responsible science

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Andrew Simms

Has our society forgotten the extreme horror of nuclear weapons?

Philip Webber

Are the UK's professional science organisations putting their money where their mouths are?

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Globally Responsible Careers in STEM

30th Anniversary Edition

SGR
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Editorial

THE NEW ACTIVIST SCIENCE

Science and technology are at the centre of multiple, immediate emergencies that loom over the fate of life on Earth. That means that how scientists and engineers choose to act, or not, could hardly matter more.

Putin's war of aggression against Ukraine is not only creating large numbers of civilian casualties, it has darkened the shadow of the nuclear threat with all its potential for escalation between the powers which hold the weapons – a problem that many had perhaps been lulled, falsely, into believing was in the past. It is also already causing huge increases in military expenditures across Europe which is damaging for at least three reasons. First, these raise the risk of further confrontation. Second, such spending takes resources away from other vital investments, like in the rapid, fair decarbonising of economies. And third, armies are themselves major sources of climate pollution, as SGRs own work has revealed.

The latest climate science from the Intergovernmental Panel on Climate Change (IPCC) does what it always does, reconfirming the severity and urgency of action. At the launch of the second volume of its *Sixth Assessment Report* – which focuses on impacts, adaptation and vulnerability – the secretary general of the UN, António Guterres, decried the lack of leadership on global heating in language rare for a diplomat answerable to the UN's member states. He called it "criminal" and said that "delay means death".

More complicated is the response to the compromising dependence of many nations on Russian gas and oil. Positively, the EU moved with speed to produce plans for a rapid reduction in that dependence, and part of that has seen pledges of increased investment in, and roll out of, renewables and energy conservation. But others, like the UK, are using the situation to promote other sources of fossil fuels, like North Sea gas and oil, and nuclear – throwing more fuel on the climate and security fires.

The UK's energy review in the wake of conflict in the Ukraine is the product of a government that seems to want to have its planet and eat it. There are some positive advances on renewables, if not enough. But there is a reluctance to walk away from fossil fuels that will compromise climate targets, and a clinging to slow, costly and insecure nuclear power which is

Editorial (continued)

uneconomic, illogical and incomprehensible were it not for the industry's historic, but tenacious military links.

The economics and practical benefits of renewables and efficiency – in terms of jobs, ending fuel poverty and increasing energy security – have improved so much that money thrown at worse answers to the energy crisis is just another example of the lack of leadership, and 'delay meaning death' spoken of by the head of the UN.

But of course the world is still in the grip of a volatile and unpredictable coronavirus pandemic killing millions. At the time of writing the official global death toll is just over six million, a number hard to imagine, but the real figure at the end of 2021, according to modelling of excess deaths, could bve as high as 18 million – more than the entire population of the Netherlands.

We have previously written about aid betrayal and the "catastrophic moral failure" of the poorest nations missing out on vaccines, as Tedros Adhanom Ghebreyesus, head of the World Health Organisation put it. The People's Vaccine campaign says that any further deaths due to vaccine inequality are avoidable, and are calling for huge public investment and a target of 70% of people to be fully vaccinated by mid-2022. Crucially from a public health and scientific perspective, they also want the suspension of relevant intellectual property rules and knowledge sharing so that any nation can access sufficient and affordable vaccines, treatments and tests.

The UK is one of the countries blocking a waiver on intellectual property rights that could make this happen. After reneging on its aid obligations, the UK, having first been accused of hoarding vaccines, now also stands accused by the Bureau of Investigative Journalism of using its donation of 'excess COVID-19 vaccines', as a way of cutting a further £140 million from its aid budget.

There is, then, no shortage of issues where concerned scientists can get involved and take action. And, there are some signs of progress. *New Scientist Live* is a flagship thematic festival which has been criticised for partnerships with fossil fuel companies. Following pressure from campaigners, including SGR, its 2022 event went ahead without any fossil fuel companies as sponsors or exhibitors. Also, SGR's work to encourage professional science bodies to cut their financial links with the fossil fuel industry is bearing fruit.

Over 400 scientists have now signed SGR's Science Oath for the Climate in which they pledge action on individual behaviour and system change. More sign and share all the time. With this and other shared initiatives that you can read about in this edition, our times are ushering in a new era of activist science. You can read here too about how ethical activism is far from being new to science.

From the climate crisis to the threats from militarism and the pandemic, deep issues of injustice rapidly rise to the surface. The late Archbishop Desmond Tutu famously observed that "If you are neutral in situations of injustice, you have chosen the side of the oppressor." It is objective, not melodramatic, to say that the choices made in the next few years on all of these crises will determine the long-term fate of not just humanity, but much else of life on Earth. Whether and how scientists choose to take sides will influence the outcome. Reading *Responsible Science* it will be obvious that SGR has taken sides. We hope you will too, and that we can work together to help bend history in the right direction.

Andrew Simms
Assistant Director, SGR

News from SGR

Science and peace campaigning

The Russian military's invasion of Ukraine has shocked the world, and our hearts go out to the people of yet another nation suffering from war. This has led to some re-prioritisation of SGR's work on science and peace issues. Our initial response has included the following:

- Phil Webber wrote an article for our website highlighting the catastrophic effects of any use of nuclear weapons, should the conflict escalate. This is republished on p.6.
- Stuart Parkinson spoke at a national webinar organised by the Campaign for Nuclear Disarmament on the threat from nuclear weapons.
- Keith Baker was interviewed on *TalkRADIO* on how the war is contributing to a growing energy crisis.
- As part of the Global Day of Action to stop the war in Ukraine in early March, Stuart also spoke at a well-attended rally in Lancaster city centre.

SGR's Stuart Parkinson speaking at an anti-war rally in Lancaster city centre, March 2022

We've backed this up by circulating information and commentary on social media and on our email lists, especially directing people to robust sources of information and on peaceful responses to the crisis.

Phil Webber, Stuart Parkinson and Nico Edwards are also continuing SGR's links with other campaign groups in this area, especially including the UK branches of the International Campaign for the Abolition of Nuclear Weapons (ICAN-UK), the Global Campaign on Military Spending (GCOMS-UK) and the Stop Killer Robots Campaign, as well as Demilitarise Education. In particular, Stuart wrote a short briefing for GCOMS-UK to coincide with the UK Autumn Budget statement, showing how the government's military spending is more than seven times that spent on reducing the UK's carbon emissions, and that recent major increases in the military budget have been effectively funded by cuts to the overseas aid budget, threatening the lives and livelihoods of the very poorest in the world.

COP26 activities

SGR took part in numerous activities in and around the COP26 climate negotiations in Glasgow in November. Stuart Parkinson was a keynote speaker at an in-person workshop on climate change and militarism at the People's Summit for Climate Justice. Liz Kalaugher spoke about the Science Oath for the Climate (see p.11) at an online workshop on science activism as part of the same event. Andrew Simms chaired an event on rapid transition, and was interviewed on *COP26 TV* about the same issue. Stuart also spoke at a protest rally on climate and militarism.

In addition, SGR's research outputs on military carbon emissions were widely used by peace and environment campaigners during the whole fortnight of negotiations, and together our co-ordinated campaign activities gave the issue a prominence which had never been achieved before. A tweet featuring a journalist asking leading US politician, Nancy Pelosi, about the issue – and her faltering reply – went viral. Media coverage featuring SGR's research or campaigning appeared in *The Guardian*, *Talk World Radio*, *The Conversation* and numerous other outlets.

Following on from our activities in Glasgow, Stuart spoke at an international webinar organised by Quaker groups to review progress at COP26. SGR is also now part of a new research and advocacy project called the 'Military Emissions Gap' – focusing on trying to deduce robust estimates for international military carbon emissions and pressure nations to reduce them. The project is co-ordinated by the Conflict and Environment Observatory and funded by the Minor Foundation.

SGR's Stuart Parkinson and Jan Maskell demonstrating at COP26, November 2021

Science Oath for the Climate

SGR's Science Oath for the Climate has continued to go from strength to strength. At the time of writing, the number of signatories has reached more than 400 – almost half of them from the UK. Signatories have spoken about their support for the oath in public fora, including on social media – and some examples are given on p.11.

SGR's advocacy work to encourage professional science and engineering bodies to cut their financial links with the fossil fuel and arms industries is also starting to bear fruit, with several organisations taking action – see p.16.

A set of behaviour change targets for oath signatories and others to sign up to, to publicly demonstrate their commitment to reaching a 1.5C-compatible lifestyle, will be launched soon.

Project work is being carried out by Liz Kalaugher, Liam Killeen and Stuart Parkinson, and it is funded by the ClimateWorks Foundation and The Martin Ryle Trust to whom we are very grateful.

For more information of the oath and related activities, see:

https://www.sgr.org.uk/projects/science-oath-climate

Globally Responsible Careers in STEM

In November 2021, SGR launched a new online resource aimed at science and engineering students looking to pursue ethical career options. The materials will also be useful to scientists and engineers who are at a later stage in their career, but are looking to move in a more ethical direction. Entitled 'Globally Responsible Careers in Science, Technology, Engineering and Mathematics' (GRC-STEM), these resources outline key ethical issues relevant to STEM careers using the UN's Sustainable Development Goals as a starting point. Users are then encouraged to fill out a self-assessment questionnaire to help identify individual strengths, interests and ethical concerns. Next, they are given a number of options for Globally Responsible Careers in STEM, and a selection of case studies, which helps them home in on a suitable career path.

The resources have been compiled by Jan Maskell and design and web-support provided by The Argument by Design. We are grateful to The Martin Ryle Trust and Scurrah Wainwright Charity for project funding.

The resources can be found at:

https://www.sgr.org.uk/globally-responsible-careers

(A downloadable booklet, based on the online resources, is also available.)

Science4Society Week 2022

SGR's annual Science4Society (S4S) Week took place took place as usual in mid-March. The activities moved online during the COVID-19 pandemic and we have found we are able to reach larger audiences this way. This year we hosted five webinars for schools exploring the links between climate change and: food and nutrition; consumption and waste; war and peace; and globally responsible careers. The speakers were Bryony Maskell, Jan Maskell, Martin Paley and Stuart Parkinson.

In advance of the week, new Communications Assistant, Lucia Simmons upgraded the S4S website – including adding to the more than 50 teaching resources – and promoted the webinars and competition 'Get It Write!' extensively across social media. The competition winner was Afrin Rasee Mohamed Kasim of Plashet School, London.

To download the resources, see:

https://www.s4s.org.uk/

The project is co-ordinated by Jan Maskell, and this year's funding was provided via legacies from SGR members for which we are very grateful.

One Planet – One Life: School workshops

SGR's project, One Planet – One Life, which ran a series of workshops on climate change and sustainable lifestyles for schools in the Morecambe Bay area, was completed in November. The project exceeded its targets with 1,345 children attending over a three-year period – despite interruptions due to the COVID-19 pandemic. Evaluation of pre- and post-learning was carried out using 'sticky dot' exercises and behaviour change pledges, with feedback from teaching staff being very positive (see box for an example).

The workshops were run by Jan Maskell. Funding was provided by Ørsted's Walney Extension Community Fund, for which we are very grateful. We are now seeking grants for follow-on work.

"Thank you so much for your work with the children last Friday. There were interested, educated and inspired by the content and delivery of your workshop.
In assembly, they recounted a lot of facts and figures relating to energy consumption and carbon emissions, changes in the car manufacturing industry, animals to name a few. They each talked about what they would do e.g. walking to school more, switching off lights, not eating meat. They talked about the Top Trumps cards and how much they had learned from that activity."

Gail Bowskill, Headteacher
Caton Primary School, Lancashire

SGR anniversaries

SGR's 30th anniversary

SGR will be 30 years old in June 2022. We're marking this occasion with a special retrospective article on p.22 – and at other activities during the year. We'll be in touch again soon with details of these...

25th anniversary of 'The Climate Train to Kyoto'

2022 also marks 25 years since SGR played a leading role in the project, *The Climate Train to Kyoto*. 36 scientists and environmentalists travelled to the UN climate negotiations – COP3 – in Kyoto, Japan, in December 1997 by train, boat and bicycle. Part of the train journey included a few weeks aboard the Trans-Siberian Express through Russia – a journey obviously not currently possible for Western citizens. SGR published a report – written by Ben Matthews and Michelle Valentine – about the journey and the issues surrounding it, published a year later. One the things the project highlighted was the growing significance of aviation emissions – and the wider importance of lifestyle change among the wealthy as a key element in the transition to a low carbon society. It also set an example for climate campaigners travelling to future COPs which has been emulated many times since, including by Greta Thunberg.

40th anniversary of 'London After the Bomb'

And 2022 marks another significant anniversary – 40 years since the publication of the book, *London After the Bomb*, written by members of Scientists Against Nuclear Arms (one of SGR's predecessor organisations), including current SGR Chair, Philip Webber. The book provided a compelling science-based description of the effects of a potential nuclear attack on London, and sold 28,000 copies, gaining widespread media attention. Sadly, it is as relevant now as it ever was.

PRINT COPIES

SGR still has a few printed copies of The Climate Train to Kyoto *and* London After the Bomb. *To order, please contact the SGR office (see back page).*

Member, Sarah Brindley (SLB Designs), promotes SGR at her stand at the Futurebuild exhibition in London. Sarah uses waste wood in her interior designs, and runs a design group for adults with learning difficulties.

New project to reduce food waste

SGR is part of a North Lancashire-based consortium that has been awarded a five-year grant by the National Lottery. Led by the social enterprise, LESS, the 'Closing Loops' project aims to reduce food waste in the local area and encourage more sustainable lifestyles. SGR's Jan Maskell will help with the monitoring and evaluation of the project, with a particular focus on carbon accounting and carbon literacy.

New National Co-ordinating Committee and staff

SGR's National Co-ordinating Committee – either elected at the AGM in November or co-opted since – is as follows.

Chair: Dr Philip Webber

Vice-chair: Dr Jan Maskell

Committee members: Dr Keith Baker, Nico Edwards, Liam Killeen, Simon Reed

We also welcomed a new part-time member of staff – Lucia Simmons – who worked as a Campaigning Assistant on Science4Society Week 2022 (see p.4).

Has our society forgotten the extreme horror of nuclear weapons?

With the Russian invasion of Ukraine, the risk of nuclear war has markedly increased. But, as **Philip Webber**, SGR, points out, the threat comes from *all* nuclear weapons, not just those in Russian hands.

The repeated euphemistic phraseology of 'nuclear deterrence', or of a 'nuclear umbrella', has lulled most people into a false sense of safety and security. Reacting to Western support for Ukraine as Russian forces invaded, President Putin announced an increase in the alert level of their nuclear weapons.[1] Many commentators expressed shock, assuming that 'the world had moved on' from such threats. But they forgot – or did not know – that there are already over 900 Russian, and an equivalent number of US, long-range warheads kept ready to fire at a few minutes' notice.[2] This has been the situation since the end of the Cold War, three decades ago. It is a highly risky situation that has been criticised even by many senior military and political figures.[3] Indeed, UK and French nuclear weapons can also be made ready to fire with some 15 minutes' notice in a crisis.[4]

The reality is that 'nuclear deterrence' threatens death and destruction on such an extreme scale that it is hard to imagine. This is no accident – a detonation above a city is chosen to maximise the lethal blast and fire radius.

SGR has extensively documented the risks, impacts and dangers of the deployment and use of nuclear weapons using the latest data from scientific studies.[5]

For example, the use of just one typical nuclear weapon[6] airburst over a major city would overwhelm any possible medical capacity with injuries including severe burns and radiation sickness.[7] In this scenario, the casualty count could quickly climb to more than a million people. A larger weapon – such as routinely deployed by Russia or the USA – could kill and injure considerably more.[8]

Indeed, the use of no more than 100 nuclear weapons would be completely disastrous for all humanity in terms of death, injury, radiation releases and widespread ecosystem impacts. Nuclear fireballs would create huge 'firestorms', injecting smoke high into the atmosphere sharply reducing sunlight and creating a ten-year 'nuclear winter'. This would bring about mass starvation and societal collapse as crops failed in unseasonal frosts and darkness.[9]

In 1985, the leaders of the USA and the Soviet Union agreed that "a nuclear war cannot be won and must never be fought".[10] This was affirmed by the leaders of the five largest nuclear weapons nations – Russia, the USA, China, France and the UK – as recently as January this year.[11] They are right. All the detailed military simulations of nuclear conflict come to the same conclusion – no one can 'win'. All sides, bystanders and the global environment would be destroyed.

But the clear implication is ignored – that nuclear weapons are rationally unusable. Any use of a nuclear weapon would be disastrous in humanitarian and political terms and would quickly escalate, ending human civilisation. Having large numbers of unusable weapons makes no sense, but this is the policy pursued by the nuclear weapons nations who are all developing *new* nuclear weapons. Some states – such as the UK – are even *increasing* their warhead numbers.[12]

Putin seems to regard his latest nuclear threat as ensuring that he can conduct attacks using conventional weapons without direct retaliation from NATO, under his 'nuclear umbrella'. This is an example of how nuclear deterrence can be used to *facilitate* conflict, leading to murderous acts and a humanitarian crisis.

With the war evolving in Ukraine, and as casualties mount, it is again time for organisations such as SGR and the wider peace and environmental movements to make it clear that any possession of nuclear weapons – and acceptance of 'nuclear deterrence' – is dangerous and irresponsible. There is no such thing as 'limited' nuclear weapons use, it would only lead to global catastrophe. We must take urgent action to publicise the genocidal, ecocidal, and suicidal risk posed by nuclear weapons before they are used by accident, due to equipment failure, or by an unbalanced political leader in a time of extreme tension. We must make the case that the nuclear weapons states should join the UN Treaty for the Prohibition of Nuclear Weapons because it sets out a clear framework to negotiate and verifiably reduce numbers of nuclear weapons to zero.[13] This would bring about the ultimate goal first set out in the 1968 Nuclear Non-proliferation Treaty – the elimination of all nuclear weapons.

