-lived. In some countries well positioned for production, it will be possible to produce green hydrogen at a lower cost than blue hydrogen by the end of this decade. Meanwhile, blue hydrogen will continue to face challenges from high gas price volatility and the costs associated with CCS, which remain stubbornly high.

In addition, blue hydrogen requires significant upfront investment in production facilities, gas infrastructure and carbon capture. In contrast, green hydrogen can be developed incrementally due to its modularity, reducing investment risks over time.

“In the steel sector, continuing to use fossil fuels poses significant risks, especially given the unrealistic expectations of CCS as a means to eliminate emissions,” Basirat says. “Although costs have not declined as fast as forecasts suggested, green hydrogen remains the most effective long-term solution for addressing the decarbonisation of primary steelmaking.”

10.How to make oxygen on the moon

From an article by Chris Baraniuk, Technology Reporter, BBC, 24 Jan 2025

Sierra Space is working on a device designed to produce oxygen in moon-like conditions. Inside a giant sphere, the engineers pored over their equipment. Before them stood a silvery metal contraption swathed in colourful wires – a box that they hope will one day make oxygen on the moon. Once the team vacated the sphere, the experiment began. The box-like machine was now ingesting small quantities of a dusty regolith – a mixture of dust and sharp grit with a chemical composition mimicking real lunar soil.

Soon, that regolith was gloop. A layer of it heated to temperatures above 1,650C. And, with the addition of some reactants, oxygen-containing molecules began to bubble out.

“We’ve tested everything we can on Earth now,” says Brant White, a program manager at Sierra Space, a private company. “The next step is going to the moon.”

Sierra Space’s experiment unfolded at Nasa’s Johnson Space Center this summer. It is far from the only such technology that researchers are working on, as they develop systems that could supply astronauts living on a future lunar base. Those astronauts will need oxygen to breathe but also to make rocket fuel for spacecraft that might launch from the moon and head to destinations further afield – including Mars.

Lunar base inhabitants might also require metal and they could even harvest this from the dusty grey debris that litters the lunar surface. Much depends on whether we can build reactors able to extract such resources effectively or not.

“It could save billions of dollars from mission costs,” says Mr White as he explains that the alternative – bringing lots of oxygen and spare metal to the moon from Earth – would be arduous and expensive.

Luckily, the lunar regolith is full of metal oxides. But while the science of extracting oxygen from metal oxides, for example, is well understood on Earth, doing this on the moon is much harder. Not least because of the conditions. The huge spherical chamber that hosted Sierra Space's tests in July and August this year induced a vacuum and also simulated lunar temperatures and pressures.

The company says it has had to improve how the machine works over time so that it can better cope with the extremely jagged, abrasive texture of the regolith itself. "It gets everywhere, wears out all sorts of mechanisms," says Mr White. And the one, crucial, thing that you can't test on Earth or even in orbit around our planet, is lunar gravity – which is roughly one sixth that of the Earth. It might not be until 2028 or later that Sierra Space can test its system on the moon, using real regolith in low gravity conditions.

Palak Patel has been working on ways to extract oxygen and metal from lunar dust. Along with colleagues, Palak Patel, a PhD student at the Massachusetts Institute of Technology, came up with an experimental molten regolith electrolysis system, for extracting oxygen and metal from the lunar soil.

Ms Patel says that future resource-extracting machines on the moon could derive iron, titanium or lithium from regolith, for example. These materials might help lunar-dwelling astronauts make 3D-printed spare parts for their moon base or replacement components for damaged spacecraft.

11.Recommended reading

ESR member John La Roche has recommended "Under the Weather, a Future Forecast for New Zealand" by James Renwick published in 2023. He found it "a good read about issues we (all) need to be aware of". He borrowed the book from the Public Library.

12.ESR Prizewinner, Zion Young

Water Scarcity is a major issue that impacts low income communities who tend to rely on ground water sources. Salt water intrusion into ground water is an increasingly serious problem. Zion Young won an ESR prize for her project on determining the feasibility of sustainable low-cost materials like plant waste (walnut shells , coconut shells and peach pits) to produce a key component of the MCDI desalination system electrode, Activated Carbon.

The MCDI system has lower energy requirements than conventional desalination methods, but is not sufficiently cost effective for low-income communities.

For MCDI electrodes, the activated carbon must have high capacitance (ability to hold salt) and fast kinetics (salt uptake speed). Overall, walnut shells carbon was the most effective with a total surface area value of 908 m^3/g compared to the 1158 m^3/g of the industrial standard, suggesting good capacitance. While for kinetics , full-adsorption was achieved after 420s at 1.8V. Although this kinetic value was slower than industry, it was evident that with further research the product could be improved. Walnut activated carbon could then act as a low cost option for the MCDI electrode system. As part of her prize, Zion has 1-year membership of ESR.

Ross Rutherford

ESR Newsletter Editor

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