ESR NEWSLETTER
July 2022

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1.Dutch group targets hydrogen-fuelled commercial flight in 2028

Extracts from an article by Daniel Boffey in Brussels, Guardian website, 13 Jun 2022

The world's first hydrogen-fuelled commercial flight of a passenger plane could take place between Rotterdam and London in six years' time, under a plan to make short-haul air travel more environmentally friendly.

The 2028 target set by a Dutch consortium is ambitious. Airbus announced its intention 18 months ago to be the first to offer zero-emission commercial aircraft models running on hydrogen, by 2035.

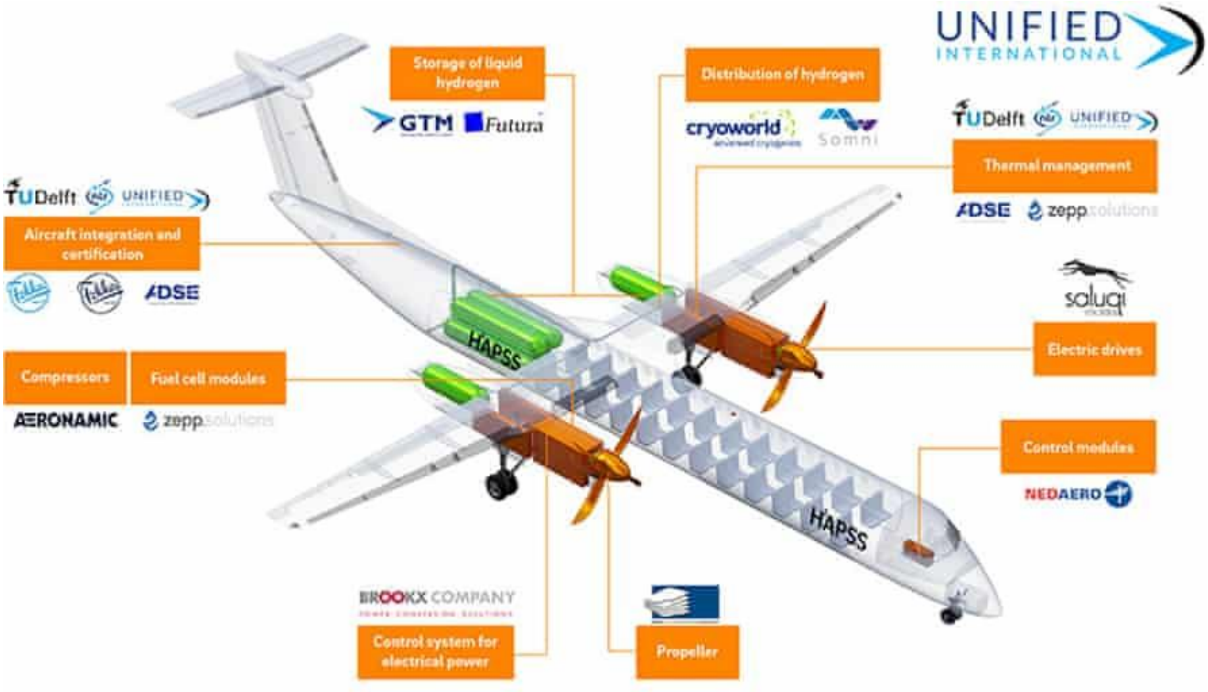
The only emission produced by burning hydrogen as a fuel is water vapour, making it a clean fuel option for heavy vehicles such as planes, trains and trucks. However, the process of creating hydrogen is only clean if the energy used is renewable.

The Dutch technology will initially be built into an existing turboprop aircraft with 40-80 seats, and it could then be used in adapted larger aircraft.

Michel van Ierland, of the consortium set up by Unified International and the Dutch regional economic development agency InnovationQuarter, whose partners include the Dutch aircraft manufacturer Fokker and Delft University of Technology, said the scheme would open up a €16bn market for the Netherlands.

"This is very interesting for Scandinavia and New Zealand, for example, where for shorter distances people are still focusing on battery-electric technology," he said, referring to plans for battery-powered commercial planes.

The use of hydrogen for fuel requires a redesign of planes, as liquid hydrogen needs to be stored in relatively heavy, insulated tanks. While conventional fuel is usually stored in the wings, the Dutch plan is to have hydrogen capsules in the plane's tail.



The planes could be a little slower over medium-haul journeys, but the duration of a short trip – such as between the Netherlands and the UK – would be little changed. Tests suggest a hydrogen-powered propeller plane should be capable of speeds of up to 370mph (600km/h), compared with 530mph for a Boeing 747 jumbo jet.