Dr Philip Webber *is Chair of SGR, and has written on the threat from nuclear weapons for 40 years, including* London After the Bomb *(1982) and* Nuclear Weapons: a beginner's guide to the threats *(2021).*

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5 SGR (2022). https://www.sgr.org.uk/projects/nuclear-weapons-threat-main-outputs ; SGR (2021) – as note 2.

6 I refer here to a weapon with an explosive power or 'yield' equivalent to about 100 kilotonnes of TNT. Many warheads are much larger.

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A new era of activist science

Photo by Markus Spiske on Unsplash.

Andrew Simms, SGR, looks at whether scientists can be activists too, and finds that far from being anything new, many of history's household-name scientists have for generations been getting involved in the moral campaigns of their day.

Should scientists be activists? Many appeal to notions of scientific objectivity to argue against engaging in the cut and thrust of campaigning. With the stakes on the climate and ecological emergency so high and growing, calls to join acts of civil disobedience are increasing too. What is the right thing to do?

Firstly it's not as if activism is new to science. Quite the contrary. Looked at in historical perspective, the relative contemporary academic timidity about engaging publicly in policy controversies looks like a more modern phenomenon. This could be the result of multiple factors including professional, competitive dynamics within universities, commercialisation and academic specialisation. But a quick glance at the sheer range, over time and issues, of the scientist activists in our feature shows that activism has been a well established norm. Today it might be considered more important than ever.

Charles Darwin was an active campaigner against animal experiments, helping to draft laws to control it. Albert Einstein was a committed anti-racism activist, as well as a voice against nuclear proliferation. Leó Szilárd was a Hungarian American physicist who sparked the Manhattan Project but then lobbied President Truman against dropping the bomb. Biologist Rachel Carson was famously outspoken on the environmental harm caused by modern farming methods, while Donella Meadows was a scientist who, as the lead author of *Limits to Growth*, called into question the entire direction of mainstream economics. American chemist Cynthia Chapple has challenged inequality and exclusion within science itself, while cognitive psychologist, Alison Green, is an example of a scientist organising on the frontline of contemporary climate protests.

Yet, in spite of this unbroken thread of activism, a collective frown still tends to wrinkle across the face of the scientific establishment when scientists do get involved in advocacy.

And activism can, of course, swing both ways – humanely towards progress or towards human oppression and destruction. Eugenicists and those seeking more efficient forms of killing have pushed their cases just as those seeking peace and to conquer epidemic diseases.

But the era of the climate emergency and the current mass extinction event is a problem of a different order. It seems to be reshaping general attitudes within science about whether, and the degree to which, scientists use their agency as professionals and citizens to bring about change.

In the last couple of years the number of initiatives that see scientists as active catalysts appears to have grown.

There are long standing groups such as the Union of Concerned Scientists based in the United States, which grew out of student and staff activism and has been campaigning for over 50 years. Scientists for Global Responsibility (SGR) itself formed more recently in 1992, the year of the UN Earth Summit in Brazil, but was made up of other pre-existing organisations including Scientists Against Nuclear Arms, Electronics and Computing for Peace and Psychologists for Peace. It also drew membership from the British Society for Social Responsibility in Science which disbanded around the same time.

But now there are groups like Scientists Warning set up in California in 2020, Scientists for Future and Scientists for Extinction Rebellion each sat in slightly different positions ≫

on the spectrum of activism. Many other such groups are emerging. It is something that reflects SGR's own research on attitudes to change within science – both at the personal level and in terms of how scientists are increasingly prepared to challenge institutional inertia. In our report Scientists Behaving Responsibly we found an 'awareness – action' gap with large numbers saying they were set to take more steps to align their lives with climate goals and challenge professional bodies. In a poll 71% thought their field of work's response to the climate emergency was either unsatisfactory, or highly unsatisfactory. More than one in three already rejected flying, with that number pledged to increase to nearly half, 48%. Over one in three did not own a car and rarely used one, and numbers planning to take 'very serious' steps to reduce the impact of their car use set to rise dramatically. A huge 72% said they were adopting largely plant-based diets, and 76% were turning their backs on new consumer goods – choosing less, second hand and long-term repair options instead.

SGR launched its *Science Oath for the Climate* in which scientists commit to making changes in their own lives and work for wider system change, encouraging others to follow suit. The Oath now has over 400 signatories committing to make changes happen. The calling is growing for people working in science and technology to act on the insights that their specialist knowledge and expertise gives them. Everyone has agency, as individuals and as members of institutions and professional representative bodies.

Sometimes we fail to appreciate the impact that intervening and making a stand – which might feel small and ineffective to ourselves – can have on others. Institutions are notorious for their inertia. Often pushing them to act does them a favour – even if they don't realise it at the time – as it helps prevent them from ossifying. Other people often just need the sight of someone else taking action to validate them getting involved and making changes too. The sheer scale and range of the climate and ecological emergency means that we all need to be activists now. The good news is that today's scientists will be following in the footsteps of bold and brave forebears on a well-established path where they've shown that it's okay to combine science and progressive activism.

***Andrew Simms** is Assistant Director of SGR. He has a background in political economics and development studies, including working for the New Economics Foundation and Oxfam.*

References for this article are provided in the online version – see: https://www.sgr.org.uk/publications/responsible-science-no-4

Scientist activists

Far from being exceptions, leading scientists across a huge range of history and different disciplines have combined often world-changing research with high profile activism, reports **Andrew Simms.**

Albert Einstein 1879–1955

The peace and anti-racism activist

Ask a member of the general public to picture a scientist and it's likely they'll conjure the iconic photograph of Albert Einstein with his shock of white hair (possibly the one taken of him sticking out his tongue on his 72nd birthday in 1951).

And, if Einstein is the archetype modern scientist it says something about the wider role of scientists, because as well as being a superlative theoretical physicist, he was also a prominent social activist. An outspoken opponent of militarism who voluntarily chose to become stateless rather than serve in the army, he became a leading voice against nuclear weapons.

But, more than that, Einstein was also a long-term and active campaigner for civil rights and against racism who worked with other activists like the singer Paul Robeson, and lobbied the US President directly over institutional prejudice shown to black Americans. Progressive activism seems then to be synonymous with modern science.

Leó Szilárd 1898–1964

The anti-nuclear nuclear physicist

Leó Szilárd, the Hungarian American physicist, had as much claim as anyone for laying the foundations of the nuclear age. He left Berlin in 1933 to escape the rise of the Nazis, working in England and the US. He contributed to the first experiment that created a sustained nuclear chain reaction, and it was Szilárd who tipped off Einstein about its potential. He helped spark the Manhattan Project that led to the atomic bomb but as soon as Germany surrendered in the Second World War he began agitating against its use.

Szilárd instigated a petition in the US calling on President Truman to not allow the bomb to be dropped on Hiroshima. As early as spring 1945 he encouraged a group of scientists to produce the Franck Report which warned of the dangers of a nuclear arms race. After the war he campaigned against the military being given control of nuclear power generation.

Rachel Carson 1907–1964

The biologist who called out the chemical industry

Rachel Carson was an American biologist most famous for revealing the ecological impacts of the organochlorine pesticide DDT. She taught at the University of Maryland and Johns Hopkins University, and conducted postgraduate research at the Marine Biological Laboratory in Woods Hole, Massachusetts. Then she took a job as an aquatic biologist in the US Bureau of Fisheries. Relatively late in her life she published *Silent Spring*, an exposé of the impact of chemically intensive agriculture and a lament for the nature lost as a result. Her work caused a sensation and also triggered a ferocious backlash from the chemical industries who attacked her in public. She was vilified for being 'emotional', wrong and called a communist. But Carson stood by her warnings and was proved right by history.

Donella Meadows 1941–2001

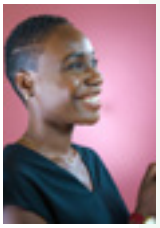
The scientist who trod on the toes of economic growth

Donella Meadows was a scientist who addressed the problem of the biophysical limits to economic systems. She was the lead author of the era-defining book, *The Limits to Growth*, published in 1972 by a group of scientists from the Massachusetts Institute of Technology and The Club of Rome. Although criticised at the time, and relying on computer modelling which by today's standards was crude, its projections for the potentially devastating impact from continued economic growth on planetary, ecological life support systems have stood the test of time. Meadows was a systems thinker who believed that a "small shift in one thing can produce big changes in everything", and she developed the 'twelve leverage points to intervene in a system', published in 1997, to enable better decision making to live within the biosphere's limits.

Charles Darwin 1809–1882

The naturalist who defied habitual animal cruelty in science and changed the law

We know Charles Darwin as the person synonymous with evolutionary theory and as someone who was seen as a profound threat to established religion in British Victorian society. But perhaps it shouldn't be a surprise that for someone so immersed in the mysteries of life Darwin also cared deeply about it. He was horrified by the callous treatment of animals by some of his equally curious, but less caring scientific colleagues, and the experience turned him into a campaigner against vivisection. Darwin was a local magistrate and used his position to punish farmers who mistreated animals. As a scientist he condemned vivisection for "mere damnable and detestable curiosity," commenting that, "It is a subject which makes me sick with horror." Darwin drafted a piece of prospective legislation to regulate vivisection which became known as the Playfair Bill, and lobbied hard for it. In 1876 the subsequent Cruelty to Animals Act was passed into law.



Cynthia Chapple

The American chemist tackling inequality to create more access for young black women in STEM

When Cynthia Chapple was shocked to find herself being used for 'photoshop diversity' at the university where she worked as a research chemist, she determined to do something about it. Through an inspirational teacher, extracurricular clubs and summer science camps she had fallen in love with the subject, but found herself the only black girl in the clubs. Then after progressing through university she found herself being used to demonstrate diversity even in programmes that she had nothing to do with. In the US black people made up just 9% of all STEM related jobs. So, to begin to change things, Chapple set up 'Black girls do STEM', which developed into an after school community in St Louis, Missouri. In 2020 more than 160 girls stated an interest to take part.

Alison Green, Scientists Warning

The cognitive psychologist campaigning to change how people think and behave on the climate emergency

Alison Green is a cognitive psychologist and former university Pro-Vice-Chancellor whose research has focused on skill acquisition. As Executive Director of the Scientists Warning Foundation, she compliments her interest in the psychology of climate denial with a practical campaigning approach to helping people escape denial and take action. Green was inspired by movements like Scientists Warning, Extinction Rebellion and Fridays for Future to such a degree that she chose to give up her academic career and instead focus her efforts on addressing the climate emergency to help protect life on Earth. She co-edited the Extinction Rebellion book, *This is not a Drill*, and at a time when many other scientists fight shy of campaigning through fear of reputational damage, can be found speaking out from the street to the conference hall on the need for rapid change.

Martin Ryle 1918–1984

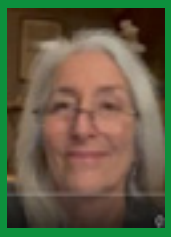
The Astronomer Royal who grew dismayed at the inhuman applications of science and became a campaigner against nuclear weapons and nuclear power and for humanitarian action

Martin Ryle, who was Astronomer Royal from 1972–1982, is said to have hated war but detested injustice and Fascism more. For that reason he enthusiastically threw himself into the Second World War effort with the Telecommunications Research Establishment (TRE). Afterwards, to distance himself from militarism he turned to astronomy. From his new subject area he kept sight of the military co-option of science and protested against above-atmosphere 'rainbow bomb' nuclear explosions in the early 1960s and in the 1970s started a wind energy research group. His activism grew with age and in 1976 he wrote a classic, ranging denunciation of nuclear power in *The Times* newspaper. Ryle lamented that, "It is scandalous that a third of the world's population does not have safe drinking water… these are problems which are soluble, but we don't solve them." Towards the end of his life he explained his motivation in a letter to friends who had apparently questioned his activism, "I believe one must do what one can with the imperfect person one is, in the time one has."

Photos: Rachel Carson © US Fish and Wildlife Service; Cynthia Chapple © bgdstem.com; Albert Einstein © Huanjo via Flickr; Alison Green © scientistswarning.org; Donnella Meadows © donnellameadows.org.

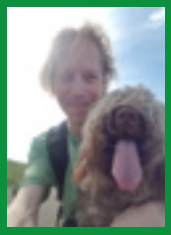
Faces of SGR's Science Oath for the Climate – will you join them?

The oath for increasing urgent action in science and technology now has over 400 signatories. They're committed to climate activism and many are promoting the oath for others to sign and act on



Professor Phoebe Barnard
University of Washington

"Do you know why I signed the Science Oath? It's because I want to live in a civilisation that makes its decisions based on evidence and logic and love and caring and the future rather than on self-interest and disinformation and superstition and hatred."



Dr Keith Baker
Glasgow Caledonian University

"I'm a signatory of the Science Oath because I firmly believe that scientists, researchers and engineers need to do a lot more than just talk the talk, we need to walk the walk and we are not seeing the political leadership and the organisational institutional leadership we need to combat climate change in the scarily little amount of time we have left... Signing this oath and adhering to the principles of it are one of the many, many things that we can and should be doing."

Professor Jonathan Bamber
University of Bristol

"We don't have the luxury of waiting any longer to make the deep changes required to avoid climate breakdown. Policymakers, governments, industry and of course the scientific community as well have to act now to make the changes needed to protect future generations from ever deepening catastrophe and climate breakdown, increasing weather extremes, threats to livelihoods and threats to lives themselves.... That's why I, along with many colleagues, signed the Science Oath for Climate."

Professor Olaf Eisen
Alfred Wegener Institute & University of Bremen

"Because we did not act in the last decades, climate change has become the climate crisis. This is why I signed the Science Oath for the Climate, to make people aware of what our lifestyle is causing, to honestly explain what consequences it already has for the planet and for us. We are destroying the ecosystems on which we depend for our survival. Time is running out for humanity to put on the brakes to stop the warming of the climate crisis, to limit the temperature increase to the two degrees range which would still provide us with the stable environment on which we depend. Beyond that we would lose control and also our ability to adapt as a society. Climate change is real. It's us. The experts agree it's bad. But there is still hope – let's act together."

Dr Phil Webber
Scientists for Global Responsibility

"I signed the #ScienceOath after working for over 20 years on reducing carbon emissions via insulation and renewables and seeing weak government policy failing to reduce emissions sufficiently. We have less than 5 years to invest in a safer world. Fossil fuel cuts are vital now."

Dr Amelie Kirchgaessner
British Antarctic Survey

"As a climate scientist I have committed to explain what the scientific evidence tells us about how serious climate change and global warming are."

Work in climate research and science?
Add your name at the SGR website and share it with the hashtag #ScienceOath
https://www.sgr.org.uk/projects/science-oath-climate-text-and-signing

Encouraging a culture of climate activism in universities

SGR's **Emily Heath** shares some tips based on her experience of leading and supporting sustainability campaigns within the UK higher education sector.

The need for activists in education

All parts of the education sector have an important role to play in teaching the factual evidence about the climate and ecological emergencies, and equipping their staff, students and communities with the skills and ambition to make a rapid transition to low-carbon living and working.

To make this happen, I think that increasing numbers of staff and students must be bold enough to challenge the status quo and become activists.

Activism can take many forms. It might involve behind-the-scenes information-gathering and policy development, using physical and digital media to influence social and political change, or participating in public protests or non-violent direct action. Everyone can do something.

Why focus on universities?

Despite all their talk about innovation, sustainability and leadership, universities have very large carbon footprints and are not doing enough to reduce them. Valls-Val and Bovea (2021)[1] reviewed the carbon footprints of 34 universities worldwide, and found that European institutions emitted an average of 2.25 tCO_2e per student per year. At the end of 2021, People and Planet reported that the majority of UK universities were not on track to meet sector-wide carbon-reduction targets.[2] Some are leading the way, but many have not yet even committed to reduce their emissions to net zero by 2050, let alone by the science-led target of 2030.[3] Universities need to get their own house in order to be credible as sustainability leaders.

A culture change is desperately needed. Academic norms include working long hours, competing in a global market and generating a lot of international travel. There is a pervasive focus on rankings and maximising income. Students imbibe these norms and perpetuate them.

If you work or study at a university, what can you do to change this competitive, conservative, money-oriented culture to one that embraces rapid change and embodies values of co-operation, equality, justice and sustainability?

1. **Unionise!** Become a Green Rep or other officer in your trade union, e.g. University and College Union (UCU),[4] or students' union. This will help you to communicate with and mobilise a lot of people, give your campaigning more clout, and benefit from training and networking opportunities and resources on a national scale.

2. **Get time and recognition for taking climate action.** Not having time is often the biggest barrier to making change happen. Could you reduce your working hours to free up some time for volunteering? Even better, could you find a way to make it part of your job or studies? Make a case for sustainability champions to be allocated some paid time every month. Integrate activism into your teaching or research. Switch jobs if yours harms, rather than helps, the planet. If you are a student, get elected as a student union officer, or choose courses, dissertation topics or placements focused on action for sustainability. Campaign to create new jobs to progress this agenda. Incentivise people by building sustainability leadership into promotion criteria. Create awards or submit nominations to recognise sustainability leaders (students, staff, institutions).

3. **Demand transparency from your institution.** It is no longer mandatory for UK universities to provide data on carbon reduction and other sustainability issues to the Higher Education Statistics Agency, although many are still doing so. Put pressure on them to publish and discuss their Scope 1, 2 and 3 emissions, targets, monitoring and action plans with enough detail to understand where emissions are coming from and how to reduce them. Ask questions, and use Freedom of Information legislation if necessary. Find out how your institution is governed, and hold decision-makers to account. Meet with them and explain how you would like to work cooperatively with them. If they are resistant, campaign for democratic reform and stand for election if you can.

4. **Find ways to embed climate education, action and justice across the whole curriculum.** Decarbonising, decolonising and democratising go hand-in-hand. Link with campaigns such as Teach the Future,[5] Students Organising for Sustainability,[6] Why Is My Curriculum White?, and the Green New Deal.

5. **Create or support pledges and petitions.** These are easy ways to engage people, demonstrate high levels of support for action, and secure commitments. They need regular promotion by a well-networked team who collectively have good social media skills and face-to-face persuasion skills.

