responsible science

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The journal of Scientists for Global Responsibility (SGR)

A membership organisation promoting responsible science and technology.
Part of the campaign awarded the 2017 Nobel Peace Prize.

Defusing carbon bombs

The best technologies for effective climate action

The Fossil Fuel Non-Proliferation Treaty

Responsible Artificial Intelligence?

Integrating science into policymaking

Including articles from:
Baroness Natalie Bennett, Dr Ian Campbell, Michaela Girvan, Dr Philip Inglesant, Prof Mark Z Jacobson, Dr Jan Maskell, Dr Stuart Parkinson, Andrew Simms, Dr Veronica Wignall and Prof Gareth Wyn Jones

News from SGR

New report on carbon footprint of football

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Plus book reviews and more

SGR
responsible science

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SGR responsible science

Editorial

Responsible science reveals the consequences of our choices

Scientific evidence isn't the whole picture. It can't tell us what to do. Choices come through politics, culture and values. But science can reveal options and their potential consequences. Deny the robust science of climate change, like the Trump administration, or tactically ignore its full implications, like the UK government, and the choices you make are blind.

This edition of our journal shows the perils of living under lies that flourish when responsible science is ignored or side-lined. Peace, human well-being and a stable climate fit for civilisation are all under threat.

As predicted, the second Trump presidency has seen climate science defunded and dismantled in the US leaving Americans, and the rest of us, more exposed. But the impact of attacks on all kinds of public institutions – including universities – goes further, hitting everything from health to nuclear arms control, undermining the protection of the population. Now, building alliances across environmental, peace, science and other organisations to resist these attacks has never been more important.

Resulting fears about the break-up of NATO are fuelling a further massive drive for militarisation in the UK and the rest of Europe, diverting money from aid and welfare budgets. The outright perversity of this shift is highlighted by how, in the UK, increased military funding is coming *completely* from these budgets.

Instead of investing to grow a more stable, convivial world by reducing inequality at home and abroad, protecting nature and leaving fossil fuels in the ground – the explosion of military spending, under its false flag of action for peace and security, fuels an ever more inflammatory, volatile global situation.

As damage to climate and biodiversity continues unabated – Ian Campbell's article explores how the Paris target of limiting warming to 1.5C is retreating from reach. But every fraction of a degree above that still counts, so pieces by Prof Mark Z Jacobson and Gareth Wyn Jones show realistic transition pathways to prioritise. We also look at the exciting development of the Fossil Fuel Non-Proliferation Treaty initiative as one way of defusing the 'carbon bombs' of remaining large coal, oil and gas deposits.

Meanwhile, as the AI industry speeds ahead, explored in Philip Inglesant's article, with regulation weak or being dismantled, the tech industry is starting to use the fossil fuel industry play-book to undermine its critics.

Building on her presentation to SGR's Responsible Science conference, Veronica Wignall exposes another great economic and cultural lie, one disproved by many social science studies, that advertising-fuelled consumerism will bring us better, happier lives. She looks at how to defuse the 'carbon bomb of overconsumption' by reducing the advertising industry's influence, and ending its promotion of polluting products and lifestyles.

Brow-beaten by authorities and increasingly repressive anti-protest laws, civil society is challenged to recapture the popular imagination with more positive visions of how we can live. Carrying the climate conversation into new arenas, such as the mass audiences for sport, is also explored in this edition. Harnessing its potential for progressive mobilisation is another way forward.

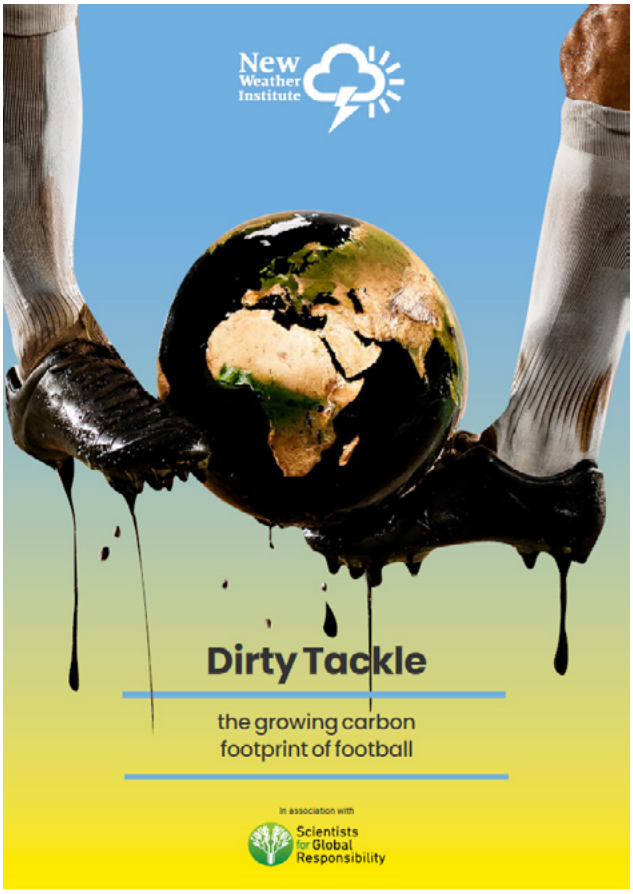
Anti-poverty, peace and environmental movements increasingly see common cause. There is much they can learn from each other. If, or when, they act together they may still create the counterweight to push back against the reckless politics of the moment, and forward to find a viable future for all. The role of responsible science is to illuminate our choices and their consequences along the way.

Andrew Simms
Assistant Director, SGR

News from SGR

New report on carbon footprint of football

In February 2025, SGR and the New Weather Institute (NWI) published a new, in-depth report called *Dirty Tackle*, which estimates that the annual carbon footprint of football is approximately 64-66 million tonnes of carbon dioxide equivalent (tCO_2e). This is similar to annual greenhouse gas emissions of the whole nation of Austria. Included within this total are emissions due to a wide range of activities, including stadium energy use, construction and renovation, merchandise, and fan and team travel to matches. It also includes - for the first time - an estimate of the induced emissions due to sponsorship deals with high carbon corporations, including oil and gas companies, and airlines. These account for a whopping 75% of football's total carbon footprint, mainly through increasing sales of polluting products. The research highlights the key role that the world's most popular sport plays in encouraging high carbon lifestyles. The report achieved a great deal of media coverage including in the *Daily Mirror*, *The Ecologist*, *Business Green*, numerous sport media outlets, and international media. The report was written by Stuart Parkinson with Andrew Simms.



More briefings on this issue are planned for later in 2025, particularly focusing on the planned expansion of international tournaments and the increasing role of high carbon sponsors.

In a further collaboration between SGR and NWI, Stuart Parkinson is also researching the carbon footprint of the winter sports sector for a publication later in the year. Snow sports, like skiing, are under particular threat from climate change, but the sector continues to accept high carbon sponsorship.

Over the last few months, Andrew Simms has also overseen the publication of other new reports on related topics including fossil fuel sponsorship of all sport, and high carbon sponsorship of e-sports. These have all been produced as part of the Badvertising campaign to challenge the promotion of high carbon lifestyles.

Military and climate change activities

The latest stage of SGR's work in this area is a two-year project (until June 2026) focused on military greenwash, funded by Marmot Charitable Trust and the Martin Ryle Trust. Stuart Parkinson is researching examples and trends in greenwashing in military-industrial sectors. The focus is on military climate strategies and activities in four key areas: measuring & reporting GHG emissions; emissions reduction targets; technologies for reducing military emissions; and strategies for reducing military emissions. Stuart has spoken about some of these issues at a conference at Queen's University Belfast, as well as at the SGR conference (see p.32).

SGR's previous research on military carbon emissions continues to be very influential. Most notably, it was quoted in the State of Palestine's submission to the International Court of Justice climate hearing. It also continues to be widely cited in academic publications, as well as by campaigners, journalists and military organisations. For example, our report on the size of the global military carbon footprint was recently quoted in a new article in Nature and by the European Defence Agency.

Nico Edwards has also continued her work on military and climate issues. She published several articles including a feature on 'Eco-friendly fire' in New Internationalist, and co-authored a 'Primer on Militarism and Climate Crises' with War Resisters International Climate Justice Working


Nico Edwards

Group. She presented her research on the military green transition and socioecological (in)justice to various academic and grassroots audiences. In addition, she helped to organise the Global Week of Action for Peace and Climate Justice in September, involving more than 100 online and offline events and actions across five continents. Hundreds of participants rallied around the message: divest from war, invest in climate justice!

Challenging militarisation, war and nuclear weapons

SGR has been awarded a grant of £20,000 by the Network for Social Change, for a new project challenging the military influence on universities and schools. The project is planned to begin in September 2025, following the recruitment of a new part-time campaigner/researcher.

Stuart Parkinson analysed the major rises in UK military spending in both the Autumn and Spring budget statements, for the British branch of the Global Campaign on Military Spending (of which he is a steering committee member). He discovered that in 2023–24, core military spending was approximately 3.5 times the size of the overseas aid budget, but by 2027–28 it will be about ten times as large.

Phil Webber spoke at a webinar on the UK nuclear weapons programme, while Stuart Parkinson spoke at a demonstration at BAE Systems' nuclear submarine shipyard in Barrow-in-Furness, and gave a talk on demilitarisation at a conference in London. All three events were organised by the Campaign for Nuclear Disarmament. SGR also supported a protest against UK militarisation of space outside the Ministry of Defence, organised by a new coalition of peace groups called Space Watch UK – https://spacewatch.uk/

Phil Webber updated his analysis of the devastating bombardment of Gaza, drawing some new conclusions, especially about the role of the US and UK arms industries (see p.29). SGR also continued to highlight the dangers of escalation in the Russia-Ukraine war, especially the risks from nuclear weapons.

Other climate activities

The proposal for a new coal mine in Cumbria was finally withdrawn by developers in April, following a High Court ruling a few months earlier. SGR had been a supporter of the campaign to stop this mine since 2018, submitting objections to both local and national public inquiries. We send our congratulations to those who led the campaign, especially local group South Lakeland Action on Climate Change.

Over the past few months, SGR has also co-signed campaign letters on a wide range of other climate and energy issues, including opposing the Rosebank oil field project in the North Sea, opposing UK government funding of new nuclear power stations, supporting climate activists who are GPs being struck-off by the General Medical Council, and supporting the Climate & Nature (CAN) Bill, which has been kicked into the long grass by the Labour Government.

In March, SGR and 12 other sustainable transport, road safety and environmental organisations launched the SUV Alliance (suv-alliance.org.uk) to campaign against the ever bigger, heavier, more dangerous and polluting Sports Utility Vehicles cluttering our streets. The SUV Alliance has a manifesto for safer, fairer and cleaner streets.

Andrew Simms has continued to speak at climate events. In particular, he spoke at the 'Love Your Planet' conference at University College London in February.

Finally, our work on sustainable food has also continued, led by Jan Maskell – see separate article on p.28.

Who's who in SGR

Executive Director:
Dr Stuart Parkinson

Assistant Director:
Andrew Simms

Education Director:
Dr Jan Maskell

Finance and Membership Manager:
Dr Emily Heath

Communications Assistant:
Rowan Harris

Co-chairs of the Board of Directors:
Dr Philip Webber, Dr Jan Maskell

Other Board Members:
Dr Keith Baker, Dr Emily Heath, Dr Stuart Parkinson, Nico Edwards

Advisors:
Dr Philip Inglesant, Fiona McOwan

Patrons:
SGR welcomed Paul Rogers, Emeritus Professor of Peace Studies at Bradford University, as a new patron.

Profiles of all of our staff, directors, advisors and our 24 patrons can be found on our website.

SGR's 2025 Responsible Science Conference

Polluter & Cyber elites – a lethal alignment?

Wednesday October 15, from 4pm (BST)

ONLINE

Further details – including how to register – will be sent to members later in the year.

OBITUARY: Martin Quick CEng, 1935–2025

Martin Quick, who was a member of the National Co-ordinating Committee of SGR, and Vice-chair of one of SGR's predecessor organisations, Architects and Engineers for Social Responsibility (AESR), has died. He was 89.

Martin studied mechanical engineering at the University of Cambridge, graduating with a Master's degree. He later became a Chartered Engineer, working for many years at the Central Electricity Generating Board (CEGB), the state-owned body responsible for electricity generation and transmission in the UK between the 1950s and the 1990s.

Martin was a Quaker and this led him to become active in peace movement, especially in the Campaign for Nuclear Disarmament during both the 1950s and the 1980s. In the 1980s, he also joined Engineers for Nuclear Disarmament. This became Engineers for Social Responsibility in 1989, which then merged with Architects for Peace in 1991 to form AESR. Martin helped with the merger. After retiring from the CEGB, he had more time to devote to AESR. This included becoming Vice-chair of the organisation until it became part of SGR in 2005. He then stayed on as a member of SGR's National Co-ordinating Committee until 2009.

Despite being an advocate for nuclear disarmament, Martin worked in the civilian nuclear industry. He did not find this contradictory, being of the view that there was an active choice to use this technology for energy or for weapons, and considered that the threat from climate change justified the continued use of nuclear power. This led to some interesting debates within AESR and SGR with members who had a different view!