The aviation industry is responsible for about 2.4% of annual global carbon emissions. Surveys suggest nine out of 10 short-haul passengers would be willing to pay more if they could be assured that their travel is emission-free.

In 2008 Boeing flew the world's first hydrogen-powered plane, a single-seater vehicle, from an airfield near Madrid, Spain.

2. How Orkney is leading a tidal power revolution

Extracts from an article by Eve Livingston in Orkney, Guardian website, @eve_rebecca, 18 Jun 2022

With the ability to generate large volumes of predictable, renewable energy, some experts believe tidal power could play an important part in the world's energy mix.

Orkney, chosen as the European Marine Energy Centre's (Emec) headquarters for its combination of strong tides and waves as well as connection to the energy grid, has become a hub for tidal power innovation. Alongside Scottish company Orbital, Spain-based Magallanes is also testing at Emec and US company Aquantis has just signed up to a six-month demo programme.

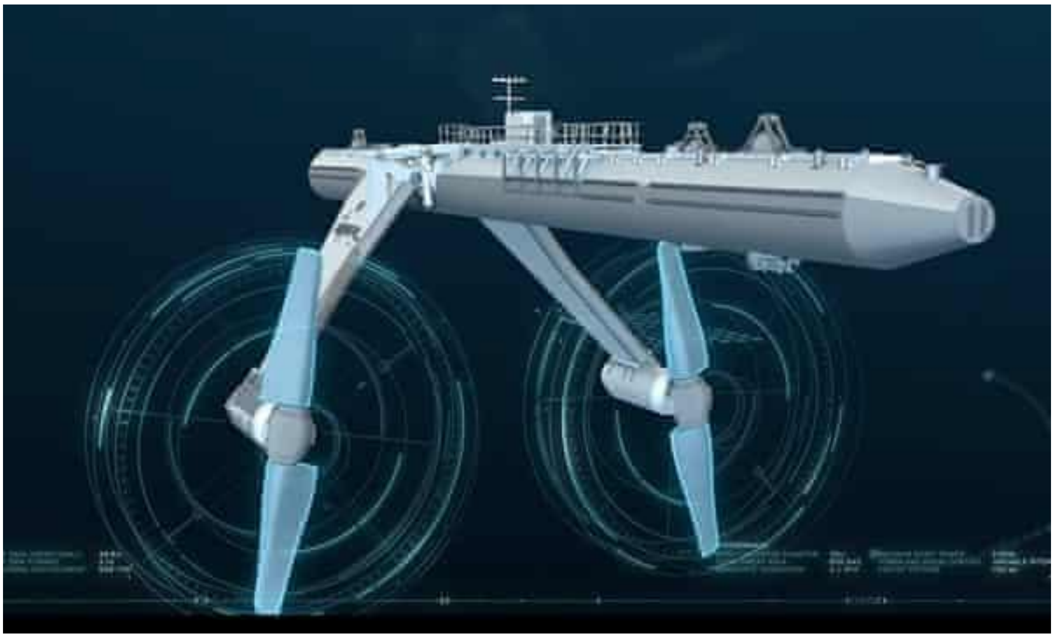
Tidal power, while not yet widely commercialised, is seen by many as the next frontier in global renewables. It's the only renewable power source that comes from the moon's pull on the Earth. "Unlike other renewables which rely on, for instance, the sun or the wind, tidal resources are predictable and continuous," says Prof AbuBakr Bahaj, head of the energy and climate change division at the University of Southampton.

Harnessing power from the waves can be done in three ways: tidal barrages, in which turbines are attached to a dam-like wall; tidal lagoons, where a body of water is enclosed by a barrage-like barrier; and tidal stream, where turbines are placed directly into fast-flowing bodies of water.

Only tidal barrages are used commercially – most notably at Lake Sihwa in South Korea and La Rance in northern France – but it is tidal stream technology that is being tested in Orkney. Tidal stream is cheaper to build and has less of an environmental impact than barrages, which alter tidal flow and can affect marine life and birds.

Tidal stream power alone could provide 11% of the UK's current electricity needs, according to 2021 research from Edinburgh University.

In Orkney, testing is aimed at lowering the costs and risks of tidal power to make it commercially viable. Orbital's O2 turbine, deployed to Orkney's Fall of Warness testing site in July last year, is the third iteration of its tidal technology. This is the version the company hopes to take to market. It consists of a 74-metre floating structure with a submerged two-bladed turbine on each side. A subsea cable connects it to the local onshore electricity grid, where the energy it produces can meet the demands of about 2,000 homes each year.