6. **Protect the right to protest.** This is threatened by repressive new legislation from the UK government, and some universities have adopted policies to deter protests on their campuses.

7. **Publicly support climate action and other activists.** Build alliances and help to give activists hope and motivation by simply thanking them or standing with them. The more we nurture climate-friendly behaviour and leadership, the sooner we will establish new social norms.

8. **Challenge greenwash, waste and high-emission activities**. Continuing to invest in fossil fuels, buying non-renewable electricity, failing to insulate buildings, and flying to academic conferences and graduation ceremonies are good ones to start with!

9. **Be brave and persevere.** Being an effective activist isn't easy, and nobody has all the answers – but don't let fear or uncertainty stop you. If you are in a privileged position (e.g. with a secure job, your own house, perhaps a senior role), use it to empower others and speak up for those who will bear the brunt of climate breakdown if we fail to act soon enough.

***Dr Emily Heath** is SGR's Office Manager. Before this, she taught Earth Sciences at Lancaster University for 23 years.*

References and useful resources

1 Valls-Val, K., & Bovea, M. (2021). Carbon footprint in Higher Education Institutions: a literature review and prospects for future research. *Clean Technologies and Environmental Policy*, vol.23, pp.2523–2542. https://doi.org/10.1007/s10098-021-02180-2

2 https://peopleandplanet.org/university-league/2021-press-release

3 For a list of all UK universities and colleges and their commitments (if any!), see: https://www.eauc.org.uk/sustainability_commitments

4 For more information on UCU Green reps, see: https://www.ucu.org.uk/environment

5 Teach The Future is a youth-led campaign which includes a teachers' network – see: https://www.teachthefuture.uk/

6 https://www.sos-uk.org/projects

Dr Emily Heath (SGR) & Dr Nils Markusson (University & College Union) at a climate protest on a UCU strike day in 2020.

The Science Museum sullies its reputation by supporting major polluters

Jess Worth and **Chris Garrard** of Culture Unstained report on how the Science Museum is doubling down in defence of its fossil fuel sponsors and alienating scientists, young people and its own, now former, board members in the process.

Last October, ahead of the COP26 Climate Summit in Glasgow, the UK was focussed on taking climate action. But the Science Museum had other ideas. On 19th October, Indian billionaire and owner of major coal and renewables company Gautam Adani, revealed on Twitter that his company has signed a major new sponsorship deal with the Science Museum, to sponsor its new 'Energy Revolution' gallery, due to open in 2023. The museum had already been under intense pressure over its existing sponsorship deals with oil and gas majors BP, Equinor and Shell, which had been announced as the sponsor of its 'Our Future Planet' exhibition on climate solutions earlier in the year.

The Adani Group is an Indian multinational conglomerate heavily involved in coal extraction and coal-fired power stations. While declaring it wants to be the largest renewable energy company in the world by 2030, Adani is also expanding its coal footprint by 800%, according to the #StopAdani campaign. But since the announcement, the Science Museum has sought to distance itself from Adani's involvement in coal production by arguing that it is Adani Green Energy – not the larger Adani Group – that will sponsor its new Gallery. However, emails released under Freedom of Information rules have now shown that the museum had originally negotiated the sponsorship deal with the parent company, the Adani Group, and that in practice there is little separation between the parent group and its subsidiary.

Just a few weeks before the announcement of the new sponsorship deal, pressure had already been mounting on the Science Museum after leading climate scientist – and the museum's former director – Prof Chris Rapley resigned from its Advisory Board over its "willingness to accept oil and gas sponsorship". Then, just as COP26 was beginning in Glasgow, mathematician and presenter Dr Hannah Fry announced in a powerful op-ed in *The Times* that she had resigned from the museum's Board of Trustees over its stance on fossil fuel sponsorship. A statement from the Science Museum's Chair Dame Mary Archer, published later that day, revealed that this had in fact been a double resignation with the Director of the Institute for Research in Schools Dr Jo Foster also resigning from the Board. One of Hannah Fry's core motivations for resigning had been the dismissive attitude shown by the museum's leaders towards the young people who had raised their concerns about the museum's fossil fuel sponsorship deals:

> *"In the last week, the museum has reacted defiantly amid the reasonable voices calling for change… This is a debate where young people are leading the charge, and I cannot in good conscience remain in post while the museum is not proactively engaging with the very people it was built to inspire."*

Youth strikers UKSCN London have been mounting a concerted campaign for Shell to be dropped as the sponsor of the 'Our Future Planet' exhibition after discovering that the museum had included placards within the exhibition from the strikes without the strike organisers' knowledge or consent. They launched a boycott of the exhibition, worked with one of the young people who'd created the placards to get them removed from the exhibition in September, and occupied the museum overnight in October.

With the controversy growing, Director of the Science Museum Group Ian Blatchford appeared on BBC Radio 4's *Front Row* programme in October in an attempt to defend the new deal

Adani's Australian Abbott Point coal loading facility with coal water run off moving north-west into the wetlands after Cyclone Debbie in 2017.

with Adani. During the interview, presenter Samira Ahmed asked Blatchford to respond to comments made by Adrian Burragubba, a Traditional Owner of land who has been targeted by Adani in Australia, that "*by putting this company on a pedestal, the Science Museum is complicit in Adani's violation of our Human Rights and destruction of our ancestral lands*". Instead of acknowledging his concerns, Blatchford staunchly defended Adani's coal business by dismissing Burragubba's comments, questioning their validity and saying, "*there is certainly a great tendency for some campaigners to exaggerate very significantly those issues".*

There was an immediate pushback online and, a few weeks later, a group of Indigenous people sent a letter to the Science Museum Group calling on its leadership to listen to Indigenous peoples' concerns about the new sponsorship deal with Adani Green Energy and, in particular, the impacts of the Adani Group's coal mines and coal-fired power stations on Indigenous communities in India, Indonesia and Australia. In their letter, they wrote:

> *"To defend Adani's controversial business operations in this way, and to dismiss the concerns of Indigenous peoples, is completely unacceptable for any publicly funded institution, and particularly concerning coming from a museum of science."*

With the museum standing firm and failing to act on their concerns, several organisations recently joined forces and arranged for a large AdVan to pull up outside the museum playing films and messages from Indigenous communities in India, Indonesia and Australia who are resisting Adani's destructive projects on their lands. Supporters and passers-by gathered to watch, unfurling banners and placards to demonstrate their solidarity with the Indigenous people speaking out.

Meanwhile, the scientific community has also stepped up its call for the Science Museum to act. Back in November, 60 prominent scientists and contributors to the Science Museum Group published a letter announcing that they will not work with the organisation until it commits to ending its partnerships with fossil fuel companies. Among the signatories were former chair of the Intergovernmental Panel on Climate Change (IPCC) Sir Robert Watson, former Co-Director of the Grantham Institute Professor Joanna Haigh, naturalist and broadcaster Chris Packham, and several SGR staff and patrons. In their letter, they write:

> *"Many of us have excellent personal relationships with the talented and committed members of staff that deliver the Science Museum's programme but we can no longer be complicit in the policies adopted by the Group's senior leadership and trustees. With sadness therefore, we commit not to work with any organisations in the Science Museum Group until it announces a moratorium on partnerships with fossil-fuel-producing companies."*

The signatories were also critical of the museum's decision to sign up to a non-disparagement or 'gagging' clause within its sponsorship contract with Shell, a story that broke on *Channel 4 News* earlier in the year following an investigation by Culture Unstained. Many were then shocked to learn that the museum had now signed up to an almost identical clause in its new sponsorship agreement with Adani.

Just a few weeks later, the UK's former chief scientific advisor Sir David King also added to the pressure, telling *The Guardian* that, "You need to lay down your conditions [to fossil fuel companies] before giving credit to them in the Science Museum [as sponsors]" and that "one of those conditions should be a commitment to no further investment in oil discovery and no further investment in [oil and gas] infrastructure – that is a relatively simple thing and would have a very significant impact." Currently, all of the Science Museum's fossil fuel sponsors – BP, Shell, Equinor and Adani – are investing in new exploration, counter to the guidance issued by the International Energy Agency that all investments in new oil, gas and coal need to end if we are to limit global heating to 1.5°C.

But even now, Chair Dame Mary Archer and Director Ian Blatchford continue to dismiss their critics and staunchly defend their fossil fuel sponsors. With so many stakeholders speaking out against the museum's stance on this issue, it raises the question of whether the museum's leaders are genuinely committed to promoting science – or just the brands of big polluters.

Jess Worth *and* ***Dr Chris Garrard*** *are Co-directors of Culture Unstained. For more information on their campaigns, see: https://cultureunstained.org/*

References for this article are provided in the online version - see: https://www.sgr.org.uk/publications/responsible-science-no-4

Are the UK's professional science organisations putting their money where their mouths are?

Liz Kalaugher details progress on SGR's latest investigation into the financial links between professional bodies and the fossil fuel and arms industries.

In October 2019, a *Sunday Times* headline read "Royal Society urged to ditch £16m fossil fuel investment" following publication of the Scientists for Global Responsibility report *Irresponsible Science? How the fossil fuel and arms corporations finance professional engineering and science organisations.* This report examined numerous professional bodies and uncovered high levels of financial ties with the fossil fuel and arms industries through school education programmes, event sponsorship, corporate membership schemes and investments. SGR then called on the professional organisations to cut these ties. Indeed, the Royal Society had declined to provide SGR with details of how much of its approximately £200m of investments were held in fossil fuel companies until *The Sunday Times* intervened.[1]

The following month, the *BBC News* website reported that SGR patron Prof Bill McGuire had resigned his fellowship of the Geological Society after 40 years as a member in protest at the Society's links with oil firms. "Geologists know more than anyone how suddenly an apparently stable climate can dramatically shift, with massive consequences," McGuire told the BBC. "The society shouldn't be accepting sponsorship from these firms and cosying up to them. It's madness." [2]

But did this public scrutiny make the Royal Society and Geological Society change their ways? And, following a period in which many eyes were on the UK as it co-hosted the COP26 climate negotiations, have similar organisations acted in line with the science? With that in mind, SGR picked up the reins and began a follow-up programme to check if the professional science and engineering organisations featured in its 2019 report had made any progress. In some cases, we were pleasantly surprised – in others, not so much.

Financial links with fossil fuel corporations...

Of the 20 institutions the original report investigated, 15 held investments. At the time, only two had ethical investment policies relevant to climate change – the British Psychological Society, which completely excludes the fossil fuel industry, and the Institution of Civil Engineers (ICE), which calls for its fund managers to be compatible with UN Principles for Responsible Investment (PRI). SGR has concerns, however, that whilst these six principles offer a menu of possible actions for incorporating environmental, social and governance issues into investment practice, they don't actually disqualify fossil fuels from investment.[3]

When SGR followed up, we were encouraged to find that six of the professional organisations had made changes to their ethical investment policies and practices. As a result, just over half – eight of the 15 institutions with investments, including the Geological Society – now have some form of investment policy or practice relevant to fossil fuels. What's more, a ninth had initiated a process to create such a policy. It is of course hard to tell how much of this change is due to SGR's report and the accompanying media attention but we think that we added to the pressure significantly.

The changes we discovered are as follows. The Royal Meteorological Society has stopped investing in fossil fuels, and in the annex to its 2020 accounts,[4] says that "the ethical policy in place does not allow direct investment in tobacco or fossil fuel providers". The Geological Society has now excluded the highest carbon-emitting fossil fuels – thermal coal and tar sands – from its investments in a formal policy. However, in correspondence, the Society told SGR it is not currently investing in *any* fossil fuel corporation – although it doesn't rule this out in the future. The Institute of Materials, Minerals and Mining (IOM3), meanwhile, doesn't have a policy but holds its investments in a fund that avoids thermal coal and tar sands. The Energy Institute, the Institution of Engineering and Technology (IET), and the Royal Academy of Engineering have also all introduced some form of fossil-fuel relevant investment policy. The Energy Institute presses those it invests in to align with the goals of the Paris Agreement, while the IET has an environmental, social and

governance policy, and the Royal Academy of Engineering asks for compatibility with the UN PRI (like the ICE). So, although there has been significant progress, only two of these six institutions have completely excluded fossil fuel corporations from their investments – and one of these may be temporary.

Perhaps the most striking finding was that the Royal Society, despite the adverse publicity, has still not introduced an ethical investment policy for its total investments of roughly £234m.[5] In a letter to SGR, the organisation claimed to be waiting for the outcome of the Charity Commission's consultation on the responsibilities of trustees regarding investments before changing its policy. This seems rather bizarre, especially as numerous other professional organisations have felt able to bring in ethical investment policies. The Royal Society also said "we all need to work towards reducing our reliance on fossil fuels, and that includes encouraging energy companies to invest in technologies that can help us to reach net-zero by 2050". However, it gave little detail on how it is carrying this out.

The Institute of Physics (IOP) is engaged in an internal process to develop an ethical investment strategy. On the IOP's webpage on physics, climate change and sustainability, set up before COP26,[6] the Institute says that it is "reviewing our investment policy with a view to better using our financial resources to combat climate change". When SGR asked for an update, the IOP said that it has made "good progress with our investment advisors" and that its Council has decided to consult the membership on "some of the thoughts and definitions that would sit at the heart of any policy".

SGR also investigated whether selected scientific professional bodies have made any progress on developing environmental policies or reducing their own greenhouse gas emissions. The IOP already has an environmental policy, while the Geological Society plans to introduce one by the end of 2022. Both organisations have started measuring their own carbon footprints. The IOM3 has signed the Professional Bodies Climate Action Charter,[7] which binds it to taking rapid action to reduce its own emissions in line with the 1.5°C Paris target. The IOM3 told SGR it has set a greenhouse gas emissions target of an almost 60% reduction in its Scope 1 and 2 (core) emissions by 2030. The Royal Meteorological Society is a supporter of the Charter and in October 2021 committed to achieving net zero Scope 1 and 2 carbon emissions by 2025, "where there is direct control through avoiding, reducing and substituting" and is also "working towards net zero indirect emissions (Scope 3) by 2030, subject to a full feasibility assessment".

The Royal Society did not tell us of any plans in this area and we were unable to find such plans or an environmental policy on its website.

The Energy Institute has also signed the Charter whilst the IET and EngineeringUK are 'supporters', indicating that they are either in the process of signing or cannot sign for technical reasons. SGR has reason to believe that another professional organisation is in the process of applying to sign thanks to encouragement from SGR.

...and with the arms industry

With regards to arms companies, the Geological Society excludes arms manufacturers from its investments as a matter of policy. The IOM3 does not have a formal policy but its investments are in a fund that excludes arms companies. The Royal Meteorological Society told us in an email in January 2022 that "our investment policy does not specifically address the issue of investment [in] arms companies, but specific instructions to our investment managers include that we will not invest in arms or fossil fuels". The Society plans to review the wording of its investment policy over the coming months "to ensure that it gives further detail around application of our environmental and ethical values to our investment strategy".

The Royal Metereological Society has stopped investing in fossil fuels, and say that "the ethical policy in place does not allow direct investment in tobacco or fossil fuel providers".

In 2019 the Royal Society told *The Sunday Times* that it had no investments in arms companies. However, as the Society only excludes tobacco from its investments as a matter of policy, made no comment on its financial ties to arms companies in its response to SGR, and is not fully transparent about its investments, it is not possible to tell whether this is still the case or, if not, how much the Royal Society currently invests in arms companies.

The IOP does invest in and take sponsorship from arms companies. We were able to ascertain the details of 43% of the IOP's investments at December 31st 2019, and 1% of these were in arms companies, meaning a total investment by the IOP of approximately £95,000 in this industry. The IOP told SGR that "Your note makes reference in a few places to sponsorship and involvement of IOP activities from companies in the defence sector. As the Learned Society and Professional Body for physics a core part of our mission is to support both the discipline and physicists across all of the sectors that they work in, and that includes the defence sector. So I hope you can understand that we would not be fulfilling our remit if we were to exclude that sector from our programmes of work." This response clearly side-steps serious questions of whether the IOP should, for example, take arms industry sponsorship for events and educational activities or invest in arms companies, given their poor ethical record. As mentioned above, the IOP Council has decided to consult its membership on its new investment policy, so SGR will be encouraging ethically concerned members to engage with this.

For the updated case study reports and the specific responses of the professional bodies to date, please see our website.[8]

Further engagement

In the next stage of our work, we are encouraging members of these scientific professional institutions to write letters to their membership magazines regarding their financial links to the fossil fuel and arms industries. We already have volunteers; please do email me at lizk@sgr.org.uk if you would like to join them. We're also preparing further case study reports – especially on UK professional engineering bodies – regarding both their fossil fuel and arms investments.

And on 1st June 2021, we took the project international, thanks to generous funding from the ClimateWorks Foundation and we're looking at the fossil fuel industry connections of professional bodies in the US, Europe and elsewhere. Watch this space for reports on our progress.

So, in answer to my original questions on whether public scrutiny has made professional bodies change their ways, it seems that it has. The Royal Meteorological Society and the Geological Society have joined the British Psychological Society and seven medical professional organisations in not holding, or being in the process of divesting from, fossil fuel investments. Although the Geological Society may take a step backwards, pressure from the public and from members could prevent this. The IOM3 has also excluded the highest-carbon fossil fuel industry links. Meanwhile, three bodies no longer invest in the arms industry. Overall, more than half of the professional science and engineering organisations in our original report now have some form of responsible investment policy with more on the way. The most prominent laggard is, however, the Royal Society. Clearly, we need to keep on pushing so that it and others turn away from the dangerous fossil fuel and arms industries.