One of the highlights of his time with AESR was working with the Estonian Government on the demilitarisation of the Tallinn dockyard after the collapse of the Soviet Union. He understood that people could only be persuaded to move away from the military if the resulting jobs were there to replace those the arms industry had left behind.

Another piece of work he was regularly involved with was staffing stalls for both AESR and SGR at university careers fairs. Here the aim was to highlight to engineering students that their skills could be put to socially useful ends, acting as a counter to the arms manufactures who were often there in force. He always enjoyed this work, particularly when he engaged with students who hadn't considered the ethics of their future careers.

Martin died on 3 January 2025 after a short illness, with family present.

Written by Stuart Parkinson with input from Martin Quick's family.

The UK's fair carbon budget will run out in 2027: here's the evidence

Dr Ian Campbell shows how, on current trends, Britain's carbon emissions will, within two years, exceed its fair share of the estimated global total that will breach the 1.5°C Paris target. He outlines the key implications for policy-makers and society as a whole.

There is much agreement that CO_2 emissions must be markedly reduced in order to limit climate change, but less agreement on how fast this must be done, with the UK government having a Net Zero 2050 policy,[1] and others advocating a 2040[2] or 2030[3] limit.

Proper planning requires policies to be based on robust scientific evidence. This article summarises the science of carbon budgets and the choices that the UK has concerning the speed of its emission cuts.

The science of carbon budgets

About half of the CO_2 released from burning fossil fuels and deforestation remains in the atmosphere for centuries or millennia, so the concentration of CO_2 is steadily rising. As the atmospheric CO_2 rises, the average global temperature rises. From the amount of CO_2 emitted in the past, and the effect that it has had, we can estimate how much more CO_2 can be emitted if global heating is to be kept below a particular limit such as 1.5°C. This is known as the CO_2 budget, or carbon budget.

In the Paris Agreement of 2015,[4] countries committed to restrict global temperature change to well under 2°C, and pursue efforts to keep it below 1.5°C. This translates to limiting further global CO_2 emissions to the appropriate carbon budget. Greenhouse gases other than CO_2 are of much less importance in the long term because of either their relatively short persistence in the atmosphere or their low proportion of overall emissions. Regarding division of the global carbon budget between countries, the Paris Agreement specifies that developing countries can increase emissions for a period to facilitate economic development and poverty alleviation, while developed countries must reduce emissions immediately (i.e. faster than the global total), and specifies equity between nations, which is usually interpreted as an equal share for each person of the global carbon budget.

The scientific consensus is that we can be 67% confident that global heating will be limited to 1.5°C if total global emissions since the start of 2020 are limited to 400 billion tonnes CO_2.[5] This budget of 400 billion tonnes has been used as the starting point of several analyses of possible pathways of UK emission reduction.[6, 7, 8] However, the UK's failure to cut emissions means that all of the UK's share of this 400 billion tonnes will be used up in 2025, and it no longer makes sense to discuss how the UK might use this share. We have to accept this as a policy failure, and instead consider a larger global carbon budget that will be less certain to keep the planet within the 1.5°C commitment, namely the 500 billion tonnes that has only a 50% chance of achieving the 1.5°C aim.[5] This 500 billion tonnes is approximately 63 tonnes per person on the planet. This is a lifetime limit, which at current rates, will run out in a country with average emissions in 2033.

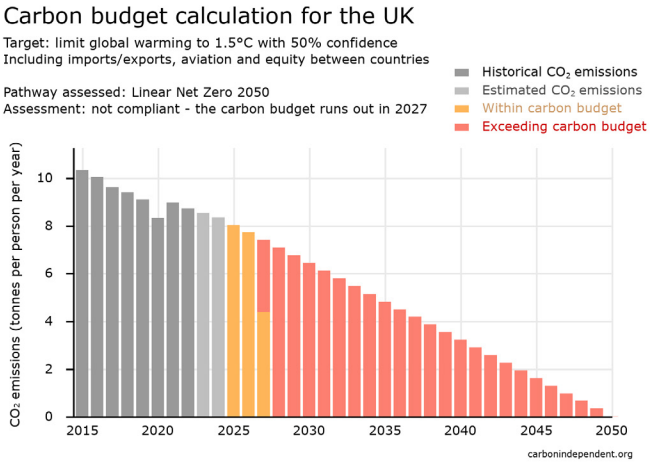
The UK's fair carbon budget for 1.5°C

The UK's CO_2 emissions are currently just over eight tonnes per person per year,[9, 10] and the UK has already used around 43 tonnes of its per capita budget of 63 tonnes in the five years to the end of 2024. This leaves a residual budget from ≫

» the start of 2025 of 20 tonnes CO_2 per person. If emissions continue with little change, this will run out in just over two years from the start of 2025, i.e. in 2027, much sooner than generally discussed.

Below are a number of pathways for emission reduction which illustrate the choices in the UK. The carbon budget charts have been generated by the calculator at the Carbon Independent website,[11] and can be replicated there via a user interface. Similar calculations and conclusions have been published in academic reports[6, 12, 13] – demonstrating that many in the climate science community already understand and accept the validity of this sort of analysis.

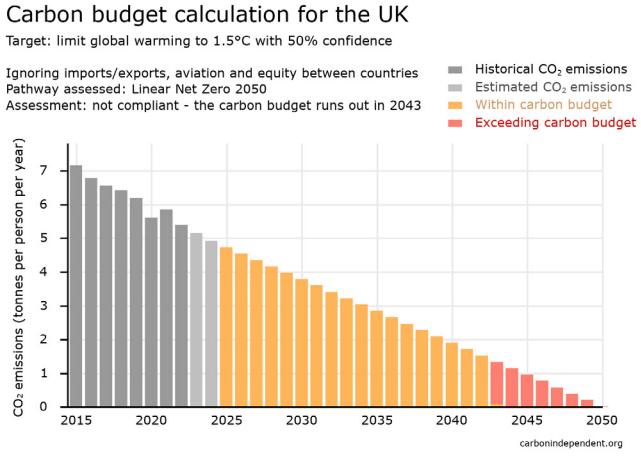
1. Net Zero 2050 (linear decline): not compliant with the carbon budget



A pathway often discussed is 'Net Zero 2050', where net CO_2 emissions are reduced to zero in 2050.

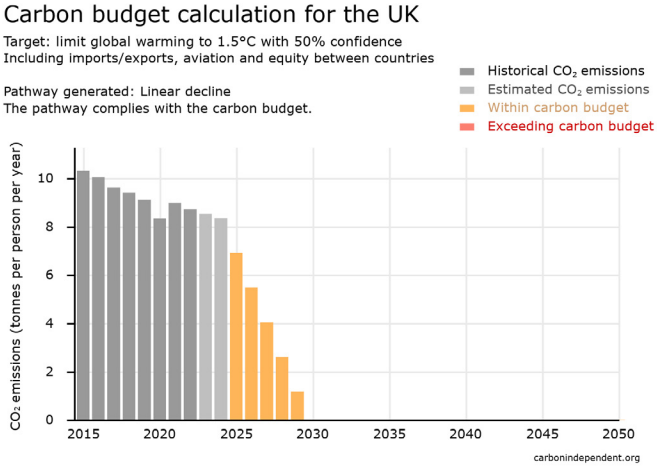
One version of this is to cut emissions steadily, by the same amount each year, which gives a sloping straight line on a chart of annual emissions. This can be termed 'linear decline'. The carbon budget runs out in 2027, and so the pathway is not compliant with the residual carbon budget. In fact, it would emit nearly three times as much CO_2 as the carbon budget of 63 tonnes per person.[6, 11]

2. Net Zero 2050 (linear decline) ignoring imports/exports, aviation and equity between nations



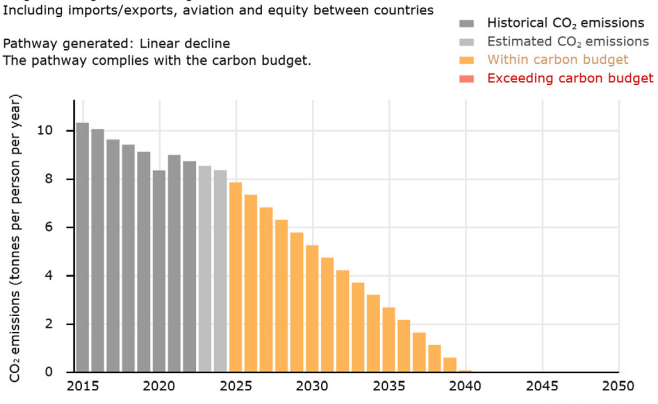
Some published carbon budget calculations ignore emissions generated in imports/exports and also ignore aviation emissions and the Paris commitment to equity between nations. By using these accounting methods, and taking more than the UK's fair share of the global budget and ignoring some of its emissions, the UK's budget lasts almost until 2050 (see chart). This is essentially the UK government's approach.

3. Compliant linear decline for 1.5°C



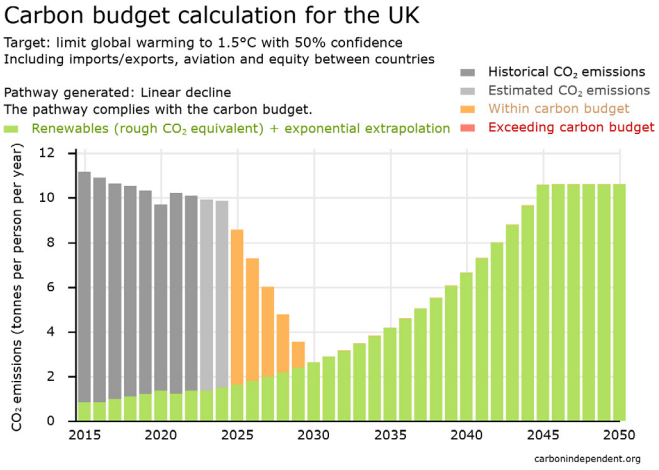
The third chart shows how fast emissions need to be reduced in order to comply with a fair UK carbon budget, if falling as a linear decline. Emissions must reduce to zero in 2030. This is the demand of the campaigning group Just Stop Oil.[3] So the demand of Just Stop Oil is in line with the Paris Agreement, whereas the UK Government's strategy is not.

4. Compliant linear decline for 1.7°C



With the lack of honest accounting and proper discussion, we must consider scenarios where the 1.5°C fair budget is exceeded. This chart shows a pathway compliant with a 1.7°C fair UK carbon budget. Emissions fall to zero in 2040.

5. Compliant linear decline for 1.5°C with renewable energy



UK renewable energy use has increased by 60% in the last five years,[14] which equals a 10% compound annual increase.

The final chart shows this UK renewable energy use as a 'CO_2 equivalent', together with extrapolation on the basis that this 10% annual growth continues.

Clearly, rapid phasing out of fossil fuels means a radical reduction in total energy use, but this need only be temporary.

Conclusions

The conclusions from the calculations are as follows.

- The UK's fair carbon budget for aiming to limit global warming to 1.5°C will run out in two years at current emission levels.
- The UK's current Net Zero 2050 timescale of emission cuts is grossly inadequate – it is derived by ignoring the commitment to equity between nations, ignoring emissions generated in the manufacture of imports, and ignoring aviation.
- If the UK wants to keep its promises under the Paris Agreement, urgent radical reduction in fossil fuel use is necessary, i.e. over 90% by 2030.

While these conclusions are based on the scientific consensus, they are not widely understood, let alone discussed.

Given the very limited timescale, technologies with long lead times for deployment such as carbon capture and storage are not viable solutions. The main focus needs to be on rapid expansion of existing renewable energy technologies (such as wind and solar), energy efficiency measures, and behaviour change. Strong action to curb fossil fuel extraction is also essential.

Political and industrial decision-making on climate change has failed, and needs major reform.

In order to make good decisions on climate change, there must be an honest debate based on robust scientific evidence, and an understanding of the immense harm being done to people and planet by the current lifestyles of the world's wealthier groups.

Ian Campbell BA BSc MD FRCS FRCR *has worked as a doctor and as a medical statistics consultant. As well as medical qualifications, he has a degree in statistics and a doctorate in the use of statistical methods in cancer research. His research on climate statistics is published on the Carbon Independent website.*[11]

This is a shortened version of the blog at: https://www.carbonindependent.org/177.html

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Carbon disarmament: the rise of the Fossil Fuel Non-Proliferation Treaty

With oil majors abandoning climate targets and politicians friendly to their interests capturing power, **Andrew Simms** looks at how SGR's campaigning history inadvertently sparked an idea, developed jointly with **Prof Peter Newell**, a keynote speaker at SGR's Responsible Science conference, that informed and framed a major international campaign for a Fossil Fuel Non-Proliferation Treaty.

The year 2018 was highly eventful, but is already slowly slipping behind the fog of upheavals since - from a pandemic to the rise of the extreme political right and a deluge of war crimes committed from the Ukraine to Gaza. But significant things happened in 2018 to recalibrate targets for climate action and suggest an additional mechanism for meeting them that could, still, enable meaningful, progressive change.

It was the year the IPCC published its special report saying that a 1.5°C, not 2°C degrees average global surface temperature rise should, for safety, be the maximum permitted. Staying within that boundary, it said 'would require rapid, far-reaching and unprecedented changes in all aspects of society.'