A graphic showing the Orbital O2 in action. Photograph: Orbital Marine

In 2020, the Canadian government announced a $28.5m investment in floating tidal energy being developed by Scottish company Sustainable Marine at the Bay of Fundy, home to the world's most powerful tides. In May, it delivered the first floating tidal stream power to Nova Scotia's energy grid.

The Faroe Islands, too, are home to ambitious tidal stream investments. Under a 2018 agreement, Sweden-based developer Minesto will install and operate two grid-connected tidal stream units and the islands' main power company, SEV, committed to buy the electricity. At the time, the deal was hailed by Minesto CEO Dr Martin Edlund as playing "a significant role" in the Faroes planned transition to 100% renewable energy by 2030.

3. How to turn your garden into a carbon sink

Extracts from an article by Isabelle Gerretsen, BBC Future,13th June 2022

As governments and companies race to slash their emissions, there is increasing interest in the ability of natural landscapes, such as forests, wetlands and mangroves, to protect against the risks posed by climate change. Horticulturalists say the humble garden can also serve as a powerful tool in this fight.

The ideal low-carbon garden has a wildness to it. It is packed with plants and teeming with life. The gardener recycles every grass clipping, fallen leaf and broken twig within the garden and avoids toxic chemicals to boost plant growth, relying instead on home-made compost and living mulch to create a thriving habitat.

Wild lawns

In the UK, gardeners were recently encouraged to let nature take its course during "No Mow May". Environmentalists say if left alone, lawns could become thriving wildlife hotspots.

Leaving the lawn mower in the shed also benefits the climate. Operating a petrol lawn mower for one hour releases as much smog-forming pollution as driving for 160km, says the California Air Resources Board (CARB). Other gardening tools are just as polluting as mowers. Using a petrol-powered leaf blower produces the same amount of emissions as a 1,770km car journey according to CARB.

Trapping carbon

Replenishing and restoring the world's soils – both in farming and natural landscapes – could help remove up to 5.5 billion tonnes of CO_2e every year, according to a 2020 study. That is equivalent to the annual greenhouse emissions of the US, the world's second largest polluter, in 2020.

Healthy soil offsets emissions by soaking up carbon from dead plant matter. To lock in as much carbon as possible, soil needs a good balance of water, pockets of air, living organisms, such as fungi, and nutrients. Gardeners maintain this balance by constantly adding organic material to their soil.

If left bare and exposed to the elements, soil will degrade and its carbon stocks will deplete. Covering the bare soil with plants, such as clover, and mulches – loose coverings of biodegradeable materials – is therefore key to prevent CO_2 from seeping into the atmosphere..

A recent study by Penn State University found that cover crops were more effective at protecting corn and soybeans from pests than applying pesticides.

Mulching also suppresses weeds, helps soil retain moisture and protects plant roots from extreme temperatures. Fallen leaves and broken twigs don't need to be removed from flower beds but can be treated as "living mulches", which are contributing vital nutrients to the soil. Living mulches can also reduce gardeners' reliance on nitrogen fertilisers, many of which have a high carbon footprint. Legumes, such as beans and peas, act as a green manure by adding valuable nitrogen – vital for plant growth – to the soil when they decompose.

An easy way to enrich your soil is by adding homemade compost. Healthy compost should contain a 50:50 mix of materials that are rich in nitrogen, such as grass clippings and vegetable peels, and carbon, such as woody stems and paper towels. Compost heaps must be turned regularly to add air to the biomass and keep it moist. Garden compost can take up to two years to reach maturity, when it turns a dark brown colour, has a crumbly texture and smells like damp woodland.

4. EV Battery Technology: The road to a breakthrough

From a downloaded article, Investor's Business Daily, Aparna Narayanan, 13 May 2022

Lithium-ion and lithium-iron phosphate (or LFP) dominate the current EV battery landscape. They have pros and cons in terms of range, raw material prices and more. Tesla (TSLA) uses both lithium-ion and LFP batteries. Emerging archrival BYD uses a specialized LFP battery.

Battery companies and automakers are investing heavily to build cheaper, denser and lighter batteries. In the future, radically different chemistries and other big breakthroughs are expected to emerge.