***Dr Liz Kalaugher** is SGR's Responsible Science Campaigner.*

References

1 The Times (2019). https://www.thetimes.co.uk/article/royal-society-urged-to-ditch-16m-fossil-fuel-investment-drw89t35f
2 BBC (2019). https://www.bbc.co.uk/news/science-environment-50467317
3 Indeed, a 2020 report by the campaign group ShareAction on investment managers cautions that signing up to initiatives such as the PRI or Climate Action 100+ does not always correspond with having a fit-for-purpose responsible investment approach. See: https://shareaction.org/wp-content/uploads/2020/06/ShareAction-Climate-Report-III-Final.pdf
4 Royal Meteorological Society (2021). https://www.rmets.org/sites/default/files/2021-05/annual_report_annexes_2020_final_1.pdf
5 SGR (2021). https://www.sgr.org.uk/sites/default/files/2021-06/Royal_Society_progress_report.pdf
6 IOP (2022). https://www.iop.org/strategy/physics-climate-change-sustainability
7 https://professionalsclimatecharter.org/
8 The latest reports and responses can be found at the bottom of the page at: https://www.sgr.org.uk/publications/irresponsible-science

Scientists' warnings and adequate response

What would it take for humanity to hear and act on the scientists' warnings of a climate and nature emergency? **Alan Cottey** discusses 'adequate response' and how to achieve it. He recommends empathic dialogue with the 'hard-to-reach'.

In 2017 William Ripple and colleagues published the article *World Scientists' Warning to Humanity: A Second Notice*.[1] The peg was the 25th anniversary of a leaflet, World Scientists' Warning to Humanity,[2] from the Union of Concerned Scientists. The UCS warning, summarised by "Human beings and the natural world are on a collision course", covers numerous environmental stresses, population growth, poverty, violence and war. The 'Second Notice' reviewed humanity's response to the UCS warning by presenting the trends, from 1960 to around 2015, of nine indicators of global ecological stress. In nearly every case a strong adverse trend is roughly the same after 1992 as before. Thus, despite ample opportunity, humanity did not heed the UCS warning.

The Second Notice prompted further warnings from expert scientists on many specific subjects, notably climate.[3] The warnings have spread awareness and acceptance of the reality of the climate and nature emergency but have so far failed in their overriding aim, for the emissions, etc, at the root of the problem generally continue to rise.

Responses

Some responses that ameliorate the climate and nature emergency have been achieved. Progress has been made towards an energy transition away from fossil fuels and towards renewable sources. Yet global emissions continue to increase. The actors with most political power (nation-states, corporations and their leaders) find it possible to set targets but offer no realistic programmes for hitting them.

A major part of the difficulty is orthodox economics, with its commitment to the measurable and to growth. Alok Sharma, President of the COP26 conference, declares "green growth is the future".[4] But humanity's pressure on the earth's ecology still increases, apart from small decreases during economic recessions. There is almost universal fear – terror, even – of recessions of this kind, which do indeed inflict much pain. There is however a better way forward, although it does require a rethink of underlying economic values.

Aspirations

Instead of accepting the present extremes of inequality, moderated by grudging redistribution, economic thinking could start from two basic principles:[5]

1. Liveable Global Habitat: to maintain and enhance a civilised human society and a liveable global habitat for a rich variety of species;

2. Necessities as of Right: to accord to all people as of right, in practice and not merely in name, the basic necessities of a civilised life.

The main obstacle to realising these aspirations is lack of imagination. Intentional degrowth could be benign and not at all like the harsh conditions of earlier economic recessions. Reductions, year on year, of the externalisation of costs, of waste, of positional consumption and of human population are possible. Sacrifice is needed but mainly of the old growth-oriented culture. The transition required can and should in many ways improve the quality of life. Two examples demonstrate the depth of changes which might be part of an adequate response.

Examples

The current state of the cultural institution of property is dysfunctional. There is an abundance of shocking statistics about extreme and increasing economic inequality, yet the trend continues. But an economy based on the two aspirational principles stated above could include a general cultural will for limits to the assets and incomes of individuals.[5]

Another dysfunctional cultural institution is work – much of what now passes as work is directed at maintaining harmful kinds of economic growth. Yet a lot of what is useful (i.e. contributes to delivering the two above aspirations) could be done by machines and software. Caring for people, and resolving the climate and nature emergency, will still leave plenty for humans to do.[6]

Empathic dialogue

Even the concerned citizens who hear the warnings have, with few exceptions, balked at advocating radical change at the pace required. And leaders cannot go far ahead of the majority. In these circumstances, activists may be motivated to press the case harder. 'Six behavioural psychology tips for effective campaigns'[7] has practical advice for activists but the language of campaigning, with its polarising and militaristic imagery, is problematic. A more fundamental issue is the controlling tone – "Changing people's behaviour" assumes one-way influence.

Pressing harder in the wrong way merely provokes defensiveness. 'They' may then be thought of as hard-to-reach. But in this climate and nature emergency, 'they' are essentially the same as us. One-way communication of scientific knowledge is not enough. Listening to the reasons for resistance is vital. It is important to acknowledge the fear of change, the allure of consumerism and whatever else may be presented. Empathic dialogue about the climate and nature emergency may include vigorous non-violent direct action. It is not a quick fix but it might, if pursued with a sense of urgency, lead to adequate responses to the scientists' warnings. "There is a place, somewhere beyond right and wrong. I'll meet you there." (Rumi)

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Towards a Fair Consumption Space: Putting people and equity at the centre of the climate discussion

Lewis Akenji, **Dana Vigran** and **Magnus Bengtsson** of the Hot or Cool Institute outline their latest research on sustainable lifestyles.

The *1.5-Degree Lifestyles: Towards a Fair Consumption Space for All* report continues the science-based approach of linking concrete changes in lifestyles to measurable impacts on climate change in order to keep to the 1.5-degree aspirational target of the Paris Agreement on climate change.

The 1.5-degree lifestyles approach examines greenhouse gas (GHG) emissions and reduction potentials using consumption-based accounting, which covers both direct emissions in a country and the embodied emissions of imported goods, while excluding emissions embodied in exported goods. A lifestyles approach to tackling the climate crisis also puts people, rather than technology, at the centre of the solution.

Introducing a Fair Consumption Space

In order to build a happy, healthy and sustainable future for ourselves, our children and future generations, we have to tackle the deeply interconnected crises of climate change and inequality.

The concept of a *fair consumption space* recognises the need to simultaneously address under-consumption, which results in unmet human needs, poor health and limited freedoms, and over-consumption, which disproportionally harms planetary systems.

The fair consumption space defines an ecologically healthy perimeter that supports within it an equitable distribution of resources and opportunities for individuals and societies to fulfil their needs and achieve wellbeing. It also outlines limits for over- and under-consumption. By defining a ceiling for per capita emissions for the nearly eight billion human beings living on the planet today, the concept of a fair consumption space puts equity and wellbeing at the centre of the climate discussion.

With limited resources and a shrinking carbon budget, over-consumption by one person affects the prospects of another, and encroaches into another's consumption space, requiring collectively working toward a more equitable distribution of limited carbon budgets.

Societal transformation will be required if we are to tackle the climate crisis head on, but we can use the concept of a fair consumption space as a guiding principle to spearhead the transition to a sustainable, low-carbon society.

Where we are and where we need to go

According to the latest assessment by the Intergovernmental Panel on Climate Change (IPCC), starting from the beginning of 2020, the remaining carbon budget for a 50% likelihood of keeping warming to 1.5°C amounts to 500 $GtCO_2$. The *1.5-Degree Lifestyles: Towards a Fair Consumption Space for All* report breaks this down into an annual per capita target from now until 2050. The current global average lifestyle carbon footprint is 4.6 tCO_2e. In comparison, we need to aim for a lifestyle carbon footprint target of 0.7 tCO_2e by 2050 (with intermediary targets of 2.5 and 1.4 tCO_2e by 2030 and 2040, respectively) to limit warming to 1.5°C above pre-industrial levels, the aspirational target of the Paris Agreement. These targets are in line with the aim to reach global peaking of GHG emissions as soon as possible and limit warming without relying on the extensive use of negative emission technologies.

The report analyses lifestyle carbon footprints of ten sample countries, representing high-, middle, and low-income countries. The findings highlight the huge inequalities and differences in lifestyle-related greenhouse gas emissions that exist among the world's major economies.

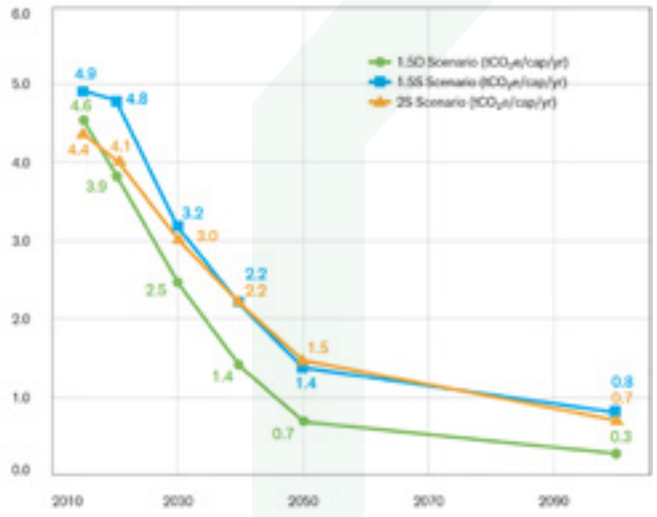
For example, an average person in Canada, the country with the highest per-capita emissions among the economies studied, was found to have a lifestyle footprint six times larger than a person in Indonesia. The other high-income countries studied (Finland, Japan, and the UK) were found to have around 70% larger footprints than the three more prosperous middle-income countries included in the study (China, South Africa, and Turkey).

These results lay bare the extent of global inequality – both economic and resource based – and confirm the well-known relationship that greenhouse gas emissions are strongly linked to per-capita national incomes. They also show massive gaps between current per-capita footprints and the required, sustainable targets.

The lifestyle carbon footprint target for 2050 is exceeded in all countries analysed, requiring rapid and radical reductions. Estimates of current annual average lifestyle carbon footprints per person for countries analysed, as of 2019, are: Canada: 17.9 (tCO_2e), Finland: 10.8, United Kingdom: 8.5, Japan: 8.1, China: 5.0, Turkey: 4.9, South Africa: 4.9, Brazil: 3.3, India: 3.0 and Indonesia: 2.2.

The footprint gaps between actual lifestyles and the targets, show that footprints in high-income countries need to be reduced by 91–96% by 2050. Upper-middle income countries already need to reduce their footprints by 68–86% by 2050. Even lower-middle income countries need to reduce footprints by 76% to meet the 2050 target.

Figure 1: Lifestyle carbon footprint budget (tCO_2e/cap/yr) from shortlisted mitigation pathways



Note: Global total emission budget was adopted from Rockström *et al.* (2017) for 1.5S, Rogelj *et al.* (2011) for 2S, and calculated as a mean of the "A2" scenario from Ranger *et al.* (2012) and "Low NonCO_2" and "All Options" scenarios from Van Vuuren *et al.* (2018 for 1.5D. The emission budget was divided by population projections from United Nations (2017) and multiplied by the household footprint share estimated by Hertwich and Peters (2009) to estimate lifestyle carbon footprint budget.

How can we get there?

There are several key learnings we can utilise to enable the societal transformation needed to set us on the path towards a 1.5°C future. First, the data compiled in the report shows key sectors that have the largest carbon footprint and identifies high impact actions to cut emissions. Second, the report outlines two separate emissions reduction scenarios for each country analysed, one focused on systems change and another on behavior change. The data shows clearly that neither scenario alone can achieve the emissions reductions required; we need both systemic change and behavior change working in parallel to limit warming to 1.5°C. Third, the report offers specific recommendations for policy approaches that have the potential to kick-start the transition to sustainable living.

Sector specific actions

The report explores impacts of consumption in six domains: food; housing, transport; goods; leisure; and services, and uses these to aggregate total lifestyle carbon footprints and reveal hotspots in the ten surveyed countries.

The three domains of food, housing, and personal transport tend to have the largest impact (approximately 79%) on total lifestyle carbon footprints. Therefore, focusing efforts to change lifestyles in relation to these domains would yield the most benefits.

Practical solutions will require three parallel types of efforts: absolute reductions in high-impact consumption (such as flying and driving less); modal shifts towards more sustainable options (such as shifting from driving to public transport or biking); and efficiency improvements (such as shifting to electric cars)—to use three examples from the transport realm.

Some of the most impactful emissions reductions options include car-free private travel, reduction of international flights, electric cars, vehicle fuel efficiency improvement, living nearer to workplaces, renewable grid electricity and off-grid energy, vegetarian-vegan diets and substituting red meat. If these options are fully implemented, they could reduce the footprint of each domain by a few hundred kg to over a tonne annually. Ultimately, the most effective interventions across lifestyle subcategories will be reducing car travel, air travel, meat consumption, and fossil-based energy usage.

Why we need both systemic and behavioural change

Most prevailing climate scenarios underplay the potential contributions of lifestyle changes to climate change mitigation and focus mainly on developing new technologies and on changes in production. But failing to shift the lifestyles of nearly eight billion human beings means we can never effectively reduce GHG emissions or successfully address our global climate crisis.

To present indicative pathways, our report analyses scenarios through which countries can meet the 2.5 tCO_2e target for 2030. For each country it presents two scenarios: one with priority on systems change (adjusting carbon intensity of lifestyles options) and a second with priority on behaviour change (adjusting volume of consumption). Both intensity and amount adjusted carbon budget scenarios highlight the urgency of drastic lifestyle carbon footprint reductions in high-income countries, as the needed footprint reductions of 69–86% require almost full (at least 95 %) adoption of low-carbon lifestyle options in all countries. Canada was an exception, as it is not able to meet the 2.5-ton target even

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30 years of SGR

20th anniversary activities
Bumper issue of *SGR Newsletter* and members forum. Social media presence established.

2012

SGR conference on risks of emerging technologies
Highlights growing risks of military drones, geoengineering, and influence of vested interests in R&D.

2011

2013

***Offensive Insecurity* report published**
In-depth report uses data from Freedom of Information requests to expose aggressive agenda of UK's military R&D programmes.

2013

SGR briefing on climatic impacts of UK nuclear weapons published
Briefing uses new climate modelling to estimate possibility of 'nuclear winter' arising from UK nuclear weapons use. Written by Philip Webber, it was used by ICAN to help make case for UN nuclear ban treaty. Expanded into larger report in 2015 to help campaign against Trident renewal.

AESR joins SGR family
Architects and Engineers for Social Responsibility (AESR) merges with SGR.

2005

***Science and the Corporate Agenda* report published**
SGR publishes in-depth report on damaging effects of corporate agenda in UK science.

2009

2005

***Soldiers in the Laboratory* report published**
SGR publishes in-depth report on extensive links between the military and UK science and technology. Launched in parliament and written by Dr Chris Langley, it's followed by two related reports in 2007 and 2008.

Iraq war briefing published
On eve of Iraq war, SGR publishes *Why the Iraq war is a warning for the planet* by Philip Webber and Vanessa Spedding.

SGR's first Executive Director appointed
Dr Stuart Parkinson appointed to newly created staff post to oversee expansion of organisation.

2003

2003

Ethical careers briefings published
SGR publishes series of 10 briefings on theme of ethical careers in science and technology edited by Stuart Parkinson and Vanessa Spedding. About 50,000 copies are distributed over a 15yr period.

2001-2006

SGR debate on genetic engineering
SGR conference hosts debate on genetic engineering which leads to research and campaigning on this issue.

1998

Climate Train to Kyoto
SGR takes leading role in organising group of scientists and activists travelling by low-carbon surface transport from Europe to Japan for COP3 climate negotiations.
(also see extended summary on p.5)

1997–1998

Science for the Earth conferences
SGR helps stage series of four conferences to discuss role of science in helping build better world.

1992–1996

SGR website launched
SGR an early adopter of new technology of the World Wide Web.

1995

Scientists for Global Responsibility (SGR) formed
SGR formed from merger of Scientists Against Nuclear Arms (SANA), Electronics and Computing for Peace (ECP), and Psychologists for Peace (PfP). Members of recently dissolved British Society for Social Responsibility in Science (BSSRS) also join. Dr Philip Webber is Chair.

1992

2014

SGR moves office to eco-village near Lancaster
Office moved from Kent to building supplied by community renewable energy. In 2020, office moves again to another eco-retrofit building, this time in Lancaster city-centre to minimise staff commuting as well.

2014

***Shale Gas and Fracking* report published**
Critical assessment of efforts to create UK fracking industry.

SGR at COP21 in Paris
SGR takes part in Alternative Climate Summit.

2015

2015

Annual Science4Society Week begins
SGR begins new science education activities for school children, co-ordinated by Dr Jan Maskell.

UN Treaty on the Prohibition of Nuclear Weapons formally agreed
Campaigning by ICAN – including using SGR's research – leads to new UN treaty. ICAN receives Nobel Peace Prize.

2017

***Artificial Intelligence* report published**
Report on risks of AI written by SGR's new Assistant Director, Andrew Simms.

2018

One Planet One Life workshops in schools
Jan Maskell runs school workshops for over 1,300 children on climate change and sustainable lifestyles.

2018–21

Responsible Science* journal replaces *SGR Newsletter
After nearly 50 editions of *SGR Newsletter*, we opt for an upgrade, edited by Andrew Simms and Stuart Parkinson.

2019

2019

Two reports on responsibility of scientists published
Numerous concerns raised, including financial links between professional bodies and fossil fuel/ arms industries – leading to new **Science Oath for the Climate** and related activities.

2020

SGR conference moves online
Annual conference held online for first time, focusing on lessons from COVID-19 pandemic for climate crisis.

2020

***Environmental impacts of UK military* report published**
In-depth report on carbon emissions and other environmental impacts of UK military, written by Stuart Parkinson. Followed by report on EU military carbon emissions in 2021 – and further research and campaigning.

2021

Globally Responsible Careers resources launched
Launch of new web-based resource, Globally Responsible Careers in Science, Technology, Engineering and Mathematics (GRC-STEM).

2021

SGR at COP26 in Glasgow
SGR takes part in Alternative Climate Summit.

SGR continues to grow
SGR staff expands to seven, has large reach via website and social media, and expertise is sought by wider audiences than ever!