By coincidence, around the same time in late 2018, we launched the Rapid Transition Alliance, a network of civil society organisations committed to making action happen at the speed and scale demanded by climate science. The Alliance's motto is 'evidence-based hope' and, to map the conditions under which rapid change can happen, it gathered real world examples of transition showing the human and technological potential to pivot quickly, and summarised lessons that might be applied more broadly.

As a result I was hunting hawkishly for relevant current case studies and historical precedents of when things move fast in the right direction. In 2017, before I became the organisation's Assistant Director, Scientists for Global Responsibility (SGR) was part of the International Campaign to Abolish Nuclear Weapons (ICAN) which was awarded the Nobel Peace Prize for its work to bring about the UN Treaty for the Prohibition of Nuclear Weapons (TPNW). This work on nuclear weapons control meant I was acutely aware that 2018 was also the 50th anniversary of the Nuclear Non Proliferation Treaty (NPT) which opened for signatures in 1968, at the height of the Cold War, after less than three years of formal negotiation. Here was a good example, I thought, of how the international community can move fast even – or especially when – the political situation is extremely hostile between key nations.

An idea occurs

Then, one evening in a South London pub, I was talking with my friend and collaborator in the Rapid Transition Alliance, Prof. Peter Newell, lamenting the state of climate inaction. There was the fact that famously, and weirdly, fossil fuels themselves as a fuel source went unaddressed in the UN Framework Convention on Climate Change (UNFCCC) and the subsequent Paris Agreement which was negotiated at annual meetings of the Conference of the Parties (COP). Shockingly, coal, oil and gas are not even mentioned. Also, the then upcoming COP 24 in Katowice, Poland, was sponsored by the nation's leading coal producer, JSW. Conversation quickly turned to why we couldn't have a fossil fuel equivalent of the NPT? Civil society had long discussed the need to leave fossil fuels in the ground and spoken about unburnable carbon. The potentially stranded assets of companies invested in fossil fuels were also being used to encourage divestment. And discussed regional agreements, for example to end coal development, had been floated. But had anyone posited a 'Fossil Fuel Non Proliferation Treaty' that learned from some of the lessons of the NPT, and drew on its three pillar structure to prohibit further fossil fuel expansion (non-proliferation) roll back existing fossil fuel infrastructures (disarmament) and support countries in a just transition away from fossil fuels (peaceful use)?

We checked and, not finding anything, made the proposal 'We need a fossil fuel non-proliferation treaty' in *The Guardian* on 23 October 2018. After this produced some lively debate, the same paper later published a letter supporting the idea signed by leading public figures like Naomi Klein, Bill McKibben, Caroline Lucas and the heads of several major environmental groups. We followed this up with a more detailed consideration of what the treaty might look like in a 2019 journal article in Climate Policy, and continued to explore questions of practical implementation in workshops and through analysis of potential pathways and elements of the treaty.

With our meagre resources and full workload at the time, what we couldn't have imagined back then was how the proposal would be transformed by the campaigning zeal and fundraising ability of the dynamic Tzeporah Berman, founder of Stand.earth and a long-standing campaigner on fossil fuels. Pulling in people and resources from around the world she grew a huge, dynamic campaign around the proposal. At the time of writing, in addition to thousands of individuals, organisations and municipalities, an increasing group of 16 countries are looking for a mandate to negotiate a treaty.

Keeping fossil fuels in the ground

The Treaty is part of what Prof Peter Newell described to SGR as a 'rising tide of supply side policies' to keep fossil fuels in the ground, including bans, moratoria and phase-out policies, subsidy removal, controls on finance flowing into the sector, or 'any tool seeking to limit the extraction and production of fossil fuels'. A tracker of such policies finds over 1,800 of them around the world today. Such policies are needed because research suggests that governments currently are set to allow 110% more production of fossil fuels in 2030 than would be compatible with the 1.5°C target of the Paris Agreement. This is known as the 'production gap'.

In addition to the Treaty initiative are other groups such as the Powering Past Coal Alliance and the Beyond Oil and Gas Alliance. Given how fossil fuel overproduction is now being discussed, it seems that the parallels between the original NPT and the proposal for a fossil fuel equivalent are increasingly strong. We called SGR's 2024 Responsible Science conference, 'Defusing Carbon Bombs'. 'Carbon bombs' are fossil fuel extraction projects that will generate more than one gigatonne of CO_2 (1 $GtCO_2$) over their remaining lifetime. The immense destructive force these carry for the environmental conditions needed to sustain humanity and much of nature can appropriately be compared with the impact of nuclear weapons. In fact, back in 2015, Baroness Joyce Anelay, a minister of state at the UK's Foreign and Commonwealth Office (FCO), said that climate change should be assessed in the same comprehensive way as nuclear weapons proliferation.

The greenhouse gas pollution of a carbon bomb is equal to the emissions from 233 million gasoline powered cars driven for a year – or, if such a thing is even imaginable, 80 trillion smart phone charges. Carbon bombs represent currently the 425 largest fossil fuel projects, but are only around 45% of oil and gas extraction projects and 25% for coal, of the entire fossil fuel extraction sector. Carbon bombs are set to consume twice the remaining 1.5°C carbon budget.

The three pillars of a non-proliferation treaty

The Fossil Treaty initiative has learned from the experience of the campaign for the TPNW, which itself sought to correct weaknesses in the original NPT. But the three basic principles, or pillars, of that early treaty, negotiated so quickly, speak strongly to what is needed to keep coal, oil and gas in the ground.

The first is 'non proliferation' itself, the task of preventing further lock-in of fossil fuel dependence and which is used to justify new exploration and production. The first step in the nuclear treaty process was a stock take of who had what weapons. The work on carbon bombs and the production gap is part of the process to assess those fossil fuel reserves which, if burned, would carry us across the 1.5°C warming line. More ways are needed of monitoring their non-use and scrutinising any policy measures likely to lead to the proliferation of fossil fuels – such as allowing the promotion and rise of gasoline hungry SUVs and aviation expansion.

The second pillar of the NPT is disarmament. In the context of the climate crisis, this can be interpreted as the managed decommissioning of fossil fuel infrastructure and its rapid substitution with clean energy. 'Disarmament' could also be seen as part of delivering the three point plan for action suggested by climate scientists that carry the highest benefits, namely: lowering energy demand, lowering material consumption, and switching to food choices that are low carbon. SGR's initiative on Fair Lifestyle Targets shows how people can take their own 'disarmament' action.

The final pillar concerns the promotion of the 'peaceful' use of technology as part of a global just transition. In a climate context, that would mean massively expanding existing initiatives to compensate poorer countries for leaving fossil fuels in the ground, while ensuring access to clean energy and the technology needed for development. Funds could be also redirected from the staggering $13m per minute that governments give in fossil fuel subsidies, according to the International Monetary Fund. As part of our proposal for the treaty, Peter Newell and I suggested a Global Transition Fund that could channel funds from carbon taxes and the redirection of fossil fuel subsidies, for example, to countries wanting to diversify their economies away from fossil fuels.

If it seems a strange geopolitical moment to suggest international cooperation for mutual survival, the same could have been said in the Cold War world of 1965. If any moment is the right one to come together and step back from the march to collective self-destruction, it is the time of greatest peril and need.

Andrew Simms *is Assistant Director of SGR, co-director of the New Weather Institute and, with* ***Prof Peter Newell****, first proposed the Fossil Fuel Non-Proliferation Treaty idea.*

A fully referenced version of this article can be found on the SGR website.

The best technologies for effective climate action

Prof Mark Z Jacobson, Stanford University, gives a whirlwind, sun and water tour of the key renewable energy technologies needed to rapidly reduce pollution. In a compelling argument for the possibilities of large-scale, immediate action, he also outlines the major social and economic benefits to be reaped from transition.

Air pollution, global warming, and energy security are three of the biggest problems facing the world today. Each year, at least seven million people die from air pollution and hundreds of millions more become ill. About 90 percent of this pollution is from energy. Global warming is already causing tremendous damage, and we have until only 2030 to eliminate 80 percent of the world's greenhouse gas emissions and until 2035 to 2050 to eliminate the rest to avoid much more than 1.5°C global warming since the 1850 to 1900 period. The world faces several energy-security risks – economic, social, and political instability that will arise when fossil fuels and uranium run out; blackmail by some countries that control the supply of fuel to other countries; high costs of shipping energy long distances; blackouts when a centralized fossil fuel or nuclear power plant unexpectedly goes down; and health and environmental problems associated with fossil fuels and nuclear.

These three problems require immediate and drastic solutions – solutions that can be implemented quickly at low cost while solving all three problems simultaneously. We need to keep our eye on the ball to solve these problems. We cannot wait until a miracle technology arrives to solve the problems or distract ourselves with poor technologies that either do not help, help minimally, or address only one problem but not the others.

Poor technologies as distractions

Poor technologies include carbon capture, synthetic (as opposed to natural) direct air carbon capture (direct air capture), blue hydrogen, electro-fuels, new small and large nuclear reactors, and bioenergy.

For example, investing in carbon capture and direct air capture increases air pollution, carbon dioxide emissions, fossil-fuel mining, fossil-fuel infrastructure, carbon dioxide and fossil-fuel pipelines, energy requirements, private energy costs, and social energy costs (by a factor of 9–12) relative to investing the same money in clean, renewable energy. What is more, over 82 percent of all carbon dioxide captured worldwide, in reality, is used for enhanced oil recovery. During this process, 30 to 40 percent of the carbon dioxide captured is released back to the air. Further, another 20 to 80 percent captured is released due to the additional oil obtained, so a total of 50 to 120 percent of the carbon dioxide captured during enhanced oil recovery is released.

Blue hydrogen is hydrogen made from fossil gas, but with two sets of carbon capture equipment added to it. As such, blue hydrogen faces the same problems as carbon capture and is not helpful. Electro-fuels are synthetic fuels containing hydrogen and carbon for transportation proposed to be made from blue hydrogen plus captured carbon dioxide, so similarly, they are not helpful. Plus, they are burned in vehicles for energy, creating air pollution.

The fossil fuel industry promotes all four technologies (carbon capture, direct air capture, blue hydrogen, and electro-fuels) because such technologies give them an excuse not to stop burning coal, oil, or fossil gas. In fact, all four technologies are opportunity costs whose real impacts are to extend the life of the fossil-fuel industry without helping air pollution, climate, or energy security one bit.

New nuclear suffers from a 10- to 21-year time lag between planning and operation (too long to be useful for solving the three problems), costs per unit energy that are five to eight times those of new wind and solar (too expensive), weapons proliferation risk, meltdown risk, stored radioactive waste risk, underground uranium mining lung cancer risk, and carbon dioxide emissions that are 9 to 37 times those of onshore wind (thus too risky). Burning biofuels for transportation, even with carbon capture, attached to ethanol refineries produces far more air pollution and greenhouse gases than electrifying transportation and providing the electricity from clean, renewable sources, while using rapacious amounts of land and water.

Wind, water and solar technologies as immediate solutions

Rather than searching for a miracle, we find in front of us existing wind, water, and solar (WWS) technologies. WWS includes energy from the wind (onshore and offshore wind electricity), the water (hydroelectricity, tidal and ocean current electricity, wave electricity, geothermal electricity, and geothermal heat), and the sun (solar photovoltaic electricity, concentrated solar power electricity and heat, and direct solar heat). When combined with storage; techniques to shift the time of electricity use (demand response); a well-interconnected electrical transmission system; and efficient electrical appliances, such as heat pumps, induction cooktops, electric vehicles, and electric furnaces for industry, WWS can solve all three problems at low cost worldwide.

The biggest reason why a WWS system is low cost is that it uses much less energy than does a combustion-based energy system. Worldwide, the energy that people use goes down by over 54 percent with WWS. The reduction is for five reasons: the efficiency of electric vehicles over combustion vehicles, the efficiency of electric heat pumps for air and water heating over combustion heaters, the efficiency of electrified industry, eliminating energy needed to obtain fossil fuels and uranium, and some efficiency improvements beyond what is expected.

On top of that, WWS reduces the cost per unit energy by another 11 percent on average, resulting in a 60 percent lower annual energy cost worldwide. Adding health and climate cost savings gives an overall 92 percent reduction in annual social cost (which is the energy plus health plus climate cost) relative to a conventional system.

The worldwide upfront capital cost of such a 2050 WWS system is around $58 trillion. However, due to the $10 trillion annual energy cost savings, the payback time is less than six years. A 100 percent WWS system may also create about 23 million more long-term, full-time jobs than lost worldwide and may require only about 0.51 percent of the world's land for new energy, less than the land required for the current energy system.

What is more, we have 95 to 97 percent of the technologies we need to solve the problem. The ones we don't have include long distance aircraft and ships and some industrial technologies, but we know technologically how to transition those. We also have solutions for "hard-to-abate" cement and steel and other non-energy emissions. So, if we have almost all that we need, why do we need "miracle technologies?" We do not. In fact, to solve our problems, we need to avoid policies that divert funds from true solutions. We need to educate the public and policy makers about what works and what doesn't, thus overcome the distractions and false advertising that have plagued us to date.

Prof Mark Z Jacobson *is a professor of civil and environmental engineering at Stanford University, author of seven books, including* No Miracles Needed, *and was a speaker at SGR's 2024 Responsible Science conference (see p.32).*

This article was first published in Cleantechnica *and is reproduced with kind permission of the author, Prof Mark Z Jacobson. It is also available on the SGR website including links to references.*

How can we defuse the carbon bomb of overconsumption?