Already in 2021, lithium-ion battery supply fell short of demand in a brisk EV market. The prices of battery raw materials also jumped. That has only intensified in 2022. Asia, led by China, commanded 90% of the world's battery manufacturing in 2021. By the end of this decade, Wood Mackenzie expects that share to fall below 70% as the West catches up. Companies seek both to reduce geopolitical risk and to reduce transportation costs, since heavy EV batteries are costly to ship.

On May 2, the U.S. Department of Energy announced $3.1 billion in funding to boost the production of advanced batteries, focusing on processing and manufacturing facilities vs. mining. An additional $60 million will go to finding second uses for used batteries. The money comes from the 2021 infrastructure bill.

Types Of Lithium-Ion Batteries

Lithium-ion batteries come in two main chemistries: nickel-cobalt-aluminum (or NCA, used by Tesla) and nickel-manganese-cobalt (NMC, used by other carmakers). Lithium is the common denominator.

These batteries provide high energy density, which allows battery-powered devices and vehicles to run longer before needing a recharge. But they age quickly and can catch fire.

In recent years, Western companies refined NMC technology, particularly by increasing nickel, which improves energy density and EV range, and by reducing cobalt, which is scarce and expensive.

With its new Ultium batteries, General Motors engineered an NCMA chemistry, which adds aluminum to increase nickel and slash cobalt, cutting battery costs by 40%. Powered entirely by huge, nickel-rich Ultium batteries, the new Hummer EV delivers a range estimated at 350 miles. GM says the new battery architecture and advanced technologies enable performance and off-road capabilities that a conventional gas or diesel pickup couldn't pull off.

Lithium-Ion vs. LFP Batteries

In the past year or so, an alternative to lithium-ion batteries took off as nickel and cobalt prices soared. Lithium iron or LFP batteries don't use nickel or cobalt. Instead, they use iron and phosphate, which are abundant in the earth's crust.

That trade-off has held LFP battery technology back in the U.S., where people tend to drive large vehicles for long distances. But battery giants advanced LFP chemistry, which is now seen offering acceptable range for a reasonable cost. Since 2020, Chinese automakers and Tesla shifted to cheaper LFP batteries for mass-market EVs with lower range, with several Western auto giants now following suit.

Besides lower costs, LFP offers a long life cycle and high safety performance. That has made it the preferred chemistry for stationary applications, such as giant battery arrays for utility-scale storage.

China's BYD uses a specialized version of LFP, marketed as the Blade. The company claims that the longer and thinner Blade batteries are far less prone to catching fire, even when severely damaged.

Tesla's 4680 Battery & the Kirin Battery

Battery companies say more innovations are on the way. Tesla's 4680 battery and CATL's Kirin headline the latest battery innovations.

Tesla's cylindrical 4680 cell — named for its dimensions, 46 millimeters wide by 80 millimeters tall — is five times larger than its predecessors. In addition, the 4680 cells adopt an entirely new "tabless" design, which has stoked much excitement.

The larger cell means more space for active battery materials and less waste for casings and the like. All in, the 4680 battery claims to improve range by

54%, including 16% from the cell design alone. Tesla claims it halves battery costs as well.

Inspired by fuel tanks in airplanes, Tesla also adopted what it calls a "structural" battery pack. The 4680 battery pack serves as a body structure, linking the front and rear underbody parts, and ditching the familiar "skateboard" battery design. This structural pack greatly reduces the number of parts and simplifies manufacturing to save costs, Tesla said at an April 7 event. Tesla is building 4680 batteries in-house and working with Asian companies, including LG Energy Solution, to scale production.

They will have to get past significant technical issues, some analysts say. Larger format cells tend to overheat — an issue the industry has struggled with for years. So far, Tesla has not been able to mass-produce 4680 cells. That limits potential cost savings, or Tesla's ability to scale up.

CATL claims its new Kirin battery will outperform Tesla's 4680, offering 13% more power with the same chemistry and pack size. It features an improved, third-generation "cell-to-pack" technology, which ditches the middle module step in assembling batteries. The Kirin battery, announced in late March, will be unveiled in the second quarter, CATL said on May 5. It's expected to come in lithium-ion and LFP versions.

In stationary storage, energy density needs tend to be lower. In fact, companies expect to recycle used EV batteries, which may still have tons of juice, for stationary applications including backup power.

Future Of Battery Technology

Battery companies continue to explore alternatives to the dominant lithium-based chemistries. Last July, CATL revealed the first generation of its sodium-ion batteries for use across EVs and stationary storage, targeting a launch in 2023.