2022

Figure 2: Carbon footprint and its breakdown between consumption domain and globally unified targets for the lifestyle carbon footprints.

Note: Average lifestyle carbon footprint of country estimated as of 2019. The vertical lines indicate 1.5D footprint targets for 2030 and 2050 (1.5°C without/less use of negative emissions technologies).

» Continued from page 21...

with full adoption of the options applied in this report. Upper and lower-middle income countries also need lifestyle carbon footprint reductions of 23–50% by 2030, but pathways allow more freedom in terms of chosen actions and adoption rates, as well as the possibility for focusing on country-specific hotspots.

The results highlight the significance of the lifestyle changes required across consumption domains in order to implement the Paris Agreement, and also imply it is not an either-or question of technology or lifestyles but rather both – improvements to the energy system and technology as well as shifts in consumption patterns are required to achieve the ambitious climate targets.

Policy recommendations

With a diminishing carbon budget amid impacts of climate change already being felt, growing social tension exacerbated by vast inequities in society, and a short timeline for action, we need every tool in the box, including options that may seem politically challenging. The report highlights a number of policy frameworks that may help society transition towards a fair consumption space within planetary boundaries. These recognise that significant lifestyle changes are, however, only possible if they occur within broader system change in the underlying economic and social conditions, and that the burden of change also includes communities, businesses and institutions, and government agencies.

One key approach is taking out the unsustainable consumption options, through 'choice editing'. Choice editing is a traditional government approach that has been primarily applied through the lens of public safety, health and security. However, with sustainability becoming an existential issue, governments need to incorporate this into their choice editing criteria. High impact options such as fossil-fueled private jets and mega yachts, excessive meat consumption and customer loyalty programs that encourage unnecessary frequent flying and stays in high-waste hotels need to be edited out, while innovation for more sustainable alternatives would need to be edited in.

A second approach requires setting limits for environmentally harmful consumption and staying within those limits. The report asks the question of whether the time has come for carbon rationing. Rationing has been used in the past as a tool to regulate water shortages in times of drought, to ensure equitable availability of fuel and food when limited. Carbon rationing is relevant, since existing policies and programs are insufficient for meeting carbon reduction targets, and second because it is a policy idea that meets calls for equitable and socially just action on climate change.

The report also recommends a set of policy approaches that aim to ensure a more equitable, wellbeing-based society. One such recommendation is a sufficiency-based approach to policy design which shifts the focus from technology and economic growth mechanisms to what is needed to increase wellbeing for all. Implicit in the sufficiency-based approach is the need for social innovation, to find new ways of meeting our needs within Earth's regenerative capacity. Another recommendation to ensure equity and guarantee access to basic needs for all, is to go beyond proposals for universal basic income and implement universal basic services (UBS). UBS are underscored by a social guarantee, which recognises that everyone has basic human needs – shelter, sustenance, health and care, education, local transport, information access, and legal support – that must be met in order to allow them to participate with dignity in society.

The full report *1.5-Degree Lifestyles: Towards a Fair Consumption Space for All* and annexes are available for download from: https://hotorcool.org/1-5-degree-lifestyles-report

Dr Lewis Akenji *is the Director of the Hot or Cool Institute based in Germany, where he has led work on what lifestyles compatible with the 1.5 degree climate target look like.*

The mirage of zero-emissions flying

Finlay Asher, of Safe Landing, assesses the technical obstacles to the decarbonisation of aviation.

Globally, the civil aviation industry plans to double in size before 2040 and possibly again by 2050. If this happens, we could see aviation fuel consumption and therefore greenhouse gas emissions triple by 2050. Both corporate and government leaders use unrealistic and distracting promises of technological solutions to greenwash this growth. In this article, I examine these claims and debunk common myths and misconceptions using a set of factsheets produced by the campaign group *Stay Grounded*, which summarise evidence from technical, academic and industry sources.[1]

Sustainability Strategy

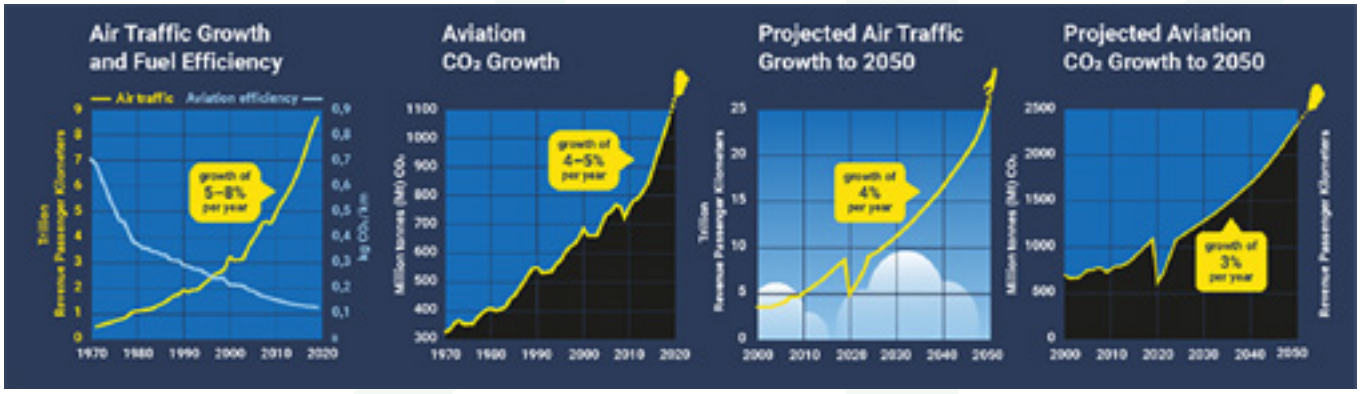
Key players within the global civil aviation industry have recently released a series of joint statements declaring a shared sustainability strategy. Airline lobby groups such as ATAG, and fossil fuel companies such as Shell have also produced aviation roadmaps with similar strategies. Despite the dip caused by COVID-19, these all show an unequivocal return to pre-pandemic levels of flying within a few years, and then a return to the rapid air traffic growth of previous decades. This growth is underpinned by the same repeating elements: conventional aircraft and airline efficiency improvements, alternative technology such as electric or hydrogen powered aircraft, and alternative jet fuels such as biofuel and electrofuels.

Efficiency[2]

Aircraft efficiency refers to the amount of fuel burned (and emissions produced) by an aircraft in order to transport its payload (passengers or cargo) a given distance (e.g. one kilometre). Efficiency improvements (i.e. reductions in fuel burn) are achieved by optimising the design of the aircraft, the engines, the airline operations (e.g. the flightpath) and by increasing the amount of passengers or cargo carried onboard the aircraft. Efficiency – the mass of fuel per passenger-km – is directly proportional to CO_2 emissions per passenger-km, with 1kg of fuel emitting 3.16kg of CO_2.

However, history shows us that 'efficiency improvements' have always been accompanied by increased emissions. This is because efficiency improvements also reduce the cost of flying and contribute to air traffic growth, leading to emissions growth which far outpaces the emissions reductions from efficiency gains. The efficiency gains can also be cancelled out by airlines

Figure 1. Aviation growth and CO_2 emissions



upgrading the class of seats, and by flying further or faster which reduces efficiency.

Figure 1 shows that in a poorly-regulated industry, efficiency improvements may facilitate market growth and increase total emissions, not reduce them. This is known as Jevon's Paradox. Thus, efficiency gains alone cannot be relied upon to decarbonise the industry – we also need regulations to limit air traffic.

The Earth's atmosphere isn't affected by individual aircraft efficiency, but instead by total emissions produced. This has been rapidly increasing, rather than decreasing.

Electric Aircraft[3]

Electric aircraft propulsion systems typically involve aircraft propulsors (propellers, or fan blades) that are driven by electric motors.

In 'fully-electric' aircraft, these motors are powered by electrical energy provided directly from batteries. Often such aircraft are described as 'zero emissions' as they have zero tailpipe emissions but this is somewhat of a misnomer as the production and re-charging emissions of batteries will remain significant for the foreseeable future.

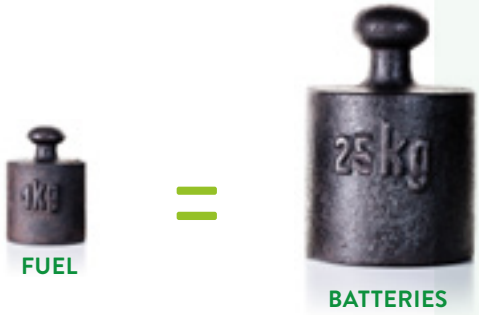
Current batteries and electrical systems are far too heavy to displace most jet fuel and combustion engines, so it's likely that only very small electric aircraft will be certified before 2050. This is reflected by the fact that most companies attempting to certify electric aircraft during the 2020s are developing aircraft carrying less than 10 passengers which don't generally fit the current configuration of most airports. In addition, unlike a fuel tank where the weight decreases as fuel is burned during the flight, a battery does not become lighter during the trip. These issues further impact the payload and range capability of the aircraft.

Currently this means that electric aircraft will likely only be viable for short flights under 1,000 km by 2050 which account for a small fraction of aviation CO_2 emissions. However, the scope to decarbonise overall aviation emissions is even more limited because, although electric aircraft can be justified for some niche cases in regions where ground transport options are poor, such as remote island or mountainous regions – everywhere else short-haul flights can be substituted by more efficient public transport options on the ground.

Hydrogen Aircraft[4]

Hydrogen can either be burned in a jet engine (hydrogen combustion) or used to generate electricity in a fuel cell to power a propeller (hydrogen-electric). It is produced from other energy sources, is very energy-intensive to produce, and is stored in liquid form at -253°C. While hydrogen power produces zero CO_2 emissions, other non-CO_2 emissions such as nitrogen oxides (NO_x), water vapour and contrails are still produced which result in global heating. It's estimated that hydrogen combustion could reduce the total climate impact by only 50-75% and hydrogen fuel cells by 75–90% versus jet fuel.

Hydrogen flight is unproven, with many technical and safety aspects yet to be understood. The main design issue is fuel storage as even liquid hydrogen has a volume over four times larger than jet fuel for an equivalent amount of energy. Boeing are sceptical and even Airbus has admitted that hydrogen will not be widely used in planes before 2050, stating that only regional 50–100 seaters would be ready for hydrogen in the 2030s, a small market with a small share of emissions. If airlines transition to using a large amount of such aircraft, this will substantially affect their operations and the design of airport infrastructure (e.g. runways, gates, terminals, fuelling and maintenance requirements). It would therefore be sensible to halt aviation expansion plans until we know to what extent hydrogen aircraft will be used.



The biggest issue with hydrogen aircraft is the timescale. Novel aircraft have a typical design, development and certification time of 15–20 years and a lifetime of more than 25 years. The production of a new fleet of hydrogen aircraft and conversion of airport infrastructure would start too late and take too long to have any significant impact on aviation decarbonisation over the next two crucial decades.

Alternative Jet Fuels or 'SAF'

Alternative jet fuels or so-called 'Sustainable Aviation Fuels' (SAF) are liquid hydrocarbon fuels that can be used with existing aircraft in place of kerosene produced from fossil fuels.

The premise of their sustainability is to create fuel using CO_2 taken from the atmosphere, rather than using fossil fuels extracted from deep underground that will then emit additional CO_2 to the atmosphere when burned. The argument is that blending these fuels with fossil fuels would therefore reduce emissions.

They can be broadly categorised into two varieties:

Biofuels – produced from biomass sources

Electro-fuels (e-fuels) – produced from electricity

While it's promised that these fuels could be scaled-up rapidly to a significant percentage of total consumption, this has already been promised by the industry for more than a decade but currently less than 0.01% of jet fuel is from alternative sources. Second generation biofuels and e-fuels are likely to only replace a small percentage of fossil fuel use in the near-future.

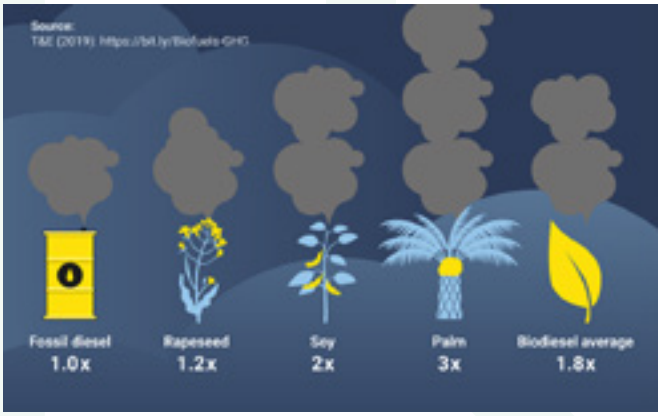
Even if scaled up further, alternative jet fuels will still cost far more than kerosene. Biofuel from 'waste oil' is the most cost competitive but still costs double the price and other biofuel and e-fuel processes cost as much as eight times the price. The only way the aviation industry can continue to grow whilst using larger quantities of alternative jet fuels, would be to obtain large government subsidies for their production. According to a 2019 ICAO study, 328 new large bio-refineries would need to be built every year by 2035, at a cost of US$29-115 billion a year to supply international aviation alone. However, investing in such refineries would pose a huge risk to taxpayer money as it's unlikely, for the reasons given here, that alternative jet fuels will always be viewed as 'sustainable'. This could result in facilities turning into 'stranded assets'.

The industry claims that "SAF can reduce emissions by up to 80% during its full life cycle". However, greenhouse gas savings of only 60% have been proposed at national levels as a threshold for 'SAF' and fuels eligible under the international CORSIA scheme can have savings as low as 10%. In addition, aviation also produces non-CO_2 emissions such as contrails which are estimated to cause a greater global heating effect than aviation CO_2. Recent studies have shown that while alternative jet fuels can contribute to reducing non-CO_2 emissions, they will only be partially reduced. So even where they are used in place of fossil fuel, significant emissions will still be generated.

Biofuels[5]

Biofuel production can use various sources of biomass as an input. First generation biofuels use agricultural crops. Second generation biofuels use industrial, agricultural, municipal or household waste, such as: used cooking oil, fat, corn husks, forest resources, or food waste.

Figure 2. Ratio of greenhouse gas emissions from biofuels compared to fossil diesel



The aviation industry often claims that it will only use second generation biofuels from 'sustainable waste' that won't compete with agriculture or cause adverse environmental or social impacts. However, it hasn't ruled out the use of first-generation biofuels, which can cause land-use change emissions, biodiversity loss, rising food prices, and water scarcity. There are plans for huge 'SAF' refineries in Paraguay using soybeans as a feedstock and such fuels are permitted in the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), which is the only internationally agreed policy and runs until 2035.

There is a very limited quantity of 'sustainable waste' available globally for second generation biofuels – this could also be used more efficiently to decarbonise other sectors and there are many competing uses such as for organic fertiliser, biodiesel for ground-based transport, and Bioenergy Carbon Capture and Storage (BECCS).

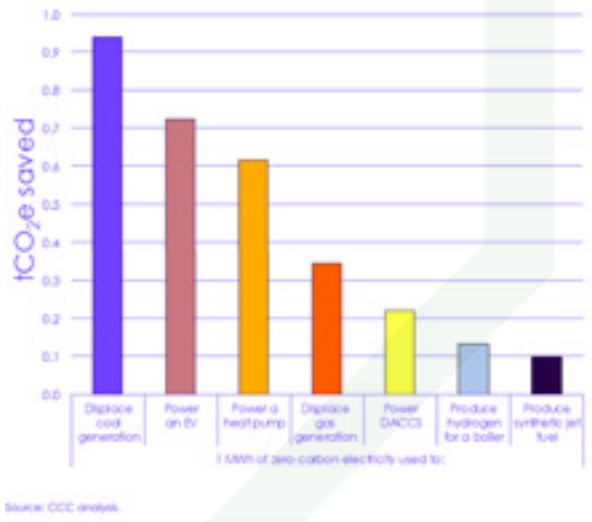
E-fuels[6]

E-fuels can be produced by combining hydrogen with carbon to create a liquid hydrocarbon. Hydrogen must be extracted from water by electrolysis and carbon extracted from the air using a process called 'Direct Air Capture' (DAC). These can then be combined into a hydrocarbon fuel using a chemical process called Fischer-Tropsch (FT) synthesis. In order to minimise emissions, these processes must all be powered with renewable energy.

Although the technology has been demonstrated, it's still at the pilot stage and several decades of heavy investment would be needed to scale up production. The production is also extremely energy-intensive. No more than about 10% of the renewable electricity input would eventually be converted into thrust to move an aircraft, whereas it can be used far more efficiently in many other applications as shown by the UK Climate Change Committee – see Figure 3.

In a scenario where 100% of the airliner fleet would use e-fuels, the resulting electricity demand would be 2.5 times higher than current global renewable energy production and about five times higher if air traffic growth continues to 2050.

Figure 3. Greenhouse gas emissions saved from 1 MWh of zero-carbon electricity across sectors[7]



As demand for electricity grows, so does the risk that renewable electricity supply won't be able to match it, prolonging the use of fossil fuels.

Conclusion

All technical options for reducing greenhouse gas emissions from aviation have serious limitations. While the development of new technologies is helpful, it cannot be an excuse to delay immediate emissions reductions to mitigate the climate crisis and meet the goals of the Paris Agreement. The only way to effectively reduce aviation emissions is to reduce air travel.

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The inclusive, sustainable international conference

How do we reconcile the benefits of scientific gatherings with tackling the climate emergency? **Richard Parncutt**, University of Graz, has trialled a potential solution.

We academics like to see ourselves as smart and good. We creatively solve problems by looking at complex issues from different angles – that's smart – and our lives are devoted to the idealistic and relentless pursuit of academic truth (however defined) – that's good.

It ain't necessarily so. Before COVID-19, frequent academic flyers probably belonged to the global top 1% of climate destroyers. Typically, half our carbon footprint was from flying. Today, as the planet approaches multiple irreversible climatic tipping points, many of us are still planning conventional single-location academic conferences and encouraging colleagues on other continents to burn a tonne of fossil carbon each to get there.