Dr Veronica Wignall, of Adfree Cities, the Badvertising campaign and Adblock Bristol, exposes the role of advertising in increasing the explosive power of overconsumption and argues that it is time to stop promoting overconsumption.

Scientists are shouting about the urgency of action, climate activists are being jailed for peaceful protests aiming to call attention to the crisis, and campaigning organisations, such as Greenpeace in the United States, are facing disproportionate and chilling legal action.

Headlines reveal the state of play with fossil fuel companies abandoning even modest green targets and doubling down on their core business of exploration and production of coal, oil and gas.

We know too that impacts are strongest on poorest communities, including disproportionate health impacts of fossil fuels throughout their use cycle. Streams of plastic waste choke vulnerable communities, while in the UK, the incineration of household rubbish was recently found to be as polluting as coal. Not only do we have to get a grip on fossil fuels, but the burden of waste that results from overconsumption, particularly by wealthier individuals in wealthier countries.

Yet, despite clear warning bells sounding on all sides, pervasive advertising continues to promote material goods and big brands, tapping into our emotions to fuel lifestyles geared around unsustainable levels of consumption. Fossil fuel companies, the undisputed pinnacle of pollution, are permitted to promote themselves through advertising and sponsorship in such a way that they are able to normalise their presence in our lives and, in effect, maintain a social licence to continue operating.

London's public transport network has hosted more than 240 advertising campaigns by fossil fuel companies including Shell, BP, and ExxonMobil since Mayor Sadiq Khan set his "zero carbon city" goal in 2018, as revealed by investigators from DeSmog. In many of these campaigns, BP and other oil majors booked out all available ad spaces in tube stations, so-called "station domination", including at Westminster and St James' Park stations where footfall includes high level decision-makers commuting to the UK parliament.

Fossil fuel advertising deliberately aims to target politicians, according to a survey of advertising professionals by research unit CAST. Norwegian oil giant Equinor, when its ads were investigated for greenwashing by the UK's ad watchdog, acknowledged that the ads were "aimed at decision-makers and their influencers, a group that included politicians in government and opposition, as well as advisors and journalists".

We continue to allow the advertising of products and lifestyles that are extremely high carbon, resulting in marketing-driven trends such as wealthy populations taking more and more flights, and 'car-spreading' as SUVs get bigger and bigger. Research by the New Weather Institute research found that a person who reports that they are "sometimes" exposed to SUV advertisements is 71% more likely to own an SUV than a standard car, and is 250% more likely to own an SUV than to own no motor vehicle, compared to a person who reports that s/he is "rarely" exposed to SUV advertisements.

An advert for the Nissan Qashqai covers the side of a whole building in Barcelona, Spain.

Similarly, we know we need to drastically alter what we eat – to reduce emissions, reduce the likelihood of pandemics, tackle antimicrobial resistance and protect health. But advertising for meat and dairy, much of it produced on a massive scale, is one of the top sectors in terms of advertising spend, particularly for outdoor advertising. Heavy promotion of energy- and carbon-intensive, waste generating consumer technology and fast fashion are yet other areas where advertising locks in polluting lifestyles, blocking sustainable behaviour change.

Advertising asserts itself into all aspects of our lives, co-opting moments of connection, tenderness, bravery and loss. It skewers our self esteem, with devastating impacts on young people. Brands in pursuit of profit are able to skew our cultural values and build widespread social norms.

We need a radical shift in our economy, how we use energy and what we finance; but what about a radical shift in the way we think? How can we unlock meaningful action towards lower consumption, and prioritise things other than unsustainable 'growth' – when our mindset is relentlessly geared towards consumption by an industry that reached a value of nearly one trillion US dollars in 2024? Removing advertising on a broad scale is a step towards the pro-social reorientation of our values.

We are seeing a rapid increase in measures to control polluter advertising at the municipal level. There have been fossil fuel ad bans across the world, some working at national level as in France, and many more at regional, city and town level from Toronto, to Sydney, The Hague, Stockholm, Gothenburg, Eindhoven, Amsterdam, Amstelveen, Groningen, Melbourne, Bloemendaal, Lyon, Zwolle, Byron Bay, Glen Eira, Wingecarribee, Fremantle, Amersfoort, Nijmegen, Haarlem, Utrecht, Darebin, Maribyrnong, Yarra and more.

In the UK, Edinburgh, Sheffield, Cambridgeshire, Basingstoke and Deane, Coventry and Somerset have all taken measures to remove advertising by some of the most highly polluting sectors.

We have to challenge overconsumption in any way we can. If advertising is the cultural water we swim in, let's challenge it. We can lobby for advertising restrictions, boycott Black Friday and stand with retail workers, and strategically object to block new billboard applications in our local areas. In other ways we can take life slow, grow plants, care for each other, support local repair cafes or political moves towards the repair economy. We can save money and get active along the way, which is proven to improve wellbeing. The challenge is to popularise these ideas, and break a lasting taboo of talking about consumption patterns.

Cities ranging from Lyon, to Grenoble, Lancy, Vernier and several US States have banned billboards, and there is a live conversation in Hamburg to do so. Grassroots groups across the UK have blocked new ad sites through the planning system, with the group Adblock Bristol mobilising communities to prevent more than 90 new billboards in the city since 2017.

Removing the 'call to consume' opens space for alternative economic visions and a shift away from individualistic materialism towards more pro-social values. Other actions we can take include supporting a planned reduction of destructive and less necessary forms of production and consumption – such as fossil fuels, fast fashion and advertising. Measures to cut demand for polluting goods and services and therefore reduce 'lifestyle emissions', should apply especially to those with the wealth to over-consume. Ending polluter ads, and reducing our overall involuntary exposure to advertising could be one of the most important and effective steps to end the norm, and remove the social licence for overconsumption.

***Dr Veronica Wignall** was one of the keynote speakers at SGR's Responsible Science conference in 2024 (see p.32). A video of her conference talk can be found on SGR's YouTube channel or via www.sgr.org.uk/events*

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Global football's dirty climate tackle

Sport was once a billboard for promoting the tobacco industry. When cigarette advertising was banned that mostly ended, but now fossil fuel companies, car makers and the aviation industry use sport to promote heavily polluting products and high carbon lifestyles. **Andrew Simms** looks at what is at stake on the biggest sporting stage of all, football, with findings from SGR's own research.

Seemingly hardened observers watched in horrified awe during January 2025 as the record Los Angeles wildfires turned whole neighbourhoods into hot, charred, post-apocalyptic remains. It must have sent cold sweats running down the backs of the city's event planners. Why? Next year, 2026, Los Angeles is set to host multiple games for the next men's football World Cup, at which the health and safety of not just players, but also the tens of thousands of travelling fans, will be at risk. Then there is the fact that the city is also set to host the 2028 Olympics. It is projected to take much longer than that to rebuild LA's burnt-out communities.

But the problem, bad as it is, doesn't stop here. The FIFA World Cup is sponsored by one of the world's biggest climate polluters. Oil and gas giant Saudi Aramco is the national oil company of Saudi Arabia, a state that has consistently obstructed climate action. More than that, under FIFA's plans to expand international competitions, football itself has a growing carbon pollution footprint. The next World Cup will grow from 32 to 48 teams, and games will be distributed across the US, Canada and Mexico. There are proposals to expand the competition even more to 64 teams for the 2030 men's World Cup, with existing games already spread across continents in Spain, Morocco and Portugal, after opening matches in Argentina, Paraguay and Uruguay.

A new scientific report, *Dirty Tackle – the growing carbon footprint of football*, commissioned by the New Weather Institute from Scientists for Global Responsibility, found that the carbon footprint of the global football industry is equivalent to the emissions from burning 150 million barrels of oil. This is similar to the annual emissions of the whole of Austria, or about 60 per cent more than those of Uruguay, the nation that hosted the first World Cup in 1930.

After a year of flooded pitches, air pollution and heatwaves threatening players' health, football's pollution is increasingly part of the climate threat to the game's own future.

Estimating football's carbon footprint

The new research presents a first industry-wide global assessment of football's carbon emissions. It covers stadium-level emissions, including those due to construction, all travel-related emissions, merchandise, and the environmental impact of key sponsorship deals with polluting companies. It assesses international and club competitions across the men's and women's games. Previous estimates of football's environmental impact have been relatively basic, excluding key elements of the sport's emissions.

Poor data and omissions have led to a widespread underestimation of football's impact and, perhaps as a result, just piecemeal attempts to address the game's pollution, such as only looking at direct, 'operational' emissions. But even these partial efforts are being undermined by the major expansion of international tournaments, the number of matches played, and the exploitation of football by corporations to promote high carbon products and lifestyles. Making real reductions therefore means tackling those issues, and taking responsibility for the transport of those attending matches – so-called 'Scope 3' emissions.

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According to the new data, just one match at a FIFA Men's World Cup Finals is estimated to emit between 44,000–72,000 tonnes of carbon dioxide equivalent (tCO_2e). This is equivalent to between 31,500 and 51,500 average UK cars driven for an entire year. These figures do not include high carbon sponsorship-related emissions, which are estimated, on average, to increase total emissions by over 350% per fixture. In the English Premier League, a single match fixture is estimated to emit approximately 1,700 tCO_2e, with travel-related emissions comprising around half of the total. This goes up by about 50% for a match in an international club competition, mainly due to air travel by spectators, and even more once sponsored emissions are included.

Sponsorships that promote heavily polluting activities are by far the largest contributor to football's carbon footprint, making up 75% of the total. These 'sponsored emissions' increase the demand for polluting products and lifestyles, such as long distance air travel, among the game's global audience of billions.

Excluding the emissions derived from sponsorship, the global total carbon footprint of football's activities is estimated to be 13–15 million tCO_2e per year, equivalent to the emissions of a nation such as Costa Rica. The activities which contribute most to this total are fan travel to matches and the construction of new stadiums. Air transport and car transport are particularly problematic. There is clear evidence that the expansion of international football tournaments, and the increase in air travel that they drive, are increasing emissions. The production and sale of merchandise, energy use and catering at stadiums, and team and employee travel also all add to the total. Over 93 per cent of these emissions are due to the activities of elite domestic leagues – those with annual attendances above one million – and international tournaments.

The FIFA men's World Cup alone has in recent years been responsible for 6.5 million tCO_2e over its four-year cycle, which includes both the qualification and the finals, with most emissions concentrated during the finals. But this total excludes sponsored emissions which can vary considerably from tournament to tournament. To date, the emissions from women's football represent a tiny fraction of the men's game, creating an opportunity to take a much less polluting development path.

Footballers calling for action

Professional footballers are using the new data to demand climate action from football's governing bodies and decision-makers. Tessel Middag, who plays for Rangers FC with 44 caps for the Dutch national women's team, said, "Football needs to wake up to the threat posed to it by climate change. From each flooded pitch to players endangered by extreme heat, climate impacts are beginning to erode the foundations of football. Without urgent change, it is only going to get worse. Instead of being a source of pollution, football can be a powerful tool for change, using a sport that is so loved and adored around the world to secure a healthy, habitable planet."

David Wheeler, a professional Wycombe Wanderers FC player, and a leading climate voice in the men's game, sees the threat from a personal and professional point of view. He says, "As a player and a parent, I want kids to have the same opportunities to play the game that I had growing up. The climate crisis is threatening that. Addressing football's growing environmental impact, and cutting its emissions, is essential for securing a future where football can continue to excite and inspire new generations. There are green shoots that are starting to spring up on football pitches around the world, where fans and players are coming together to demand ambitious and immediate action. What is needed, though, is real leadership from governing bodies."

Leadership needed from football's governing bodies

So far, however, the lack of acknowledgement from football's governing bodies over the climate threat posed to the entire football pyramid is symbolised by FIFA entering its huge, unprecedented commercial partnership with Aramco. The sponsorship deal was criticised by more than 130 female players due to concerns for women's rights, the safety of LGBTQ+ communities, and Aramco's continued pollution. Both FIFA and UEFA have signed up to the UN Sports for Climate Action Framework, which commits them to a 50% reduction of emissions by 2030. However, it is clear from their expansion of tournaments and polluting sponsorship that emissions are not reducing, and they are not remotely on course to hit such a target.

Immediate actions needed include:

- a halt to the expansion of international competitions;
- clubs and governing bodies need to make more realistic assessments of pollution that include 'sponsored emissions';
- a phase-out of sponsorship deals with major polluters, such as fossil fuel companies, airlines and car makers.

Other measures could improve the experience for fans and cut pollution, such as giving a bigger share of match tickets at international competitions to local fans, and aligning the schedule of games to make fan travel by public transport more realistic. Meanwhile player welfare could be improved by reducing the burden of more and larger international competitions, with similar, wider benefits. Crucially, players should also have freedom of speech to talk publicly about their environmental concerns and take a leadership role, to use their platforms to speak out on climate threats and be able to criticise polluting sponsors without fear of censure.

Everyone wants sport to be clean, but until actions like these are taken, the global game is committing a dirty tackle on the climate, fans, players and its own future.

*The research was led by **Dr Stuart Parkinson**, Executive Director of Scientists for Global Responsibility, and co-authored by **Andrew Simms** of the New Weather Institute, and Assistant Director of SGR. A different version of this article was published by DeSmog. The full research report can be found on the SGR website.*

Integrating science into policymaking: a vision for proactive evidence-based policies

With repeated failures to heed warnings from scientists over environmental and health threats, **Baroness Natalie Bennett** and colleagues argue for major changes to the relationship between science and policy-making.