Although in its early days, the sodium-ion battery holds up well even in very cold climates and virtually eliminates the fire risk tied to lithium-ion batteries, CATL said. At least initially, it will be confined to less intensive applications and those where high safety and low costs matter, such as backup power, offshore wind power and electric scooters.

Sodium-ion batteries could also help with shortages of critical battery materials. They do not use lithium, cobalt or nickel, which are expected to see demand soar as EVs boom. Like iron, sodium is cheap and plentiful in nature. However, sodium is three times heavier than lithium and can't match lithium's energy capacity.

Solid-State Batteries Could Replace Lithium-Ion
Besides sodium-ion, solid-state battery technology could replace lithium-ion cells. Solid-state batteries promise far higher energy density and quicker charging, along with lower fire risk. As a result, several auto giants invested in QuantumScape, SES and SolidEnergy.

The big difference with a solid-state battery lies inside the electrolyte. While lithium-ion batteries use a liquid electrolyte, their solid-state cousins use a solid form. But analysts predict it will be a long while before solid-state technology moves from battery labs to the real world. Thus far, it has been held back by conductivity and instability issues. Solid electrolytes are expensive to produce.

The Road To 2030

Major automakers want half their vehicle sales to be electric by 2030. As the energy transition quickens, global battery supply will meet only 60% of the expected demand by decade's end, Oslo-based Rystad Energy forecasts. That lends more urgency to the quest for the holy grail — a cheaper, simpler, better battery.

In the meantime, electric cars will continue to run on lithium-ion or LFP battery cells for now, with costs likely to spur shifts back and forth. Some breakthrough battery technologies may be a decade or more away, like solid-state cells. Other promising ones, such as sodium-ion batteries, are closer at hand but come with drawbacks.

5. Kiwi Electric Bus Conversion

This bus, on display at Auckland's QE2 Square on Thursday 14th July, is a diesel to electric conversion produced by Masterton based Tranzit Group. Tranzit has been running its bus in Wellington.

According to their representatives at the display site the conversion cost $400,000 and, when fully charged, the range is 250km. The bus is to be trialled in Auckland.

The batteries were sourced from China and were manufactured by CATL.

A great initiative which hopefully will result in AT converting its diesel double decker buses to electric in the relatively near future.

Photo: Ross Rutherford

6. Australian company secures $700,000 deal for carbon capture and storage machine

From an article by Graham Readfearn, Guardian website, 1 Jul 2022

A solar-powered and tent-sized Australian prototype machine that can suck CO2 from the air has secured a $700,000 contract to capture and store carbon. The deal, part of a project backed by corporates including the owners of Google and Facebook, is thought to be the first time an Australian company has secured a deal to remove CO2 using direct air capture (DAC) technology.

AspiraDAC will deploy about 180 of the machines, developed and made in Australia, to capture and store 500 tonnes of CO2 by 2027 at an agreed US$1,000 (AU$1,469) a tonne.

In April several major corporates, including the owners of Facebook and Google, announced a new venture called Frontier that would commit US$925m (AU$1,359) to projects that pull CO2 from the air and then store it. In the first major purchase under the venture, technology company Stripe, one of the partners in Frontier, announced this week it was spending US$2.4m (AU$3.5m) on six direct air capture projects around the world, including AspiraDAC.

The executive director of AspiraDAC, Julian Turecek, said up to 180 modules would be needed to fulfil the contract and these would cover an area of less than half a hectare. He said the company had not confirmed the location or the geological storage for the site, but confirmed depleted oil and gas reservoirs at Moomba, in South Australia, were being considered.

Southern Green Gas has developed the machines in partnership with the University of Sydney, and will build and deliver them to AspiraDAC. The business development manager and co-founder at Southern Green Gas, Brett Cooper, believed the contract to deliver the emissions reductions using DAC was a first in Australia. Each module can capture two tonnes of CO2 a year.

At the core of the Australian machine is a sponge-like material developed at the University of Sydney that holds on to CO2 molecules as air passes through it. Fans draw air into canisters containing the sponges, and then heat is used to extract the pure CO2 that can be pumped and stored underground. All power comes from the solar panels that cover the units like an A-frame tent.

The Sydney team of scientists and student researchers won a $250,000 prize last year to support the development of the material from tech billionaire Elon Musk’s US$100m (AU$147m) X-Prize that is trying to establish large-scale carbon removal projects.

An International Energy Agency plan for the world’s economies to reach net zero emissions by 2050 says direct air capture technologies will need to deliver more than 85m tonnes of CO2 capture by 2030. Currently, the agency says the technology can deliver just 10,000 tonnes around the world.