Worse, many are still pretending not to understand. When international academic conference traditions are questioned, our first impulse is to feign polite surprise. Surely, when people from different continents get together regularly, international conflict can be prevented?

That may be true, but international conferences can also be seen as a kind of colonialism.[1] Traditionally, most participants belong to the upper middle class of richer countries. Although we could pay for the trip personally, we often get research funding. Colleagues in less-rich countries can seldom afford the total cost (travel, hotel, registration) or apply for funding. Students in richer countries may find funding or manage to cover the costs, and conference attendance helps them to get an academic position, but that also perpetuates colonialism. Speaking of which: global heating is caused mainly by the Global North, but those who suffer the most will belong to the Global South. For billions of people, climate change is a matter of life and death.

Most academics agree that their conferences should be more inclusive and sustainable, but few realise that these two goals can be achieved simultaneously without sacrificing the motivating effect of the 'conference experience'. To find a solution, we need to train what cognitive scientists call our 'spatial-temporal reasoning'. Imagine a distributed conference program, in which the presentations and other events are organised spatially by geographic location and temporally relative to a 24-hour clock. Imagine that all hubs are nominally equal (resist the idea of a central location with satellites).

There are two kinds of internet-based audio-visual communication: high-quality one-way, transmitted with a short delay (e.g., YouTube); and almost instantaneous, lower-quality, two-way (e.g., Zoom). In a multi-hub conference, every event at every hub can be streamed simultaneously in both ways, each channel acting as a backup for the other. For a given talk, any number of hubs can pick up one or both streams. When a live audience at a hub watches a virtual presentation, the local technician can show the one-way stream for the presentation proper and switch to two-way communication for the discussion

Considering time-zone differences, and respecting normal local working hours, daily real-time communication is possible between any two hubs, anywhere in the world, if the end of the working day is 12 hours after the start. So we need a siesta in the middle of the day. In the morning, each hub can communicate with hubs toward the East; in the evening, toward the West. If the program at each hub is divided into two four-hour slots separated by a four-hour siesta, and the hubs are eight hours apart, the evening sessions at one hub coincide exactly with the morning sessions at another. Sessions missed during the night can be watched later as YouTube videos.

The first planning step is to establish three 'reference hubs' that are equally spaced around the globe, hours apart (check time zones at timeanddate.com). In the Northern summer, they could be in London, Tokyo, and Los Angeles; or Berlin, Sydney, and Phoenix. At those locations, the program might run from 9–13.00 and 17–21.00 each day. Next, add hubs in time zones within about two hours of reference hubs (bigger deviations can be tolerated by smaller hubs). The earliest local program might be 7–11.00 and 15–19.00; the latest, 11–15.00 and 19–23.00. That way, a 7-hub conference can have one hub each in Africa, Europe, India, East Asia, Australia, North America, and South America.[2]

Any number of hubs is possible if the organisation is decentralised, each hub choosing freely from offerings of other hubs. Locations that cannot be included in a given conference for timing reasons can be included in a later conference by shifting the reference hubs or holding the conference in a different month, considering variations in daylight saving.

Conferences can be co-ordinated by the establishment of global reference hubs equally spaced around the globe and running conference programs in the local timezone.

For an individual participant, a multi-hub conference means repeatedly choosing among parallel live and virtual talks. In coffee breaks, informal group meetings mix real and virtual communication, and can be planned in advance. Researchers interested in specific issues can find each other and establish new collaborations.

The advantages of such a conference can outweigh the disadvantages, even without considering emissions. Disadvantages include not meeting distant colleagues in person; not seeing many talks live; and not visiting a new country. Advantages include a new balance between local, regional, and international; frequent face-to-face contact with regional colleagues; a larger, more diverse conference; new participation by colleagues from less privileged countries; establishment of academic disciplines in new countries (a kind of development assistance); saving money (spending it instead on funding for doctoral students or development assistance); and saving travel time.

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Militarising research: The dark side of Global Britain's science agenda

The British government wants the nation to be a 'science superpower' – but, asks **Stuart Parkinson**, SGR, is this just a smokescreen to hide the expansion of military and economic priorities within the science and technology sectors?

As part of its post-Brexit 'Global Britain' agenda, the UK government wants the nation to be a 'science superpower'.[1] To this end, it announced[2] in early 2020 – just as the COVID-19 pandemic was beginning to take hold – a major increase in its own R&D spending by 2025 and longer-term targets for this spending across the whole economy. Various science bodies have analysed these spending targets and concluded that they are not ambitious enough – but there is arguably a much greater problem: that those guiding Britain's science and technology agenda are more concerned about narrow military and economic objectives than wider social and environmental goals. Indeed, with Russian forces invading Ukraine, the clamour for more military technology is getting louder.

Is UK science spending large enough?

The UK's total spending on R&D – across the public and private sectors – was £38.5 billion in 2019 (the latest year for which figures are available), which was just over 1.7% of Gross Domestic Product.[3] The Royal Society and other research bodies have pointed out that this expenditure was well below the average for both the European Union (2.0%) and the OECD group of industrialised nations (2.4%).[4] The government response was to set a target to increase this figure to 2.4% by 2027 – the first step being to raise public spending on R&D to £22bn by 2024–25.[5] Arguably, this spending increase is ambitious given that, in 2019, only £10.5bn was spent[6] – and, of course, the pandemic has caused considerable damage to the economy in the time since. Still, some bodies – such as the Council for Science and Technology[7] – argue that the government should aim higher as the economic returns on such investment could be correspondingly larger.

The military quickly muscles in

One thing that was especially striking about the government announcement on the R&D spending increase was the lack of detail on how it would be spent. Four months after this, in July 2020, the Department for Business, Energy and Industrial Strategy (BEIS) published a UK Research and Development Roadmap – but many elements were deferred to future strategy papers.[8]

One government department that was quick off the mark, however, was the Ministry of Defence (MOD). In October that year, it published its new Science and Technology Strategy[9] (STS) identifying several 'capability challenges' that R&D should focus on, including 'asymmetric hard power' and 'securing advantage in the sub-threshold'. I'll say more about the implications of this military jargon shortly, but first it's worth considering which scientific and technological areas are seen by the MOD as a priority. The STS discusses these in terms of seven 'technology families'[10] which it seeks to exploit:

- Advanced materials – including using nanotechnology and synthetic biology;
- Artificial Intelligence (AI), machine learning and data science;
- Autonomous systems and robotics;
- Power, energy storage, conversion and transmission – including nuclear power and batteries;
- Sensors;

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- Advanced electronics and computing – including quantum computing; and
- Effector technologies – including for cyber weapons and directed energy weapons.

These families cover an enormous range of current R&D and demonstrate the MOD's intent to bring most areas of UK science – including academic research – within its sphere of influence.

Just weeks after the publication of the STS, Prime Minister Boris Johnson announced the largest increase in British military spending for 70 years, including a particular emphasis on developing and deploying new weapons technologies. As I discussed in the last edition of *Responsible Science*,[11] this was part of the Integrated Review (IR) of Security, Defence, Development and Foreign Policy – with the main strategy documents not being released until March 2021.[12] A key element of the IR is that a new more aggressive UK military posture is to be followed below the level of armed conflict – called 'persistent engagement' – and it includes a more belligerent nuclear weapons posture,[13] more warships deployed to the seas around Russia, China and the Middle East, an increase in offensive cyber activity, the further development of military robots with autonomous capabilities, new UK launch sites for military satellites, and much more besides.[14]

Deeply embedded within the IR is the UK's ambition to be a 'science superpower' by 2030. One key way in which this is reflected is by a large increase in military R&D spending – to at least £6.6bn over four years.[15] However, in a striking example of how ill-thought the strategy was, it also led to an immediate cut of £120m in the 2021–22 R&D budget on international development – including work which helps improve security such as poverty alleviation programmes – with the promise of reduced annual budgets thereafter.[16]

Another of the key documents published as part of the IR was the Defence and Security Industrial Strategy (DSIS).[17] This defines 'Capability and Technology Segments' which are the equipment priorities for the UK armed forces:[18]

- nuclear – including warheads, reactors and the submarines that use them;
- cyber – including for offensive and defensive purposes, and cryptography;
- complex weapons – including missiles and bombs;
- novel weapons – including directed energy weapons;
- air capabilities – including combat planes and helicopters (some of them robotic craft);
- maritime capabilities – including warships;
- land capabilities – including artillery, armoured vehicles and general munitions;
- space capabilities – including launch sites;
- CBRN – defences against chemical, biological, radiological and nuclear weapons;
- test and evaluation; and
- cross-cutting capabilities – including ISR (intelligence, surveillance and reconnaissance), C4 (command and control, communications and computers), and sensing and detection.

Aerial drone use during Royal Marines exercise
© MOD Crown copyright, 2021

This list reveals – more overtly than in the STS – how the R&D and equipment programmes feed into both military and industrial ambitions, intertwining them and making each more dependent on the other. Indeed, the traditional distinction between military and civilian programmes is deliberately blurred within the strategy, especially in areas such as shipbuilding, space technology and AI.

These joint ambitions become even clearer in another of the key aims of the DSIS – to "maximise the economic potential" of what it calls "one of the most successful and innovative sectors of British industry".[19] So, in another example of the IR's doublespeak, it encourages an expansion of UK arms exports while failing to acknowledgement any of the human rights issues which have plagued these exports for decades. One recent example is, of course, the export of strike planes and bombs to Saudi Arabia where they have been used in the ongoing war in Yemen, despite contributing to war crimes.[20] Another concern is that, as Britain develops armed robots with more autonomous capabilities, this will undermine international efforts to ban the development of lethal autonomous weapons systems (LAWS).[21]

The speed at which the MOD seeks to utilise some of these emerging technologies is disturbing, and was emphasised in a presentation by the Defence Chief Scientific Advisor at the notorious DSEI arms fair held in London in September:[22]

- the first test of a drone swarm for British military use – using AI for control – was carried out in 2020;
- the use of 'big data' analysis in a recent NATO exercise accelerated decision-making speeds by an order of magnitude;
- three contracts have already been issued to industry for directed energy weapons – specifically high energy lasers and radio-frequency weapons – for UK navy and army deployment, with testing scheduled to run from 2023 to 2025;
- research in synthetic biology is being used to create new durable materials for military use; and

- efforts are being made to expand links with the 'security' industry, including exploiting overlaps with border control and policing technologies.

It's also important to remember the large level of international collaboration within the military technology arena, not least the rapidly expanding National Technology and Industrial Base (NTIB), a joint programme between the USA, UK, Canada and Australia.

Arguably, however, the most controversial new international programme is AUKUS – a joint programme between Australia, the USA and the UK to build the next generation of submarines for the Australian Navy. The controversy surrounds the fact that these will be nuclear-powered – for a military which does not yet have any nuclear-powered craft. (Indeed, Australia has no civilian nuclear power stations either.) To make matters worse, the type of reactor most likely to be used in these submarines would run on highly enriched uranium – i.e. nuclear weapons-grade – thus undermining the Nuclear Non-proliferation Treaty.[23]

Military influence on Net-Zero Strategy?

I've highlighted the growing number of industrial programmes which intentionally include both military and civilian technological development – such as in shipbuilding and space – but what about the military influence on programmes that are funded only by civilian agencies?

Let's start with the new Advanced Research and Invention Agency (ARIA), which is being set up with £800m of public money.[24] The ARIA's focus is on high risk, but potentially transformative, R&D which could "create industries of the future". It will operate outside of the UK's mainstream science funding system and, critically, be subject to fewer ethical controls. Significantly, it is modelled on DARPA, the US Defense Advanced Research Projects Agency.

This risk-orientated approach also reflects that found in the MOD's STS, which seeks to "invest in new, riskier activities".[25] The discussion of risk in these programmes relates to the risk of failure to achieve an economically viable product. But there are, of course, wider risks – that the rush to deliver a product to market risks any potential health and environmental impacts being marginalised. I will return to this point below.

Another civilian area in which military fingerprints can be found is the Net-Zero Strategy (NZS) for reducing the UK's carbon emissions, published in October 2021.[26] For example, the strategy only gives limited attention to the expansion of onshore wind, solar and marine renewable energy – with no clear targets for deployment or funding – while the reverse is true for nuclear technologies, which also feature prominently in IR strategy documents. There's a target for another new large-scale nuclear project to reach 'final investment decision' by 2025 (most likely Sizewell C), while a fund for the development of advanced nuclear technologies is given £385m of public money. This is despite the poor economic, technological and environment case in favour of the nuclear options, while across the world, and increasingly in the UK, renewables are outcompeting fossil fuels, let alone more expensive nuclear.[27]

As pointed out in the previous issue of *Responsible Science* by academics at the University of Sussex, it's hard to explain such distorted thinking without considering the very close links between Britain's military and civilian nuclear industries.[28]

Another example from the NZS is the focus on developing and deploying so-called 'sustainable aviation fuels' such as

Royal Navy testing of marine drone
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biofuels and synthetic fuels. While these can be manufactured from renewable resources, there are serious technological, environmental and economic obstacles still to be overcome (see Finlay Asher's article on p.25). The main focus for the reduction of carbon emissions from aviation should be – according to the government's climate advisors – reducing the demand for flying,[29] but this is completely missing from the NZS. Strikingly, shortly after the publication of the NZS, the Royal Air Force announced[30] its 'NetZero ambition' – also heavily dependent on sustainable aviation fuels, and again without any attention to the need to reduce demand.

A narrow economic focus?

Returning to the concern that narrow economic goals are being prioritised at the expense of environmental and health ones, it's instructive to look at broader government policies.

For example, the new 'Brexit Freedoms' Bill – making its way through parliament at the time of writing – is aimed at 'cutting red tape' partly to accelerate the development of new technologies, such as AI and gene editing. However, the very real concern is that it will undermine important social, environmental and health safeguards.

Another example relates to the new Environment Act, under which a post-Brexit watchdog, the Office for Environmental Protection, is being set up. Here too, there are significant fears about the new regulatory structures.[31] This is especially worrying given the criticisms that whistleblowers have already levelled at the existing Environment Agency over its recent poor enforcement record against businesses which have broken the law.[32]

Overall, it seems that the balance between R&D focused on narrow economic and military objectives or more on wider health, environmental and social goals will be decided by the new Office for Science and Technology Strategy (OSTS) set up in June and attached to the Cabinet Office in central government.[33]

It has four priorities:

- Sustainable environment
- Health and life sciences
- National security and defence
- A digitally and data driven economy

While it's good to see environment and health as leading priorities, this is blunted by the language of 'green growth' and 'life science business' within the description of the OSTS's role – and the lack of attention to issues of inequality. Hence, it's hard not to fear the prominence of economic and military priorities given the concerns above.

Taking a stand

With Putin's war on Ukraine, the political push to increase UK R&D spending on military technologies – rather than on supporting broader efforts to improve international security – is only getting stronger. Indeed, the latest ten-year Defence Equipment Plan – published in February – includes an increase of £48bn – a massive 25% rise over the previous year's projection.[34] This will add to the growing arms races between the major military powers – especially in nuclear and robotic technologies – making the world less secure and continuing to fuel human rights abuses in places like Yemen. At the same time, it will divert expertise and funding away from poverty alleviation programmes and distort our efforts to tackle global environmental crises like climate change.

We need to increase the resistance to this agenda. We need more scientists and engineers to take a personal stand by refusing to work on military-funded programmes. We need more non-governmental science and technology bodies to support these efforts. We need more partnerships between scientists and advocates working in peace, human rights, environmental protection, poverty alleviation, and health. Only then will we be able to shift the UK's science agenda back towards a more ethical path.

***Dr Stuart Parkinson** is Executive Director of Scientists for Global Responsibility (SGR). He has written widely on the military and corporate influence on science and technology.*

STOP PRESS

As this edition was going to press, new UK energy policies were due to be announced – driven by the desire to reduce fossil fuel imports from Russia. The disturbing signs are that a further entrenchment of nuclear power will be part of these policies.

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Is the University of Edinburgh involved in research for autonomous weapons?

Partnerships between the military and UK academia are being rapidly expanded. **Alba Andrés Sánchez** examines whether some of them might be used to help develop lethal autonomous weapon systems (LAWS).

The University of Edinburgh is currently working alongside three other universities in a consortium called the University Defence Research Collaboration (UDRC).[1] This is a multi-million-pound joint venture funded by the Ministry of Defence (MOD) and the Engineering and Physical Sciences Research Council (ESPRC) aimed at using academic research to boost military capabilities. The EPSRC also funds other networks and initiatives aimed at promoting co-operation between UK universities and the military in areas relating to artificial intelligence (AI) and data processing.[2]

Projects with relevance to LAWS

One of the main projects being carried out by the UDRC – and led by Edinburgh – is 'Signal Processing in the Information Age' which has a value of nearly £4.1m over six years.[3] The research description includes deep learning, suggesting that the outcomes can be used for intelligence gathering, target detection, and recognition and tracking – these being critical functions of armed drones. The likely application of this research in a military setting is emphasised by the involvement of project partners including BAE Systems, Leonardo, and Thales – all leading arms corporations which have an active interest in autonomous systems. Moreover, the MOD has direct access to an academic signal processing pool deployable on short notice, raising many ethical questions and highlighting the militaristic application of the research outcomes. Hence, there are clear indicators that this project can assist with the development of LAWS.

Another project led by Edinburgh is the 'UKRI Trustworthy Autonomous Systems Node in Governance and Regulation', which has a value of over £2.6m over 3.5 years.[4] It is studying trust in autonomous systems especially related to the creation of regulatory structures, and issues of responsibility and liability.[5] Some of its project partners are also leading developers of military technology with an interest in autonomous systems – BAE Systems, Thales, and the Defence Science and Technology Laboratory. Professor Ramamoorthy, the lead researcher, is also Personal Chair of Robot Learning and Autonomy in the School of Informatics and has a history in developing autonomous robots.[6] There is no mention of any ethics- or law-focused academics participating in this project, which raises questions about whether these aspects will be given due weight in the research, or whether there will be a bias towards favouring laxer regulations for autonomous systems development driven by, for example, commercial pressures.