In the almost 80 years since the end of World War II, the existing body of science has grown exponentially, with a doubling time for scientific research papers published of 14 years.[1] Our government institutions, however, have remained almost identical to how they were when the monarch was also Emperor of India. Departments have been created, wound up, or merged in that period, but the fundamental underpinnings of the state – the civil service and their political masters – are the same. So how can those in charge of the clunky, siloed descendants of the Imperial administration cope with more than five doublings in the amount of scientific knowledge over such a short time?

Put simply, they cannot. The COVID-19 pandemic has laid bare the ineffective manner in which governments approach science, with lobbyists for commercial interests frequently able to subvert and distort evidence for their paymasters' interests, and political concerns of the moment taking priority over longer-term policymaking. Officials and ministers are overwhelmed by the amount and complexity of information available to them and, with fewer than one in nine current Labour MPs holding a degree in STEMM,[2] are rarely qualified to analyse it rigorously.

Scientific and medical understanding are changing fast; many former 'certainties' and models have been debunked or heavily qualified, but ministers and advisers formed their views and approaches under the old frames, with a degree of hubristic certainty that can no longer be justified.

As demonstrated by a recent discovery (published in pre-print) of novel 'obelisk' structures of the human microbiome,[3] our understanding of our bodies, health, and the world we live in is far from complete. Most ministers or officials, when confronted by a disease issue are highly likely to seek a medicine or vaccine response; changing the environment to improve the health of microbiomes, or even general health, is unlikely to be on their radar. Even though the field of microbiome research is relatively young, it is already acknowledged that many modifiable diet and environmental factors act through the microbiome,[4] impacting health and development of metabolic diseases. Research also points to poor health of the microbiome as a mediating factor in health inequality.[5] We need modern health policies, capable of dealing with the links between our environment and our health.

As Professor Jim Norton once put it, perhaps generously, "there [is] generally a poor understanding (by ministers) of science and scientific methods".[6] This is exacerbated by the increase in conflicting reports in the scientific literature. Turning again to the pandemic response, during the early phases of which little was known about the SARS-CoV-2 virus, the government handed the reins to the Chief

Medical Officer and Chief Scientific Adviser, claiming to defer to 'the science'. However, just like 'sovereignty' before it, those in power hollowed out the definition of science, and eventually seemed to pick whatever current version of science fit best with the politics of the day.[7] The response descended into 'policy-led science', not science-led policy.

Thus, in recent years, science became little more than a buzzword used under the Conservative government (2010–2024) to shift blame.[8] Its corpse is now regularly wheeled out to justify decisions that have been taken almost entirely based on ideological considerations. Previous Labour administrations did not have to contend with such acute science-based crises as the pandemic—though climate change played an important role in the discourse—but the current roster of MPs does not inspire hope as regards a rapprochement between policy and science, under any future government.

Future governments will unfortunately have to deal with more crises, of greater severity, that will require a robust and reliable mechanism for integrating scientific knowledge into policymaking. Though the COVID-19 pandemic has (rightly) dominated the conversation surrounding global health and health services since 2020, the shadow of bacterial antimicrobial resistance (AMR) – with 1.27 million attributable deaths in 2019 alone – looms large.[9]

This is to say nothing of drug-resistant fungal pathogens, which the World Health Organisation highlighted as an emerging threat in 2022.[9] When I raised this topic with the government at the time, the response[10] I received highlighted that they were missing the forest for the trees: that a member of the G7 and a leading world economy would take pride in investing only £6m over five years into antifungals shows a disconnect with the scientific zeitgeist, which may well cost lives in the long run.

A critical area to current and future governments are crises at the intersection between human and environmental health. These will require even more nuanced scientific understanding, as well as systems approaches to understanding the often-non-linear contributions of various parameters. While climate change (and its effects on food security and water scarcity) is an obvious such crisis, there are others lurking just over the horizon. I am thinking in particular about what I have come to call 'the 3Ps': plastics; pesticides; and pharmaceuticals. We could include a fourth: PFAS, also known as 'forever chemicals'.[11]

While fossil fuel pollution and deforestation often dominate headlines, human overuse of these novel entities has led to us exceeding the planetary boundaries. That is to say, the rate at which we are polluting the environment with the 3Ps "is not consistent with staying within the safe operating space for humanity." [12] Critically linked is the perpetuating culture of incorporating entirely unnecessary additives to products to boost sales. A particularly egregious example is the inclusion of silver in period products claiming anti-odour properties.[13] This not only perpetuates damaging stigmas but also subjects users and the environment to an unnecessary driver of AMR.

A new approach

But this trajectory can be changed. The proposals outlined below seek to promote a forward-thinking approach to integrating scientific understanding into policymaking. They are not meant to be comprehensive or final, but rather a starting point for debate.

Incorporating diverse perspectives: Engaging early-career researchers, who bring fresh perspectives unburdened by the status quo, is essential. However, these researchers often face challenges in influencing policy,[14] such as the precarity of their (often fixed-term) contracts, ever-shrinking real-terms R&D budgets, and a lack of familiarity with policymaking processes. The latter could be addressed by mandating that UK Doctoral Training Programmes include an aspect of policy training (such as through a Professional Internship for PhD Students (PIPS)-like scheme).

Bridging science and policy: More widely, there is a lack of dedicated government support in translating the findings of the brilliant research community throughout the UK into effective policy. Industrial interests too often interfere with making good science into good policy.

The same approach applies to the 3Ps. Single-use plastics, for example, could be phased out in packaging, with increased R&D funding dedicated to leveraging the UK's scientific excellence in developing sustainable alternatives. Additionally, I am actively engaging with the government on the issues of pesticides, pharmaceutical, and biocidal pollutants, particularly their role in contributing to antimicrobial resistance.

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» ***Modern policymaking:*** An essential aspect of contemporary policymaking, highlighted by my House of Lords Private Members' Bill on biocide regulation that recently had its first reading, and its accompanying policy brief,[15] is the need for evidence-based approaches that are tailored to the specific challenges we face. The type of response required to address cross-sector issues like public health, antimicrobial resistance, and environmental pollution, varies greatly depending on the context. In such complex scenarios involving the interaction between multiple environmental and human health factors—such as the impact of PFAS or the cumulative effects of various pollutants—a more nuanced, systems-based analysis may be required to capture the full scope of potential risks and benefits. In such complex broad ranging scenarios, it becomes crucial to employ the precautionary principle. This approach ensures that even when risk is incalculable or uncertain, where there is the potential for significant harm, protective measures are taken. Given the well documented deterioration of human, animal, and environmental health, we must ensure that crucial action actions are not delayed on the grounds of 'waiting for evidence'.

Moreover, challenges like the perpetual substitution problem, where harmful substances are replaced with equally problematic alternatives, underscore the difficulty of creating lasting, effective policies. This highlights the importance of integrating diverse sources of evidence, from scientific research to lived experiences, into policymaking processes. It also emphasises the need for adaptive policies that can evolve as new evidence emerges, ensuring that responses are both scientifically sound and practically effective. As we advance, the ability to discern and apply the appropriate type of evidence to each issue will be crucial in developing policies that not only mitigate harm but also foster long-term sustainability and public health.

The isolation of science from wider society, and the resulting handicap in addressing world problems, has been debated for decades,[16] with minimal tangible improvement. However, with continued momentum and growing success, prioritising the resolution of these complex scientific challenges—guided by the best available evidence—will remain a central focus.

This article was prepared by Baroness Natalie Bennett, Dr Paul-Enguerrand Fady, and Dr Katy Stokes.

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***Katy Stokes** is an early career researcher focused on designing AI for low-resource settings to improve health equity, with experience at the science-policy interface in areas like health technologies, AMR, and 'One Health'.*

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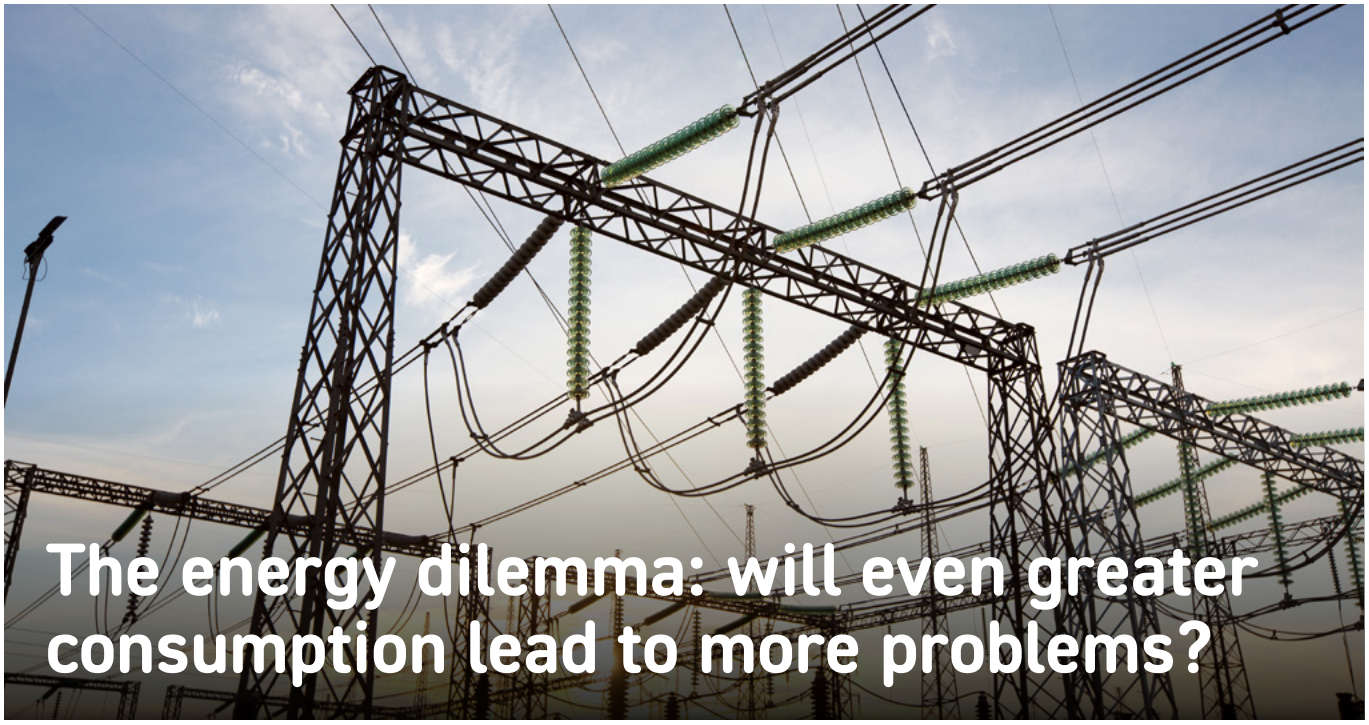


The energy dilemma: will even greater consumption lead to more problems?

Prof Gareth Wyn Jones, Bangor University, draws on evidence from physics and biology to economics and political science to explore the effects of greater energy consumption on social and environmental goals.

It has been recognised for well over a hundred years that "free energy is the capital consumed by creatures of all kinds and by its conversion everything is done".[1] Nevertheless the implications of this fundamental premise and the continuing acceleration in the totality of human-derived, free energy transactions on human welfare and on the planet is rarely part of the political or scientific dialogue. This is in marked contrast to the attention rightly paid to the impacts of specific energy sources such as fossil fuels and nuclear fission.

Politicians and business assume that the current economic model of ever-accelerating, energy-dependent material growth should, indeed must, continue. It is generally acknowledged that human-induced climate change necessitates that greenhouse gas (GHG) emissions arising from fossil fuel use be cut radically and rapidly. However, this is proving socio- and geo-politically very challenging. Tacitly, a recourse to substantial carbon capture and storage (CCS) and likely planetary geoengineering is accepted. Regardless of the ensuing risks, ever more energy use sustaining unfettered and unending economic growth is deemed fundamental to the future of even the most affluent, energy-rich, societies. Securing sources of cheap GHG-free energy are assumed to be both essential and beneficial, justifying enormous investment in various technologies, including nuclear fission and fusion.