In May, the US government announced a US$3.5bn program to build four major hubs for direct air capture projects.

The world’s biggest direct air capture plant is in Iceland and the company behind the plant, Climeworks, announced this week it was expanding capacity to 36,000 tonnes of CO2 a year.

7.Methane may be much more sensitive to global heating than previously thought

From an article by Kate Ravilious @katerav, Guardian website, 5 Jul 2022

Methane is four times more sensitive to global warming than previously thought, a new study shows. The result helps to explain the rapid growth in methane in recent years and suggests that, if left unchecked, methane related warming will escalate in the decades to come. The growth of this greenhouse gas – which over a 20 year timespan is more than 80 times as potent than carbon dioxide – had been slowing since the turn of the millennium but since 2007 has undergone a rapid rise, with measurements from the US National Oceanic and Atmospheric Administration recording it passing 1,900 parts a billion last year, nearly triple pre-industrial levels.

"What has been particularly puzzling has been the fact that methane emissions have been increasing at even greater rates in the last two years, despite the global pandemic, when anthropogenic sources were assumed to be less significant," said Simon Redfern, an earth scientist at Nanyang Technological University in Singapore.

About 40% of methane emissions come from natural sources such as wetlands, while 60% come from anthropogenic sources such as cattle farming, fossil fuel extraction and landfill sites. Possible explanations for the rise in methane emissions range from expanding exploration of oil and natural gas, rising emissions from agriculture and landfill, and rising natural emissions as tropical wetlands warm and Arctic tundra melts.

But another explanation could be a slowdown of the chemical reaction that removes methane from the atmosphere. The predominant way in which methane is "mopped up" is via reaction with hydroxyl radicals (OH) in the atmosphere.

"The hydroxyl radical has been termed the 'detergent' of the atmosphere because it works to cleanse the atmosphere of harmful trace gases," said Redfern. But hydroxyl radicals also react with carbon monoxide, and an increase in wildfires may have pumped more carbon monoxide into the atmosphere and altered the chemical balance. "On average, a carbon monoxide molecule remains in the atmosphere for about three months before it's attacked by a hydroxyl radical, while methane persists for about a decade. So wildfires have a swift impact on using up the hydroxyl 'detergent' and reduce the methane removal," said Redfern.

To understand what was driving the methane acceleration, Redfern and his colleague Chin-Hsien Cheng used four decades of methane measurements and analysed changes in the climate to identify how the availability of hydroxyl radicals might have changed and what impact the changing climate might have had on methane sources.

Their findings, published in the journal Nature Communications, suggest global heating is four times more influential in accelerating methane emissions than previously estimated, with rising temperatures helping to produce more methane (by speeding up microbe activity in wetlands for example), while at the same time slowing down the removal of methane from the atmosphere (with increasing numbers of wildfires reducing the availability of hydroxyl radicals in the upper atmosphere). “It was a really shocking result, and highlights that the effects of climate change can be even more extreme and dangerous than we thought,” said Redfern.

“If the oxidative capacity of the air is also in trouble, as these results suggest, then we have a double-edged sword,” said Euan Nisbet, an earth scientist at Royal Holloway, University of London, who led the UK’s Global Methane Budget project and was not involved in the study. “That’s a real worry because methane acceleration is perhaps the largest factor challenging our Paris agreement goals.”

While carbon reduction needs to remain the main focus, Redfern and Cheng said methane cannot be ignored. Nisbet agreed, saying: “Much of the emission comes from recently industrialised or developing countries and they need help. What is needed is not money but good governance. We need to persuade China and India – the two biggest emitters – to join the global methane pledge and deal with their coalmine vents, crop waste fires and landfill emissions. And we need to look at Africa where methane emissions may be growing rapidly from growing population, widespread crop waste fires and landfills, and warming natural wetlands.”

Meanwhile, reducing and preventing forest fires and biomass burning is also important. “The worry is that climate change may accelerate such risks, feeding back to accelerating atmospheric methane concentrations in a vicious circle,” said Redfern.

Ross Rutherford

ESR Newsletter Editor

17 July 2022

Appendix: Webinar, 20 July

Engineers for Social Responsibility Webinar, July 2022

Earth building developments in New Zealand,
and related low energy low carbon natural building materials

by Hugh Morris

Wednesday 20th July 2022, 6pm, on Zoom

Join Zoom Meeting
https://aut.zoom.us/j/93702884522
Meeting ID: 937 0288 4522