The University of Edinburgh also has some involvement with the BAE Systems project Tempest[7] which has the aim to develop combat aircraft including 'autonomous systems'. The MOD has stated that there are more than 600 organisations working on this project, including small businesses and academia. Partnerships involve organisations both inside and outside the military-industrial sector,[8] and the whole collaboration is called Team Tempest. Edinburgh's involvement is shown by its three-way research partnership with Heriot-Watt University and Leonardo – but the university website does not mention this project in any way (neither its funding, areas of research, nor the academics involved). This lack of transparency is deeply concerning. The partnership also extends to the Centres for Doctoral Training in Applied Photonics as well as in Robotics and Autonomous Systems.[9] The latter forms part of the university's Edinburgh Centre for Robotics, which offers funded PhD training programmes. The University of Edinburgh's website states that these programmes are sponsored by the EPSRC[10] but the links to BAE Systems and Leonardo are not disclosed. There is also no mention of how the research outcomes will be utilised to develop autonomous aircraft for BAE Systems. Therefore, candidates applying to this opportunity will be unaware of the connections of research outcomes to arms companies and the potential development of LAWS.

Student concern

Following a motion from Edinburgh University Amnesty International representatives, which passed in the Student Council in January 2021, the university's Student Association signed the Future of Life Institute pledge on LAWS.[11] The Student Council then put pressure on the University to sign the pledge but this was rejected in March following objections by the College of Science and Engineering due to the alleged dual-use nature of the research outcomes, i.e. their ability to be used for both civilian and military applications. However, the university does not have a comprehensive Research Ethics Policy which deals adequately with issues such as autonomous weapons. If the university's partnerships with arms companies and the MOD are considered as well, the argument that further ethical safeguards are not needed becomes especially unconvincing.

The rapid pace of technological development in AI and robotics is raising major ethical issues, not least concerning the development of autonomous weapons. Universities – like Edinburgh – which pursue military-funded research in these areas, without much stricter safeguards, risk helping to fuel an international arms race which will endanger us all.

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To scare or not to scare? Is a message of fear more effective than a message of hope?

Jan Maskell, SGR, summarises the academic evidence on one of the key debates in climate communication.

According to the Climate Change Committee, 62% of future emissions reductions depend – at least in part – on behaviour change.[1] What makes for an effective message to encourage and enable the different practices and routines that are required to achieve those reductions? What is more effective, fear or hope?

When messaging works – and when it doesn't

Fear arises when individuals perceive themselves to be faced with imminent physical harm[2] and is thought to be a useful motivational tool as its associated action tendency is to protect oneself from harm. Similar to fear, hope derives from the perception of an uncertain future, but unlike fear, it is associated with more positive future expectations. Hope is a feeling of "wishing and yearning for relief from a negative situation, or for the realization of a positive outcome when the odds do not greatly favor it"[3] and its associated motivational function is to encourage goal pursuit.

Threatening message information tends to invoke fear – and the threat of climate change has been communicated often using the 'deficit model' of science communication,[4] with the hope that more knowledge would lead to desired attitudinal and behavioural changes. There is significant evidence that information provision alone is a weak driver of behaviour.[5] A key argument against the deficit model is that it presumes that most people process information according to a scientific model: that they engage in a considered and unbiased reflection

on the data, after which they reach a conclusion. According to the principle of motivated reasoning[6] people often start with a conclusion, and then selectively attend to, critique, and remember information in a way that is designed to offer support for their original perspective. This application of confirmation bias can lead to cognitive dissonance,[7] where actions or ideas are not psychologically consistent with each other. As discomfort is triggered by an existing belief clashing with new information, the individual tries to find a way to resolve the contradiction to reduce their discomfort. Motivated cognition is often something associated with climate change denial; that is, people are motivated to deny the science because the alternative is unattractive, inconvenient, or stressful.[8]

The evidence across multiple domains indicates that fear appeals are most effective when they contain a threat component and an efficacy or control component – with the latter leading to action.[9] Like threat messages, efficacy appeals have the potential to evoke emotions that may be important to their ultimate success, most notably, hope. Optimistic messages feel good, but have the potential to create complacency, potentially leading people to ease off from making the required sacrifices, political choices, and lifestyle changes. Fear-based messages – so long as they are not exaggerated and are combined with concrete pathways for action – have the potential to maintain urgency, and there is little evidence that they drain efficacy.[10]

People are also much more likely to accept challenging information when it comes from one of their own (an 'ingroup' member) than when the same comments are made by an outgroup member. Threatening messages that come from an outgroup member are rejected more than the same message from an ingroup member, regardless of the objective quality of the argument.[11] Challenging climate change messages, therefore, should be channelled through people who are in the same social categories as the audience.

Not just hope versus fear

These principles are supported by the Behavioural Insights Team who propose key elements to a 'successful narrative for Net Zero'.[12]

- Positive tends to out-perform negative. Environmental campaigns have often drawn on negative messaging (based on guilt, eco-anxiety, or admonishment), however, research shows that positive messaging (e.g. based on pride and future-optimism) increases engagement and adherence to pro-environmental messages.
- In order to mitigate helplessness or inertia, attaching narratives to clear asks is important. Making pro-environmental choices is often extremely complex with many trade-offs to make, and encouraging people to care, needs to be combined with a clear understanding of what they can do about it.
- A positive message can be created around co-benefits so these should be emphasised. Even when concern for the environment is high, it is often a 'nice to have' and self-interested motives for enjoyment, affordability, convenience, and health take precedence. Different frames will resonate with different groups depending upon their values – but overall, health framings, and positive messaging, regularly perform well.

Acknowledging that communications on their own tend to have a very modest impact on behaviour change, building a compelling and positive narrative, with clear asks, can help to influence behaviour change. The issue is not as simple as whether a message of fear or hope is more effective. Messages need to create sufficient awareness of the issues avoiding admonishment, anxiety, or guilt framings. The required action needs to be simple and clear, include a positive and fair narrative which emphasises the co-benefits of climate action, and be delivered by the right messenger.

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Solving the UK's energy crisis: Heat pumps and insulation for peace?

Even before the Russian invasion of Ukraine, the UK's home energy bills were shooting up, catapulting millions more into fuel poverty. But there are solutions which tackle this poverty, reduce carbon emissions, and in the longer-term insulate us from some conflicts, argues **Philip Webber**, SGR.

The war in Ukraine is forcing Europe to understand an interlocking crisis of conflict and energy. The EU and – to a lesser extent – the UK import fossil fuels from Russia, thus helping to fund the invasion. The EU and UK are actively removing themselves from financial transactions with Russia but so far there has been limited discussion of how reducing carbon emissions to zero would reduce this financial policy conflict – ultimately also to zero.

Indeed, with global energy prices skyrocketing even before this crisis, the consequent growth in fuel poverty – in the UK and elsewhere – has been adding another argument in favour of rapidly moving away from fossil fuel dependence.

In this article, I focus mainly on home energy use in the UK, and the need for a rapid transition that makes much greater use of energy conservation and domestic renewable energy.

However, it's impossible to cover this without addressing wider and deeper issues with the nation's energy policies and programmes, so I give a brief overview of these and suggest ways forward to improve home warmth standards and reduce carbon emissions at the same time in a rapid, real, levelling-up green transition.

Energy sector privatisation

The first key problem with the British energy industry – which began back in the 1980s – is the degree to which it is run by privately-owned corporations. Margaret Thatcher's Conservative government privatised the gas supply industry in 1986 and the electricity sector in 1989.

Today, the UK energy generation and supply network is managed by a wide range of private monopoly suppliers, mostly based overseas. We Own It and Citizens Advice estimate that each year, the energy and network supply companies extract value of £3.7bn in share dividends and profit, money which largely incentivises fossil fuel consumption and which could otherwise be re-invested in energy saving and modernising the energy infrastructure.[1] They further estimate that an energy sector buy-back would pay for itself in around eight years even if shareholders were compensated fully, i.e. with no penalties for years of underinvestment in infrastructure.

So, part of the solution is an urgent restructuring of energy generation.

Early home energy schemes

It took until 1994, after the iconic 'Earth Summit' of 1992, with the realisation that carbon emissions from fossil fuel use needed to be reduced, that government placed the first obligations on energy companies to help insulate homes, improve domestic energy efficiency and reduce bills – and also to encourage early deployment of renewable energy technologies.

A series of home insulation grant schemes were created usually offering 50% of the upfront cost of insulation or heating improvements for those with lower incomes or in fuel poverty. However, UK housing energy efficiency levels were poorer than much of the rest of Europe, and standards for new housing – when it is far cheaper and easier to install better insulation as part of the fabric – remained weak. Tens of thousands of 'excess deaths' were – and still are – registered each winter as a result of cold living conditions.[2]

In addition, early small-scale renewable energy schemes – e.g. roof-top solar panels and farm-based wind turbines – struggled to achieve planning permission, and the companies running the electricity networks resisted local generation and charged high connection fees. The energy supply system remained focused around large fossil fuel and nuclear power stations and was not designed to work well with local energy generation.

From 2002, the Labour government placed a 'levy' on energy bills to contribute to home insulation and subsidies for new renewable schemes – both large and small.

In 2006 the Stern Review commissioned by the UK Treasury, concluded that climate change would lead to annual costs to the economy of 5–20% of Gross Domestic Product (GDP) whilst action to avoid this disaster would be far cheaper at up to 2% of GDP per year.[3] This report boosted green policies to some extent.

Throughout this period domestic energy consumption fell – mainly as a result of EU regulations to improve the efficiencies of electrical appliances and gas boilers, together with some contribution from home insulation programmes. But the reality remained that most homes were still poorly insulated.

Climate denialism hits back

In a very important counterpoint to the progressive climate measures, from the mid-90s onwards, powerful sections of the corporate media – supported by fossil fuel interests – attacked the green agenda, including questioning the whole concept of climate change as a result of human activity.

Wind turbines, solar panels, and low energy light bulbs were roundly criticised. However, they chose as their main target the levy on household consumers' energy bills to partly fund renewable generation and insulation. There were many things wrong with the system and how it was funded. By creating a levy rather than funding improvements out of general taxation, government created an easy target for criticism – especially given its lack of progress in tackling wider poverty and inequality. The market-driven energy supply did not work well and, as the government bolted-on various attempts to correct for systematic market failures – for example, by paying wind farms to not generate electricity under certain conditions – further easy targets for criticism were created. The real issue was a failure to plan for an energy transition effectively and to have coherent policies and programmes. Thus, whilst some criticisms were valid, the real culprit of political and economic policy failure avoided scrutiny, whilst green technologies received misplaced attack.

The deliberate dismantling of climate policies – 'cutting the green crap'

After the Conservatives came into power in 2010, in a coalition government with the Liberal Democrats, a few climate-friendly programmes were initially launched, but then came a serious change in policy direction.

In 2013, the Cameron government announced that they were going to pare back various environmental measures – which became known as 'cutting the green crap' – leading to an immediate reduction in average home energy bills by some £112/year.[4] In practice, this meant that continued funding for

CASE STUDY: Kirklees Council's home energy schemes

During the 2000s, as head of the environment unit at Kirklees Council in West Yorkshire, I coordinated a series of home energy schemes. By 2006 we had worked on several renewable energy projects funded by a range of UK government departments and the EU, installing the largest amount of domestic solar photovoltaics (PV) in the UK. We won an Ashden award for this work. Apart from the funding base, the work was only possible through the direct support of local government working with housing associations, social and adult services, and a range of other public services including the fire service, schools and police. In other words, the work was at scale and coordinated.

Over the next three years we delivered the largest (and last!) city-scale programme for home insulation, home safety and warmer homes in the UK: Kirklees Warm Zone. This cost £21m and insulated some 55,000 private homes at zero cost to the householder. 50% of the cost came via the government's CERT (Carbon Emissions Reductions Targets) scheme, which was abolished shortly afterwards. We also improved thousands of domestic heating systems, provided debt advice, improved take-up of benefits and made safe numerous lethal home appliances. This programme also won an Ashden award along with several others. The success of this scheme was through its strong marketing, delivering measures at scale, street-by-street and ward-by-ward, and very close management by the local authority which minimised low quality work and fixed mistakes quickly – all vital to public support and acceptance.

Follow-up research at the University of Leeds[5] confirmed that this work delivered real energy savings that were still visible in official local statistics years later. In fact, the insulation programme delivered more savings than assumed by the government models by at least 20% and were particularly effective at reducing fuel bills for those in the lowest income percentiles. This study found that participating households reduced their energy bills by an average of £125 or 15%. The study also identified the level of background reductions in energy use of 12% – around £100.[6] This was due to people's own home improvements and a gradual increase in boiler and appliance efficiencies. This study suggests that, with 100% take-up of home insulation and starting from a typically uninsulated base, domestic energy reductions of 27% could be achieved over a four-year period.

In terms of overall benefits, the programme paid for itself within five years, created a shorter-term number of jobs and economic benefit, and continued to deliver energy savings, health and quality of life benefits to this day far exceeding the initial cost.

However, these benefits are widely distributed amongst householders, particularly those on low incomes. From a market perspective, this is a difficulty because these community-wide benefits cannot be easily monetised to make such schemes self-funding for a commercially-funded body.

In 2014, we presented our evidence of the wide community and societal benefit to civil servants. They were very impressed with the results. But at the time, their overriding focus was on impending departmental re-organisation and worries about their future careers. So, this learning was obliterated by the 'cutting the green crap' agenda.

In 2015, the government scrapped the proposed zero carbon homes standard and a million new homes were built to poorer energy insulation standards resulting in higher running costs and more carbon emissions.

home energy efficiency programmes was sharply reduced, new onshore wind farms were effectively banned (this measure taking effect in 2018), and some other green programmes scrapped. Two new, smaller domestic energy efficiency programmes – the 'Green Deal' and the Energy Company Obligation (ECO) – were introduced. Crucially, these schemes were marketed to individuals typically, rather than areas or communities, and delivered by sets of competing private companies.

The policy changes announced in 2013 led to dramatic change. The number of cavity wall insulation installations per year dropped by 92% and for loft insulation by 74%.[7] The 'Green Deal' was later branded a failure by the National Audit Office.[8] The reasons for its failure – many of them repeated in its successor, the Green Homes Grant programme of 2020–21 – were that they abandoned the successful methods of the previous programmes – including those run by local government (see box). There was no strong marketing campaign. The Green Deal was a bad deal financially for consumers. It offered a loan repaid over several years – with no grant incentive – and the interest rate was higher than bank rates. The householder had to get several quotes after finding 'trusted' or approved Green Deal contractors. There were thus no economies of scale and prices were high. Quality control was also a problem.

Thus market-based ideology trumped evidence-based research and experience – and failed.

Then, in 2015, the government scrapped the proposed zero carbon homes standard. Thus, up to the time of writing, a million new homes were built to poorer energy insulation standards resulting in higher running costs. Most of these costs would have been met by developers, not householders.

Carbon Brief recently estimated[9] the overall impact of 'cutting the green crap'. By the winter of 2022, if the government cuts had not been made, energy efficiency programmes would have saved £902m, onshore wind £1,956m and zero carbon homes £198m per year – a grand total of £3,100m/year. These measures if kept in place would have saved the average household around £40/year and the average business a further £60/year.

So, progress has stalled and home energy costs could be somewhat cheaper. But is there a solution to high energy prices that is consistent with reducing carbon emissions and improving security? Before summarising a viable way forward, it is important to address the widespread misinformation about the latest energy price rises.

Why have home energy costs increased so sharply?

In short, home energy costs have increased in the last few months because the wholesale price of fossil gas has doubled – and then the war in Ukraine has exacerbated this. Nevertheless, much of the debate up until the breakout of war still focused perversely on the level of the 'green levies' on fuel bills – presumably in a hangover from the prolonged media attacks on these levies for the last two decades. Whilst the 'green levies' stand at around £180, 'other' costs in energy bills – network costs, operating costs, profit and supplier failure – amount to around £530 (in fact, the majority of this sum is a result of dealing with 27 smaller energy companies who have recently gone out of business), whilst the wholesale price of gas – previously £400–500 – had, just before the outbreak of war, doubled to over £1,000.[10] This global gas market is also the reason why an expansion in the extraction of North Sea gas or another attempt to establish a UK fracking industry would not significantly reduce gas prices – any new gas would be sold, as usual, to the highest international bidder not in ways which would lower costs for British domestic users.

But it isn't at all obvious why the cost of *electricity* is also set to go up dramatically. The cost of renewable electrical generation is currently 30–40% of the typical domestic electricity tariff.[11] But the UK electricity market pools all generation together according to its short-term[12] wholesale price. Renewable and nuclear generation are run as much as the technologies and weather conditions allow. But the remaining power, primarily gas-fired generation, is used when overall demand outstrips this core supply. These generators only deliver if the market price covers their operating costs, so this price is almost entirely set by the cost of wholesale gas for electrical generation. Despite this, renewable generation is still reducing electricity bills – but by far less than it could in a restructured market.

A longer-term solution?

This electricity market needs to be changed. One suggestion is to set up a green energy supply pool funded by long-term fixed-price contracts.[13] This pool would only buy from the wholesale gas market for limited times. To minimise these costs, the green

pool would offer discounts for customers willing to shift their consumption to off-peak times, or use electric vehicles (EVs) or in-house battery systems to smooth energy demand. This would reduce emissions at the same time as reducing electricity bills.

Turning to gas, its main use in the UK, apart from powering large power stations and some industrial processes (which could convert to electricity), is for domestic central heating. Typically, this supplies 80% of home heating. As a first step, this consumption (and hence cost) should be reduced by a comprehensive home and business retrofit insulation programme combined with a fast-paced roll-out of heat pumps. As heat pumps run on electrical power, it is vital that the electricity energy market is restructured to take advantage of the very low price of renewable generation as outlined above. Renewable generation also needs to increase in scale and to include other reliable sources such as tidal power. Demand smoothing as discussed above can help to limit the necessary expansion in the overall size of the network generating capacity.