Energy, work and power

Energy is recognised to come in various and diverse guises e.g. chemical, kinetic, thermal, nuclear. In all cases, it is defined by an ability to do work. This work can also be accomplished in a number of ways from moving an object or energising a chemical reaction, to generating heat, light or sound. Work per unit time is the physical definition of power. As more energy is exploited, or used with greater efficiency, more work can be carried out per unit time and power generated. Notwithstanding the conservation of energy and mass (and the inexorable growth in entropy[1]), in open systems far from thermodynamic equilibrium, such as planet Earth, free energy transactions can lead spontaneously to structures of increasing dynamic complexity.[2,3,4] Such energy-dependent complex, dissipative structures are intrinsically unstable, including in biology.[2] In living organisms, a hierarchy of increasingly sophisticated regulatory systems have evolved and been integrated into the genetics of each emergent life-form to maintain their integrity.[3] This applies to humans as to a single cell, and is a concept also applicable to social organisms.[5]

Energy step changes

At a macro level, planetary and human history reveals a series of major step changes in the energy economy of the biosphere. These have led, sequentially, to the emergence of more complex living organisms and latterly more complex and dynamic societies. This trend reveals a massive acceleration in the rate of change as more energy is accessed or is exploited more efficiently. Each step has also led to emergent entities which are also exhibiting new potentials and in most, perhaps all, cases, new ways of processing information (Figure 1). Nevertheless, each step ≫

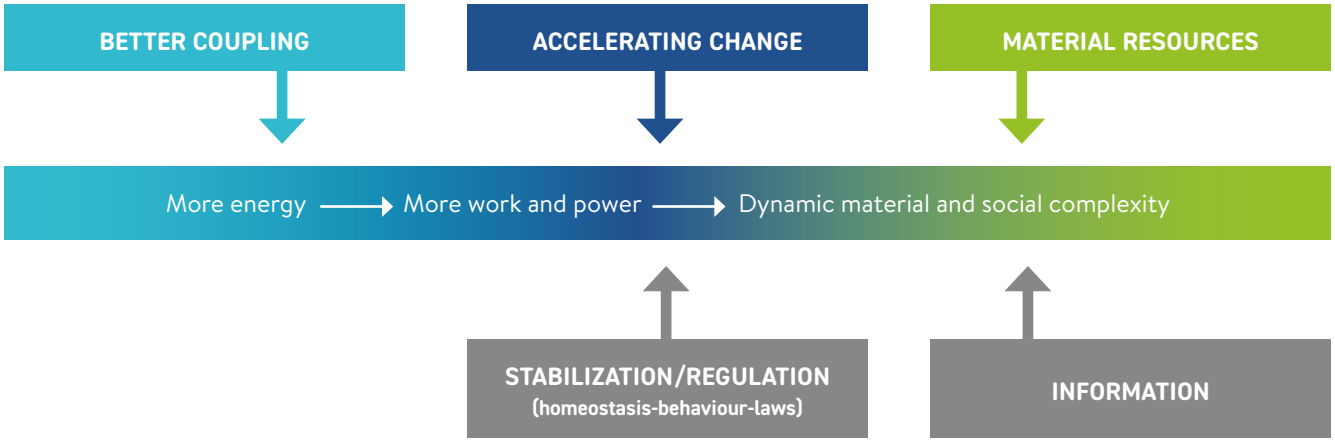


Figure 1: Energy as a driver and a dilemma

on the ladder of complexity has remained dependent on the functioning of less complex forms and on the health of the whole Earth system.[3,4,6]

This brief summary implies that the impacts of exploiting more and more sources of free energy by human society and/or an ability to capture free energy transactions and generate power with more efficiency, are highly relevant to humanity's future.

This relevance is irrespective of the sources of the energy or their individual environmental impacts.

With the evolution of the genus *Homo* – humans and our immediate ancestors – the scale of energy use by sentient individuals has been transformative.

The resting metabolism of a human equates to about 100 W (2.4 kilowatt-hours (kWh) per person per day or 2,100 kilocalories[a] (kcal) $p^{-1}.d^{-1}$). However the hunter-gather-cooker lifestyle, shared by early *Homo sapiens* and its earlier ancestors, such as *Homo erectus*, over some two million years, has been estimated to require about 300 W (7.2 kWh $p^{-1}.d^{-1}$; 6,200 kcal $p^{-1}.d^{-1}$.[7] The additional energy is required for hunting, gathering, food processing, tool-making, shelter and socialising and clothing. Uniquely amongst animals, some 20–25% of metabolic energy in *Homo* species is devoted to brain function. The investment of this energy in a capacity for complex information processing, in cognition, cooperation, competition and conscience, has overtime transformed both human society and humanity's ability to exploit planetary resources. Over more than a million years a uniquely planetary-dominant species emerged.

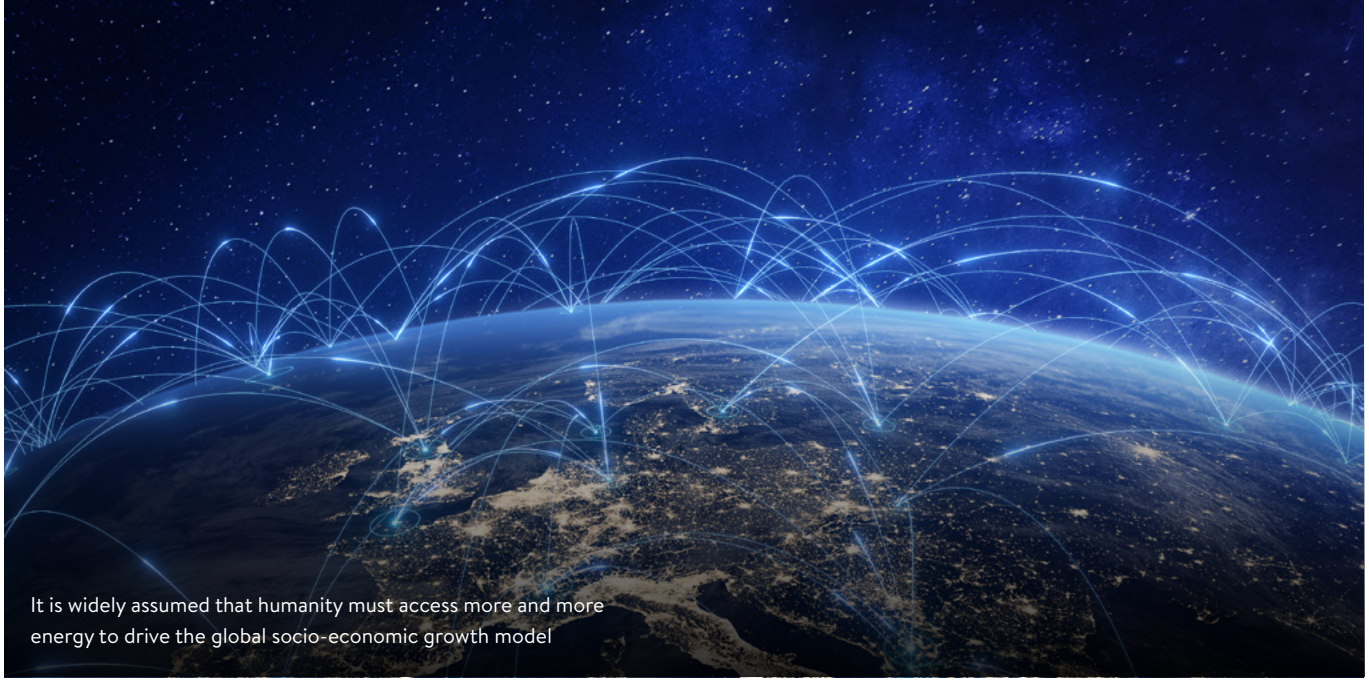
With the advent of agriculture and, later, more populous and quasi-stable urban communities about 5–10 thousand years ago, the human energy budget to support the totality of social metabolism far outstripped the purely physiological requirement. The former is estimated at about 2,000 W (48 kWh $p^{-1}.d^{-1}$; 41,000 kcal $p^{-1}.d^{-1}$).[7] This revolutionary step change in the energy economy saw the emergence, in a number of locations, not only of denser, more complex, more stratified communities and polities, but of record keeping, numeracy and literacy. New ruling and controlling political, military and religious elites arose, able to take advantage of these new potentials of the energy-richer societies.

In the last 250 years, the growing exploitation of fossil fuel energy led to the Industrial Revolution and 'the great acceleration'. These are characterised not only by a remarkable growth in global energy use but in the prosperity of a significant proportion of humanity. Human population and resource use, including near-annual photosynthate,[b] have expanded rapidly. Humans have colonised much of the global ecosystem. This emergent life-style in the contiguous USA is estimated to require, on average, 12,000 W per person per day (288 kWh $p^{-1}.d^{-1}$; 250,000 kcal $p^{-1}.d^{-1}$).[7]

Within this global trend, there remain enormous differences in the energy use (social metabolism) of divergent communities. Few hunter-gatherer-cooker communities remain, but well over a billion humans have a resource base not dissimilar to that pertaining before the Industrial Revolution. This although some technologies such as mobile phones have spread rapidly. Even within the contiguous USA, per capita wealth and energy use vary by more than 100 times. Given that fossil fuels provide over 80% of energy demand, this divergence is correlated with GHG emissions. Globally these differences are, of course, even greater. Average per capita GHG emissions vary one hundredfold from over 50 tonnes of carbon dioxide equivalent (tCO_2e) in Qatar to about 0.5 tCO_2e in the

a Kilocalories are popularly known as 'food calories'. 1 kWh is approximately 860 kcal.

b Photosynthate is the product of photosynthesis in plants and micro-organisms, initially in the form of sugars, which provides energy for the food web. In some locations, humans are now commanding over 70% of the annual net production not employed by the plants themselves.



It is widely assumed that humanity must access more and more energy to drive the global socio-economic growth model

Democratic Republic of Congo.[8] In terms of GDP per head, average wealth varies from below $500 per person to over $100,000, but even these stark figures mask significant internal variations. Clearly, given the historic relationship between energy and living standards, the energy demands of the poor are legitimate.

Implications

The focus of this article and the books on which it is based[3,4] is on the countries and societies where energy exploitation is at its most intense. They are the most energy-enriched but also the most challenged by the need to replace cheap, convenient fossil fuels with alternative GHG-free sources within the next decade or so. This necessitates a new energy revolution differing from all previous revolutions in being driven by human scientific understanding as well as socio-political failure. It is a failure that stems primarily from humanity's inability to regulate the main driver of the Industrial Revolution.

A further complication is that this fossil fuel energy revolution has become, in recent decades, contemporaneous with the digitised information revolution. The latter is changing radically the relationship between energy, power and complexity. These energy-intensive technologies are processing information at an unprecedented rate, opening up new ways of communicating, whether for social interaction or for disseminating specialised information, e.g. medical diagnosis. The rapid processing of information has empowered new ways of influencing and controlling populations. As noted briefly earlier, the historical analysis[3,4] suggests that each new energy revolution has led to new entities able to exploit the emerging opportunities. Human planetary dominance and the human colonisation of virtually all ecosystems can be interpreted as examples of this phenomenon.

As mentioned, in political and technological circles,[9] it is widely assumed that humanity must access more and more energy, albeit GHG-free, to drive the global socio-economic growth model. In this view, climate change and reducing GHG emissions are a temporary glitch in the march of progress: a glitch that can be overcome by technology. In this discourse, any relationship of human welfare and planetary health to the energy-driven rate of change and growth in complexity is discounted.

However it is the contention of this paper[3,4] that these assumptions are erroneous and must be challenged.

It must be asked, in the first place, how well is humanity, especially in the energy-rich societies, and the planet coping with the current rate of human energy exploitation? And secondly, how might a continuing increase in energy use, and/or the new coupling implicit in AI etc., affect humanity and the rest of the biosphere?

It is suggested[4] that, recently, the development of appropriate regulatory systems, analogous to homeostatic systems in organisms, has failed to keep up with rate of change. Indeed it is very challenging, in non-autocratic societies, for appropriate regulation to be agreed at a pace commensurate with that of technological change, e.g. control of social media. This failure is all too evident environmentally[10] with human impacts on the planet exceeding a number of safe limits in addition to the climate threat. Less well documented is the evidence that complexity and an even accelerating rate of change are emotionally, socially and economically damaging to humans.[4]

Some of these problems can be ascribed to elements in our inherited behaviours derived from our long hunter-gatherer-cooker ancestry such as our tribalism, dependence on instinctive biases and heuristics, and poor appreciation »

of risk. However many of the difficulties arise from the laws and conventions adopted since the Agricultural and Industrial Revolutions to regulate and seek to stabilise societies in the heat of rapid, multi-faceted industrial and social change.[4,5] The ladder of complexity seems, inexorably, coupled to new regulatory systems, as well as to emergent elites. In human society, the latter then have a dominant voice in establishing the new regulatory systems, laws etc. so tending to confirm and reinforce their dominance.

The hypothesis summarised here implies that ever more energy exploitation, irrespective of the source of that energy, will:

- increase the material and social complexity of society;
- accelerate the rate of social and economic change;
- reinforce the need for enhanced regulation to stabilise the growth in complexity, with inherently unpredictable consequences to human freedom and well-being;
- increase human demands on all other planetary resources – renewable and non-renewable – especially if poverty is to be diminished, and should population growth continue (which is deemed desirable in the current economic model);
- lead to the adoption of policies and technologies with both 'known unknown' and 'unknown unknown' impacts on our planet and on human welfare;
- likely lead to the emergence of new powerful, controlling, technologically-adept elites able to exploit the new energy-information regimes.

This multi-dimensional scenario raises important issues:

- Do we, in our democratic, but energy-intensive, material growth-oriented societies, have the capacity to create effective regulatory systems to cope with and to stabilise growing complexity?
- Do we, as individual humans, have the ability, psychologically and socio-economically, to adapt to and even to embrace ever growing complexity and accelerating change with both its new potentials and instabilities?
- Such growing complexity, while impacting on human behaviour and politics, will have environmental and resource implications. Can our planet cope? Will more safe limits be exceeded despite techno-optimisms?[9]
- What might be the impacts of an increasingly asymmetric access to power and of the emergence of new elites, implicit in the info-energy revolution? Such asymmetry might be the consequence of exploiting new abundant new, low-carbon energy sources e.g. fusion as well as radical new, AI-induced, ways of coupling energy sources and information to work and power.
- Are humans content to be subject to more and more regulation, likely at the behest of a (cyber) elite?
- How might these changes impact on our understanding of our own humanity?