The critical advantage of heat pumps is that they typically generate three times as much heat energy, by extracting it from the air or ground, as the electricity required to run them. This means they are one of the most energy efficient technologies available. Furthermore, by increasing levels of home insulation combined with local generation such as roof-top solar PV and continued improvement in the efficiencies of electrical appliances, electricity demand could be reduced even further.

One example of a community already running a sustainable local energy system, powered by its own off-grid energy supply, is the Scottish island of Eigg. The resident-owned network is powered by hydro-power, wind and solar PV. It supplies electrical power 95-97% of the time whereas formerly residents used diesel generators for at least 50% of their supply.[14]

Reducing domestic heating bills in the short-term

In February this year, the government announced it will fund some price reductions for householders and to smooth the energy price spike by a loan repayable over four years. Despite this, energy bills will still rise dramatically. Smoothing the price rise over several years does not address the fundamental problem and is vulnerable to future price rises. The government has chosen not to apply a windfall tax on the profits of large energy suppliers despite these increasing dramatically. There are also large existing subsidies paid to the fossil fuel industry. These need to be diverted to renewables and households and some industrial consumers to keep increases in bills to within price controls set by government. Before the outbreak of war, fuel poverty was already predicted to rise to six million households, an increase of 50%. The latest government data reveal over 29,000 excess winter deaths in 2021 arising from the impacts of cold homes.[15] This, along with high levels of food insecurity, is a shocking indictment for such a rich economy as the UK.

Conclusions

The government continues to ignore the societal and economic benefits of programmes of home insulation. Whilst the upfront cost may seem high, the benefits in health, jobs, and energy savings mean that such schemes pay for themselves in about five years and continue to deliver benefits for the next 40 years. They would create a real programme for 'levelling up'. A re-invigorated programme of heat pump installation and the phasing out of gas boilers would dramatically reduce UK carbon emissions when combined with the expansion of the renewables network. And a rapid implementation of this policy now would also help break the link between energy use and the invasion of Ukraine.

Strong government support for modernisation of the electricity supply network and market should be combined with the ending of fossil fuel subsidies and real long-term zero carbon policies – for example, a halt to all airport expansion, a sharply reduced road-building programme, and a stop to new coal mines and oil fields. This would send a clear message to the financial markets that new types of development, based on principles of sustainable development and zero carbon, will now be the new normal and that government is prepared to underwrite the investment to keep costs manageable. An overheating climate is a real and present danger far greater than the COVID-19 pandemic.[16] It requires similar support. The UK government has spent at least £370bn during the pandemic in a new form of quantitative easing (QE) that has gone largely unannounced.[17] The government could, if it chose, use QE to fund the necessary low carbon transition. But the key crucial difference in this case would be that the spending, rather than shoring up an economy in enforced suspension, would deliver a new front against climate change and improve energy security with additional benefits including improved health and a real levelling-up agenda across all of society and the UK economy.

***Dr Philip Webber** is Chair of SGR, and a former head of environment at Kirklees Council, West Yorkshire.*

STOP PRESS

As this edition was going to press, new UK energy policies were due to be announced – driven by the desire to reduce fossil fuel imports from Russia. The signs are not good that the lessons outlined in this article are being learned.

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How the UK can learn from countries climbing out of gas dependence

In light of UK energy policy failings, **Andrew Simms** and **Freddie Daley** from the Rapid Transition Alliance look at where, even before the rapid shift in EU energy policy triggered by Russia's invasion of Ukraine, huge leaps were being made in other countries' transition away from dependence on polluting gas.

Does it seem odd that in a gas price crisis, there have been people arguing we should dig ourselves deeper into the grip of that particular fuel? We've been here before – and it didn't end well. A poorly regulated banking system crashes and its defenders say that even less rules are needed to recover. Or, house prices go through the roof and instead of controlling property speculation, more money is poured into the market without either regulating prices or building substantially more homes.

In the grip of yet another fossil fuel price crisis, there are already voices saying that we need more of what got us into the mess in order to escape it. It's like thinking, 'my head hurts because I knocked it, if I hit it even harder the second knock will take away the pain of the first.' When it comes to the energy issue, some seem incapable of even imagining a situation in which economies stop hitting themselves on the head with further fossil fuel addiction.

And that's a shame, because there's an abundance of evidence of the ability to shift rapidly to much less economically and ecologically damaging energy systems. Collaborating with UK research body Nesta, the Rapid Transition Alliance looked at several cases of successful escape pathways from dependence on gas, with all its pollution, price volatility and dangerous geopolitical leverage.

Fossil gas is still a very common fuel used for heating homes, being literally plumbed into our daily lives. The idea that this could change quickly is hard to grasp. But it's easy to forget how recently and radically home life has changed in many European homes. Only two generations ago, one in four homes in England and Wales still lacked an indoor shower, bath or toilet. In just over two decades, that number fell to 1%.

Tellingly for current decision makers, charged with delivering not just stable, affordable energy supplies, but meeting zero carbon targets in a matter of decades, the transition from outdoor to indoor plumbing required large-scale modernisation of existing infrastructure, new technologies, supportive and targeted legislation, and significant changes in behaviour. The shift then was also propelled by a variety of environmental and health concerns to do with sanitation pushed by citizens, just as issues of air pollution and harm from global heating are pushing the need for change today.

There are big, immediate lessons to be learned in our case of the Netherlands. The Dutch have been hooked on gas for decades. Gas to the Netherlands is what oil is to the Gulf

States. In 1959, the ninth largest natural gas field in the world was discovered in the northern province of Groningen. Within just five years, nearly all Dutch homes were connected to the gas grid. As of 2018, gas heated nine in every ten homes in the Netherlands.

But now the Netherlands plans to abandon its gas grid and use this transformative shift to drive the decarbonisation of its wider built environment. It may never have happened without a combination of public outrage and ultra-local decision making. The trigger for change was outcry following a series of earthquakes linked to fracking. And, in 2019, the Dutch decided to go completely gas-free by 2050, and to halt domestic production by 2030, or possibly sooner.

Things began happening quickly. In July 2018, six business associations representing everything from distribution systems to construction companies and housing corporations announced an initiative to disconnect at least 100,000 houses from the gas grid by 2021. By late 2018, 27 cities had presented a plan to each take at least one neighbourhood off gas by 2020.

By the end of 2018, the Dutch subsidiary of German supermarket chain Lidl had disconnected all its 410 supermarkets in the Netherlands from the gas grid, taking just four years to change to heat pumps powered by electricity from renewables. To hit national climate targets, the Dutch needed to disconnect between 30,000 and 50,000 homes from gas every year up to 2022, and 200,000 homes a year from then on. It's a work in progress but with a clear direction set.

With gas typically used for heating homes, the big question for countries like the UK has been: what is the alternative? Step forward the overlooked relation of renewable energy technologies, the heat pump. Here, chilly Finland has shown the way ahead. In 1970, 90% of Finland's space heating was provided by burning timber and oil. By 2012 a combination of district heating schemes, where heat is transmitted from a centralised source through a network of insulated pipes to multiple buildings, and electricity and heat pumps had completely changed the picture with oil reduced to just 11% of fuels used and biomass 21%.

The total energy output of heat pumps in Finland now meets around 15% of the heating needs of the residential and commercial building stock. In 2018 alone, sales rose 22%, with more than half a billion euros of investment seeing 75,000 heat pumps installed. A country of around 2.7 million households is now home to one million heat pumps. Since 2000, the amount of energy used by Finnish households for heating has also declined by about 15%. Never let anyone tell you that heat pumps don't keep homes warm and cosy, because the European countries with the coldest climates are also the ones with the highest number of heat pumps.

The shift in Finland happened with a different dynamic to the one now underway in the Netherlands. It began at the small business and household level because people recognised that heat pumps were a simple, practical technology that worked. The example showed how informal peer-to-peer learning can galvanise the spread of new, low carbon energy technologies. But to quickly scale-up, it also shows the importance of creating a positive regulatory environment with financial incentives to accelerate uptake – a case of bottom-up and top-down working together. This, it needs repeating, is the very opposite of the inconsistent and unpredictable policy environment in the UK which has dramatically undermined the roll out of the renewable technologies solar and wind, and also any home

The Netherlands plans to abandon its gas grid and use this transformative shift to drive decarbonisation

energy efficiency retrofit programme (see Phil Webber's article on p.37).

But the real cruelty of this particular crisis is the suffering it causing for families who are stuck using costly gas. In the UK, families watch prices rising while fossil fuel companies furnish themselves with billions in profit. The projections are truly grim: two million more households are expected to slide into fuel poverty after current price rises. This means that the total number of British households in fuel poverty will reach six million – the highest level since records began. Meanwhile fossil fuel firms, like BP, are promising over one billion pounds of share buybacks as they are set to cash in on the crisis. If the climate crisis is enough to challenge the social licence of these firms, then profiting on pushing millions of British families into fuel poverty ought to be the last straw.

For many of these families, getting off gas for environmental reasons will be lower concern than having to choose between warmth and food, but it should be the urgent priority of any responsible, caring government, not least for the wider economic benefits and job creation it will bring. Following Brexit the UK government claimed that it was still 'open for business', but right now it needs to be open to ideas and the examples set by those nations that are moving quickly to ditch dependence on gas.

Andrew Simms *is Assistant Director of SGR. He has a background in political economics and development studies, including working for the New Economics Foundation and Oxfam.*

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Natural carbon sinks: not just trees

Wiebina Heesterman summarises the importance of the natural carbon sinks that are often overlooked – such as seagrass and soil.

The importance of protecting and regenerating forests – both to help tackle climate change through the increased uptake of carbon dioxide, and to help prevent biodiversity loss – is widely accepted. However, the need to look after and expand other 'natural carbon sinks' receives much less attention.

Let's take the example of seagrass. There are about 30 different seagrass species worldwide. Although seagrass is often thought of as a low growing plant, looking rather like common grass, it may be as short as a few centimetres or as tall as seven metres.[1] It is actually a completely different plant, and can grow down to 30 meters below sea level – one of the few plant species able to flower below water. Even more amazing is its capability to soak up carbon: seagrass meadows account for 10% of the carbon sequestered successfully by the oceans, even though they only take up 0.1% of the seafloor, and they are estimated to take up carbon 35 times faster than a rainforest.[2] There are four sea grass species common to the UK, the most common being *Zostera marina*, also known as common eelgrass.

There are several other natural carbon sinks which are generally overlooked. Most are associated with intertidal habitats, such as salt marshes[3] and mangroves.[4] Coral reefs are often thought to act as carbon sinks as well, although this is no longer the case due to ocean acidification.[5]

With climate change fast becoming the major risk to our world, any nature-based solution able to mitigate the worst is doubly welcome. Unfortunately, many natural sinks have been badly compromised during the last 50 years or so. For example, marshland has frequently been drained in the interest of food production, compromising its beneficial climate role. Overall, it is estimated that possibly 50% of the world's wetlands may have been lost.[6]

Marshland is not the only casualty of humanity's craving for short term profit. A substantial number of other natural carbon sinks have been affected to the extent of losing much of their efficacy due to their capacity to generate immediate financial rewards. The peat from peat bogs has been exploited for heating and more wastefully in garden soil mixtures.[7] Hedgerows have been grubbed up because of the mistaken belief that planting crops on just any stretch of soil would permanently keep on generating profit for the owner. This does not take into account that the carbon-fixing features of these soils will save them and their descendants much more in the future, ignoring the fact that healthy soils are of great benefit – they are even able to soak up carbon dioxide[8] and support biodiversity.

In late 2021 a UK soil health plan was announced by the Department for the Environment, Food and Rural Affairs (Defra).[9] This implies the restoration of severely depleted and polluted soils, not least because many soils are contaminated by micro-plastics and micro-fibres.[10] Instead of being built up by the introduction of organic waste material in the top layers to be drawn down by earthworms, farm soils may contain tiny pieces of plastic instead. Even though this is poor fare for the worm population, they are still ingested and deposited deeper down, clogging up pores in the soil and being taken up by the roots of plants, impeding their growth and introducing them into the food chain.[11] Somehow the knowledge has been lost that soils require nurturing and replenishing with organic material – in the past one way of regenerating their fertility was to leave part of one's land, perhaps a quarter, lying fallow, rotating the fields under cultivation with different crops, amongst others nitrogen-fixing ones, such as beans and clovers.[12]

However, the benefits of regular maintenance of natural assets are not immediate nor easy to quantify in financial terms. Yet attempts are being made to do exactly that, including for carbon sequestration.[13] It is quite clear that there are many pitfalls in evaluating environmental attributes in such a restrictive manner. While other ways of measuring values exist,[14] and ought to be better known, money is still the acknowledged norm and likely to remain so for a long time yet.

Awareness of the fact that the increasing levels of carbon dioxide and other greenhouse gases in the atmosphere threatens a climate that has been extraordinarily stable for the last 10,000 years or so is still not high enough among policy-makers or the public. This makes it extremely difficult to take adequate steps to prevent or delay the climate crisis. However, one immediate action would be to renovate some of the most effective natural climate sinks: restoration of salt marshes[15] has been proposed as being a "relatively cost-effective mechanism to halt the loss of, or increase, carbon sequestration" and long-term carbon storage. The advocates argue that they would be one of the most resilient carbon sinks as their potential to trap particles, including of carbon dioxide, would even increase in the event of sea level rise.

Dr Wiebina Heesterman *is co-author of the book,* Rediscovering Sustainability: Economics of the Finite Earth.

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From science to activism: how should action follow climate research?

SGR Conference and AGM – 6 October 2021 – ONLINE

Summary by Stuart Parkinson

With everyday life continuing to be impacted by the COVID-19 pandemic, SGR again held its annual conference and AGM online. Over 70 people attended via Zoom, including one who connected via phone. Six speakers gave short presentations and, after some questions, the group was divided into small groups in 'breakout rooms' to discuss the issues further. Use was also made of online polling software and shared editable documents to improve interactivity during the event. After a short break, we reconvened for the AGM. Assistant Director, Andrew Simms chaired the conference, while Chair, Philip Webber chaired the AGM.

All six presentations can be viewed on SGR's *YouTube* channel, and the associated 'powerpoint' slides can be downloaded. For more details and full links, see: https://www.sgr.org.uk/events/sgr-conference-2021-science-activism-how-should-action-follow-climate-research

Lewis Akenji, Director of the Hot or Cool Institute, kicked off the event with a presentation on 'What do 1.5C lifestyles look like?' He summarised his institute's latest report in this area, outlining the carbon emissions paths that nations and individuals would need to follow to help keep global temperature change below 1.5C. He pointed out that scientists could take a lead in exemplifying this sustainable behaviour, and so encourage its uptake much more widely in society. These issues are covered in more depth in an article on p.20.

Andrew Simms then outlined the thinking behind SGR's Science Oath for the Climate and the subsequent progress in gaining signatories. For the latest on this project, see p.3 and p.11.

Liz Kalaugher, Responsible Science Campaigner, followed, summarising SGR's work encouraging professional science and engineering bodies to sever their financial links with the fossil fuel and arms industries. For the latest on this project, see p.16.

Executive Director, **Stuart Parkinson** was next, summarising SGR's research and campaigning on military carbon emissions. He summarised the data from SGR's two recent reports in this area – one on the UK and one on the EU – and the need for more involvement from climate scientists to help expand the data in this much neglected area. He pointed out how climate and peace campaigners could work together to reinforce each other's messages.

Education Director and Vice-chair, **Jan Maskell** then summarised SGR's education work for students at schools and universities as part of the projects, Science4Society Week, One Planet – One Life, and Globally Responsible Careers. More details can be found on p.4.

Finally, **Emily Heath**, Office Manager, talked about her experiences trying to combine her previous job as a lecturer in environmental science with campaign activities at her university. She gave nine examples of where academics and students could take action – and these are summarised in an article on p.12.

In the breakout rooms, webinar participants discussed two questions, 'What types of climate action are you taking, or thinking of taking?' and 'How can SGR support you in this?' The first question generated a wide range of responses from lifestyle changes to research to campaigning activities, while the second covered things like information on effective ways to reduce personal carbon emissions to information on the irresponsible activities of professional bodies.

SGR's Annual General Meeting

Phil Webber opened the SGR AGM, thanking members for attending and for their support over the past year. Stuart Parkinson summarised the annual report – giving a whirlwind tour of the organisation's activities during a very busy reporting period. Emily Heath summarised the accounts, which were in good shape. SGR's National Co-ordinating Committee (NCC) for the coming year was then elected – see below for a full list of current members – and those stepping down were thanked for their contribution.

Phil then introduced an item on SGR's legal status, proposing that the organisation explores transitioning from a 'voluntary unincorporated association' to a 'company limited by guarantee'. The advantages of this, he argued, would be greater legal protections for NCC members and more opportunities for external funding. Members were generally positive on this proposal, while the importance of consultation through the transition process was emphasised.

The overall feedback on the event from participants – via questionnaire and individual comments – was generally very positive.

THE NEW NATIONAL COORDINATING COMMITTEE

Chair: Dr Philip Webber

Vice-chair: Dr Jan Maskell

Committee members:
Dr Keith Baker, Nico Edwards, Liam Killeen, Simon Reed

We also welcomed a new part-time member of staff – Lucia Simmons – who worked as a Campaigning Assistant on Science4Society Week 2022 (see p.4).

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SGR is an independent UK-based membership organisation promoting responsible science and technology. Our work involves research, education, campaigning and providing a support network for ethically-concerned professionals in these areas. You can join SGR as a member if you are or have been a science/design/technology professional in the broad meaning of the words: our members come from many disciplines including natural sciences, social sciences, engineering, computing, architecture and design, and interdisciplinary areas. They work in research and development, manufacturing, teaching, science writing, or are students or retired. Members are invited to contribute their expertise to help make SGR even more effective. If you are not a science/design/technology professional, but want to support our work, you can help us by becoming a supporter.

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EDITORIAL ISSUES

The editorial team for this issue of *Responsible Science* was: Andrew Simms and Stuart Parkinson.

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