A discussion of these issues lies outside the scope of this short paper whose primary objective is limited to raising the profile of the 'energy issue' and to underlining the dangers of assuming that ever-accelerating human energy exploitation is axiomatically desirable.

In the next decade or so, the fossil fuel-driven growth scenario and humanity's long obsession with energy and the power it affords, politically, economically and militarily, is likely to be confronted by environmental reality. The current trajectory of global energy demand use, of GHG emissions, of environmental excess, as well as geo- and local politics (all reinforced by the growth paradigm) make the achievement of rapid roll-out of low emissions technologies within the required time-scale improbable.

Ironically, both the logic of the hypotheses in this paper and the timeframe of the climate crisis suggest that the priority in energy-rich societies must be to reduce energy use *per se* as rapidly and steeply as possible: to seek to live well on less. Such a priority is, of course, politically and socially very challenging. But arguably it is more realistic than either a belief in the rapid global roll out of new, GHG-free energy or a recourse to untested CCS or geo-engineering and to humans being dominated by a new emergent elite.

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Responsible AI: are governments and corporations giving up?

Dr Philip Inglesant, SGR, warns that the recent upsurge in enthusiasm for Artificial Intelligence (AI) downplays the increasing dangers which are arising due to the erosion of safeguards.

The current 'AI boom' threatens to run like a steamroller over responsible innovation. The announcement of the UK AI Opportunities Action Plan, which pushes aside societal concerns so that Britain can become a 'AI maker' rather than an 'AI taker', and proposals in the USA for a 'Manhattan Project' in Artificial General Intelligence, are only the latest manifestations of this trend.

The AI Action Summit, which took place on 10–11 February 2025 in Paris, illustrates the issues at stake. The final statement on inclusive and sustainable AI was endorsed by over 60 nations but, notably, not the USA and the UK.

This article provides a brief introduction to the rapidly developing situation.

Key issues in AI

AI seems to be everywhere. It makes decisions that affect our lives in large and small ways, from who we see as friends on social media to the medical treatment we receive to whether we are given a bank loan. One type of AI – Large Language Models – can give us answers to questions phrased in ordinary language, and even compose letters and poems for us.

However, there is a far bigger picture:

- AI as a key enabler for innovation and future prosperity – but bringing major societal changes, not necessarily shared equitably;
- AI carrying out tasks autonomously, without human intervention – removing human agency, even in life-and-death decisions; and
- The quest for Artificial General Intelligence (AGI) – AI surpassing humans in all cognitive domains, perhaps beyond human control.

While there is some recognition of the need to address basic issues of AI safety, such as privacy, security, and potential misuse, the wider issues are ignored or denigrated as 'anti-business'.

From 'Regulated AI' to 'Responsible AI'

AI is hardly a new idea, but the current boom is enabled by extremely powerful computers with vastly increased processing speeds and the ability to handle huge volumes of data using innovative mathematical methods.[1]

There is some acknowledgement of the risks, for example, in moves over the past few years in both the UK and USA to set up AI Safety Institutes, and the World Economic Forum AI Governance Alliance.[2] In his speech announcing the UK AI Opportunities Action Plan,[3] Prime Minister Keir Starmer said, "We will test and understand AI before we regulate it … we will make sure this technology is safe". However, in this view, regulation must be "proportionate and grounded in the science … because of fears of a small risk … Too often you miss the massive opportunity".

This narrow view on regulation and safety ignores the broad societal implications which require genuinely responsible AI development and deployment. The more urgent risks from AI are not that it will fail to work 'safely', but rather that it works as intended but with unintended – but not unforeseen – consequences.

In an article in MIT Technology Review,[4] Nathan E Sanders and Bruce Schneier argue that "tech's darling is artificial intelligence", with the potential to change the world in many ways. However, they say, we have been here before. In 2011, social media was feted for its role in enabling the democratic uprisings known as the Arab Spring. Now social media is widely blamed for spreading misinformation, harming mental health, and perhaps throwing elections. ≫

» "Let's not make the same mistakes with AI that we made with social media", they say.

Unfortunately, with vast amounts of money potentially at stake, and the consequent competition between governments to be the 'number one' country for AI, responsible AI is being pushed aside as easily as a steamroller flattens newly-laid asphalt.

The AI steamroller

In contrast to Hollywood scenarios of an evil 'Skynet-style' superintelligence taking over the world, the clear and present danger is that so many aspects of our lives will soon be controlled by AI that it will no longer be possible for humans to have adequate oversight of the decisions being made.

The 'AI steamroller' is driven by governments and by very large, mainly US, corporations. Geopolitics is also an important factor. In response to what some are calling the New Cold War and the perceived threat of China overtaking the USA in key technologies, the US-China Economic and Security Review Commission recommended[5,6] that Congress establish and fund a programme along the lines of the Manhattan Project of World War II, dedicated to "racing to and acquiring an Artificial General Intelligence capability" to maintain USA leadership in AGI.

The original Manhattan Project developed the atomic bomb. Scientists were seriously worried that a nuclear bomb would ignite the atmosphere, until calculations showed that this was highly unlikely or impossible.[7] Similar control problems surround AI but, according to pioneer Geoffrey Hinton, the risk in this case is much more probable.[8]

There is now an 'AI Arms Race'.[9] One of President Trump's first actions on 21 January 2025 was the announcement of the 'Stargate Project', a new company with (eventually) $500 billion of investment from funders including SoftBank, OpenAI, Oracle, and Emirati investment firm MGX.[10] At the Paris Summit, President Macron announced a total of €109 billion of private-sector investment in French AI developments.[11] The UK has promised to follow, in keeping with its AI Opportunities Action Plan.[12,13] Meanwhile, China has recently shaken US AI hegemony with its open-source DeepSeek AI model.[14]

It is telling that the UK Action Plan was written by technology entrepreneur Matt Clifford. One of the plan's core principles is to "be on the side of innovators: In every element of the Action Plan, the government should ask itself: does this benefit people and organisations trying to do new and ambitious things in the UK? If not, we will fail to meet our potential".[12]

This is a high risk strategy. AI should be judged not on how much it benefits business and 'innovators' but on how much it benefits humanity. If there is any hope of stopping or slowing the AI and AGI steamroller, it must come from international cooperation or, as Shahab Hasan writing in Medium argues, "governments, researchers, and the global community" working together.[15] Future of Life Institute president Max Tegmark is blunter: an AGI race "would be a suicide race," since AGI by its nature cannot be controlled.[16]

Big tech abandons its principles?

Early in 2024, the corporation OpenAI, which has a stated mission to develop "safe and beneficial" AGI, softened its prohibitions on the use of its models for weapons development or military applications, and by October announced that it would now be prepared to work on national security "in a way that stays true to our mission".[17] OpenAI argues that this will help to keep AI leadership with "democratic countries… guided by values like freedom, fairness, and respect for human rights". But a careful reading shows how far this departs from OpenAI's mission, stated in its charter, to ensure that "artificial general intelligence … benefits all of humanity".[18]

Despite the fine words, OpenAI has been in partnership with Microsoft since 2019, including as provider of the Azure AI which forms a large share of Microsoft's services to the Israeli military in the war on Gaza.[19] Microsoft is a major investor, has access to OpenAI Intellectual Property and, despite recent changes to their partnership, the OpenAI programming interface remains exclusive to Microsoft's Azure cloud platform.[20]

Then, in December 2024, it was announced that OpenAI was joining military technology company Anduril in a strategic partnership to develop counter-unmanned aircraft (anti-drone) systems.[21] This, they claimed, was also a response to the "accelerating race between the United States and China to lead the world in advancing AI". Work for the military is lucrative and, no doubt, politically astute – but "when your customer is the US military, tech companies do not get to decide how their products are used".[22]

Towards the future

Despite the AI steamroller and the rapidly-changing world geopolitical situation, moves to unwind and abandon responsible AI are not going unchallenged. There are interventions by community organisations such as the Future of Life Institute[23] (although Elon Musk is, according to their website, still an FLI External Advisor), by academic leaders in AI including Yoshua Bengio, Stuart Russell, and Geoffrey Hinton,[24] and government actions such as the EU AI Act[25] and the UK National Safety Institute[26] (while the fate of its opposite number, the US AI Safety Institute, must now be in considerable doubt). Although the California Safe and Secure Innovation for Frontier Artificial Intelligence Models Act, SB 1047, was vetoed by governor Gavin Newsom,[27] the reported reason was more to do with concerns over the narrow targeting of only very large AI models and the difficulty in regulating a technology that is still in its infancy. Most recently, in his keynote speech to the Paris AI Summit, US Vice-President JD Vance warned that "excessive regulation of the AI sector could kill a transformative sector just as it's taking off".[28] But the challenges of regulating an emerging technology are not exclusive to AI; this is an old idea, and must not be the excuse to do nothing.[29]

The Paris AI Summit concluded with the 'Statement on Inclusive and Sustainable Artificial Intelligence for People and the Planet'.[30] The refusal by the USA, along with the UK, to sign the statement is partly founded on resistance to regulation in any form, but also in the insistence that "to safeguard America's advantage, the Trump administration will ensure that the most powerful AI systems are built in the US, with American-designed and manufactured chips".[28] Conservative America has also long made clear its opposition to regulatory attempts to combat misinformation, which it views as censorship.[31]

The opposing camps are, at least, becoming clearer.[9] On one side is the USA, which is aggressively against any form of AI regulation and promotes 'America First'. On the other is the European Union, the African Union, United Arab Emirates, African nations including South Africa, India (co-host of the Summit) and even China, who collectively declare their support for AI which is diverse, multi-stakeholder, human rights based, human-centric, ethical, safe, secure, and trustworthy. The position of the UK seems to be somewhere in between.

This is a fast-moving area of concern, and this short introduction does not pretend to cover all the issues. For example, there has not been space here to discuss the enormous power requirements of AI, or explore some of the US AI initiatives in more depth. Further SGR articles will examine these developments.

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Whales and international climate change law

Michaela Girvan proposes new ways to protect cetaceans under international environmental law due to their role in helping to tackle climate change.

Whales and other cetaceans are important in helping to remove carbon from the atmosphere, and they do this in several ways. Firstly, they consume carbon-rich prey, and the carbon is then stored in their bodies for decades. When they die, their carcasses sink to the ocean floor taking the carbon with them. Secondly, some species feed in deeper waters, and when they return to the surface, they excrete nutrients which fertilise ocean plant life which itself takes up more carbon from the atmosphere. It is this latter process – known as the 'whale pump' – which has by far the larger effect, thought to fix tens of millions of tonnes of carbon per year.

The science surrounding the carbon sequestration capabilities of whales is not novel; it has been established for over two decades.[1] Comprehensive studies have quantified the contributions of multiple whale species to carbon capture,[2] facilitating vital oceanic processes.[3] However, these advancements in scientific understanding have not yet been reflected in international environmental law. This needs to be corrected.

Mapping the legal connections

The interplay between international ocean law, climate change law, and the regulation of whaling presents a complex landscape shaped by numerous United Nations treaties. Key among these are the UN Framework Convention on Climate Change (UNFCCC), the UN Convention on the Law of the Sea (UNCLOS), and the Convention on Biological Diversity (CBD). Each has been subject to extensive scholarly discussion, focusing on their implications for marine conservation and climate science. However, despite the wealth of literature surrounding cetacean science and the legal frameworks governing their conservation, a critical gap remains: where are whales in climate change law, and how might we begin to include them?

The relationship between humans and whaling is nearly as old as ocean law itself,[4] with ancient civilisations establishing unwritten maritime customs. The earliest formalised ocean laws are traceable to Rhodes around 900 BCE.[5] Fast forward to the twentieth century and there is UNCLOS, adopted in 1982 and effective from 1994. This replaced the 'quad-treaties' of the 1958 Convention on the High Seas. UNCLOS holds significant relevance in climate change law without the phrasing ever being in the text. In contrast, the International Convention on the Regulation of Whaling (ICRW) appears outdated amid contemporary environmental challenges and evolving societal values on wildlife conservation. When the ICRW was established in 1946, climate change was not a concern, and as such the terms 'climate change' and 'carbon sequestration' are absent from its text and legal discourse. However, these concepts are crucial for understanding whale

biodiversity, population dynamics, and shifting migratory patterns, as whales will follow food to more suitable climates as oceans heat up.

The primary focus at the ICRW's creation was to regulate unsustainable whaling practices,[6] ensuring the sustainability of whale populations—an objective that has largely been achieved and one in line with the CBD and global biodiversity aims, with whale populations rebounding significantly and only a handful of nations continuing to partake in commercial whaling activities.

The complexities of conservation efforts, along with ongoing challenges in enforcement and compliance, suggest that despite the progress, the effectiveness of the ICRW's governing body – the International Whaling Commission (IWC) – remains "ambiguous".[7] Important questions remain about the continuation of the ICRW in its current form. The evolution of international environmental law, ocean law, and emerging fields such as climate, biodiversity and plastics law, highlights the growing need for ICRW to adapt, to remain the competent authority for cetaceans dealing with modern legal challenges. Those adaptions need not be large.

Reforming international law

There exists a growing consensus that the IWC is outdated, operating under an antiquated treaty and scientific understanding.[8] This analysis contends that the matter of increasing the abundance of cetaceans has shifted to their critical role as 'climate mitigators'. This term I define here as "a species aiding in the mitigation of climate change through their specific biological processes and cycles." Despite the significant ecological contributions of whales,[9] particularly their involvement in carbon sequestration[10] and ocean nutrient cycling, global law has largely overlooked this importance. A key reason for this shortcoming is the significant delay between the emergence of scientific understanding and its codification into law.

While the International Tribunal for the Law of the Sea (ITLOS) recently issued a landmark advisory opinion addressing climate change, this opinion remains non-binding and serves primarily as an interpretative guide for future legal considerations. Although it references biodiversity and ecosystem health, it does not specifically address cetaceans, whales or any particular species. This absence is unsurprising, given the monumental scope of the advisory opinion and its historical significance in legal discourse. The need for an updated legal framework that recognises and incorporates the ecological importance of whales in climate mitigation efforts is increasingly urgent.

To address this critical legal gap, I propose two pathways worth further exploration. The first is to add a new annex to the existing ICRW acknowledging cetaceans as some form of 'climate mitigator' species in law. With global law processes, this may take 10 to 50 years. If we are in no rush to aid our climate-mitigating allies, then this would be a viable option. Alternatively, a more creative angle could involve amending the 'IUCN Red List' for endangered species to include a climate annex, recognising their carbon-capturing efforts of cetaceans as climate mitigators.

The inclusion of cetaceans as 'climate mitigators' into global climate law is not merely a matter of their conservation or ecological necessity, but would have much broader benefit. The frameworks governing international ocean and environmental law must evolve to reflect the issue of climate change. The contribution of whales, dolphins and other cetaceans to marine ecosystems is essential for global climate health. Without a re-evaluation of the ICRW, and the incorporation of established scientific data of cetaceans into climate change legislation, we risk neglecting a vital component of legal discourse for our planet's ecological protection and humanity's struggle against anthropogenic climate change.

Michaela Girvan *is the lead representative for Common Weal for the UNFCCC, a co-founder of The Ocean Rights Coalition (TORC), and a specialist in international ocean law and governance. TORC actively encourages research collaborations on science and law, which can be used in its campaign work - see: https://oceanrights.org.uk/*

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Closing Loops: taking climate action around food in North Lancashire

Dr Jan Maskell provides an update on a local, sustainable food project with which SGR is working.

In May 2022 FoodFutures, a sustainable food network based in North Lancashire, launched Closing Loops, a five-year project supporting a vision for a local food system and wider local economy that is healthy, resilient and fair.

The £1.5 million project is funded through the National Lottery Community Fund and is developing initiatives to reduce and repurpose waste, including food waste, whilst promoting healthy, seasonal and sustainable food and supporting regenerative enterprises.

SGR's role in the project is to provide monitoring and evaluation guidance which is necessary to meet the funder's requirements and also to improve the project's outputs and outcomes.

The project has five workstreams:

Composting

The aim here is to build a network to encourage community composting and to spread awareness, skills and knowledge. The network includes demonstration sites and 'Composting Champions'. Training is offered to community groups who want to set up or develop their composting activity.

Gleaning

The project's Gleaning Coordinator supports Eggcup, a charity working in North Lancashire to help people through tough times with a low-cost food membership. Eggcup intercepts surplus food across the region and supplies it to people in the community instead.

Gleaning is where volunteers rescue food that would otherwise go to waste, including cauliflowers, pumpkins and kale, from farmers in the area. Workstream activities include gleaning days at local farms, and 'Share the Harvest', an autumnal event to prevent waste, and harvest locally grown surplus apples and pears. Individuals or groups can also borrow harvesting tools for free, apply for a small support grant, or add a glean, cooking workshop, neighbourhood harvest festival or other events to the activities programme.

Chef and cooking network

This workstream is establishing a network of growers, farmers, chefs, community cooks and passionate volunteers to build community food skills and support good food procurement. It involves promoting positive changes to how we eat, such as:

- local, seasonal and sustainably/regeneratively produced food;
- cooking more and learning skills to preserve food;
- eating more plants and less and 'better' meat, eggs and dairy ('better' meaning a focus on organic, free range and pasture-fed animal products);
- reducing food waste; and
- and promoting access to good food for all.

REconomy

A regenerative economy is where local enterprises, organisations and people live and work in a way that protects and restores the environment, builds healthier communities, and improves people's wellbeing. A micro-finance scheme (run jointly with the local Community Volunteer Service) - the 'Pots of Possibility' - annually awards several grants of between £5,000 and £10,000 for local projects which help to develop a zero-waste, circular and regenerative economy. One set of grants is awarded by a panel decision, and the second via a public voting event.

Communications and marketing

The final workstream publicly promotes the various campaigns and activities of the whole Closing Loops project. Included in this are four seasonal markets a year which aim to celebrate the seasons and variety of local produce and products. As well as a range of local food and craft stalls, there is live music, cooking demonstrations using seasonal produce, and engagement with community organisations.

At each market, the season's new issue of North Lancashire's community food magazine THRIVE - https://foodfutures.org.uk/thrive/ - is launched. Printed copies of the magazine are delivered to outlets across the district with an electric cargo bike, with support from a local e-bike shop, 'e-radicals'.

Closing Loops' stated aims are to create and cultivate an ecosystem of people from all walks of life taking responsibility and working together to reconnect people, place, community and nature. By linking up existing initiatives and co-developing new solutions we can move from sustainable to regenerative, and ultimately scale out beyond our district by building a model for a regional REconomy that works and nourishes people.

Dr Jan Maskell *is Co-chair of SGR. She is a chartered psychologist, and author of the forthcoming book,* Work Psychology and the Climate Crisis.

New on the SGR website

Since September, we have published eight new blogs and presentations on the SGR website, in addition to the articles published in this edition of the *Responsible Science* journal. Below is a short summary. All of these can be found on our website under: www.sgr.org.uk/resources

Future War: Will it really be clean and green?

In a presentation to an academic conference at Queen's University Belfast, Dr Stuart Parkinson, SGR, summarised the flaws in recent military claims that new arms technologies will markedly reduce civilian casualties or environmental impacts.

Oil and gas 'sportswashing' now a $5.6 billion industry

This blog summarised a new report, published in September, which uncovered the extent to which fossil fuel corporations use the popularity of sport to promote their 'brand', and divert attention away from their highly polluting activities.

Stop hobbling UN research on nuclear war impacts, scientists tell UK government

In this media release from October, SGR called upon the UK government to stop lobbying against a UN resolution to carry out new research on the potential impacts should a nuclear war take place. The resolution was later passed by the General Assembly by 144 votes to 3. Shockingly, the UK and France joined Russia to vote against it. The research study will commence in the near future, and will be the first UN study on this topic since the 1980s.

Tackling global risks in the second Trump era

The return of Donald Trump to the US presidency is undermining efforts to tackle urgent global risks. In this blog from November, Dr Stuart Parkinson, SGR, examined Trump's likely impact on two key issues, climate change and the threat of nuclear war. Many of Dr Parkinson's concerns have been borne out in the months since, but there have been significant signs of resistance. The analysis in this article points to how this resistance can be increased.

Civil and military nuclear programmes: will they be derailed by skills shortages?

In December, Alasdair Beal examined the state of the UK nuclear industry – both civilian and military – and found that the proposed expansion had a serious workforce problem. In the months since, we have seen some scaling back of the government's ambition, especially in the civilian sector, but no sign that the workforce problem is close to being dealt with.

Gaza: how the West's weapons are fuelling a catastrophe

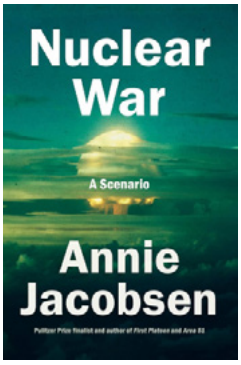
Dr Philip Webber, SGR, has written further updates of his earlier analysis of the considerable humanitarian impacts of the war in Gaza, including probable genocide. In this latest update, published in February, he summarised the role of the arms industries in the USA, UK, and elsewhere. Of course, despite the two-month ceasefire earlier this year, the situation in Gaza continues to worsen.

An act of conscientious objection for the climate

In this blog, Dr Gianluca Grimalda reflected on his legal victory, achieved following the termination of his academic contract when he refused to fly.

UK nuclear weapons: from Vanguard to Dreadnought

In this online presentation, Dr Philip Webber, SGR, summarised the latest situation with the UK's nuclear weapons programme. He covered: the numerous technical problems, especially with the new Dreadnought submarine and nuclear reactor programmes; the rising costs, including the latest government announcements; and the heightened risks from nuclear confrontation, including outlining the destructive capabilities of the Trident weapons system.



Nuclear war: a scenario

Annie Jacobsen; Transworld Publishers Ltd; 2024; ISBN 9781911709596; 400pp

The risk of nuclear war occurring hangs over us all, every moment of every day. It would mean the end of human civilisation, and possibly of humanity itself. It is surely one of the most important of issues, and yet you would struggle to catch any of our leaders discussing it. You do wonder if this silence is deliberate. When previous attempts have been made to try and provide some guidance about how to survive a nuclear war, it has led to massive street protests. So our leaders probably feel it is best not to talk about it. And anyway, as Annie Jacobsen highlights in this disturbing book, it is well accepted by those involved in nuclear policy that there isn't actually anything that could be done to protect the populace anyway. So best to just call nuclear weapons 'the deterrent' and claim our security depends on it.

This book is therefore a very welcome insight into what nuclear war would actually entail. Jacobsen is a Pulitzer Prize finalist for her previous book on the inner workings of the Pentagon, and her research for this new book is equally detailed and very thorough. Over many years she has interviewed dozens of senior military and political figures and others involved in nuclear planning and policy, who are all listed, and throughout her text she refers to the source of the data she is presenting. She also includes a large bibliography.

The scenario that Jacobsen uses is just a story she weaves around the facts about the start and progress of a nuclear war that she has gleaned from all her extensive discussions and interviews. Her scenario uses one possible event that leads up to the start of a nuclear attack. There are many such possible events, thousands of which, as she points out, have been explored by nuclear planners in their war game rehearsals. What is clear from these is that once an initial missile has been launched, the outcome is nearly always the same – all the world's nuclear weapons are eventually released and the world is destroyed.

The book starts with a nuclear attack on the USA by North Korea. It takes us through the events that occur during the first hour following the detection of the tell-tale exhaust of an intercontinental ballistic missile. It painstakingly relates, minute by minute, the responses that the US military have been rehearsing over and over for the last 70 years. All these responses follow on from each other; the initial warnings of the missile detection and the estimation of its target, the engagement of the political leadership, the attempts to use anti-missile systems, the rush to move the political leadership to supposed safety, the painful deliberations leading up to a limited nuclear response from the USA, the response of the Russians, up to the eventual decision to let everything go. By the end of that hour most people in the northern hemisphere are either dead, or dying from burns or radiation exposure.

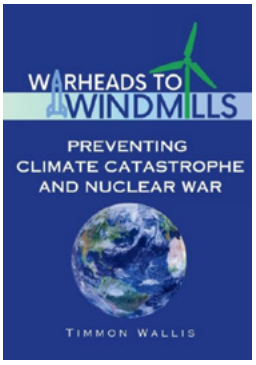
It feels like no-one would be stupid enough to start such an unbelievably awful event. But as the author points out, world leaders don't necessarily act rationally. And perhaps more significantly, as the book powerfully illustrates, all the complex readiness for nuclear war just leads to a massive state of unstable equilibrium. If a nuclear attack is suspected the responses have to be immediate. (The US land-based missiles, for example, are constantly ready to launch in only 60 seconds). These responses are governed by a 'launch-on-warning' policy which means that nuclear missiles would be launched as soon as a suspected attack is detected. So in many ways the decision to engage in nuclear war has already been taken. We're just waiting for that trigger warning signal. And of course, as the author reminds us, the massively complex technical systems involved have very often gone wrong, and we are just lucky none of them have yet led to a missile launch.

Ultimately the decision to launch a response comes down to the US president, with six minutes allocated to make a decision. They have someone following them everywhere with a case carrying the launch codes. The Russian leadership has an equivalent. But, as Jacobsen points out, it is unlikely the president has anywhere near enough knowledge to make that judgement. Apparently President Reagan once stated that we can always call the missiles back if we find it's a false alarm! (We can't.)

The narrative goes further. The author quotes recent papers that use modern climate models to predict the aftermath of a full nuclear exchange. The modelling shows that a nuclear winter, where there is an almost complete lack of any sunlight reaching the surface of the Earth, would last for around ten years. Plants would die and no food could be grown. Even those people in the southern hemisphere who survived the massive global radiation threat would struggle to survive this long. When the sun returned the radiation levels would still be very high, and it would take 25,000 years or so for them to decay to current levels.

This book is really very disturbing. It's about the insane gamble of basing our security on a threat to completely destroy ourselves. It outlines facts that we would all probably rather not know about, but learn about them we should. And for the sake of life on our beautiful world we should all act on that understanding. We must rid ourselves of these world-ending weapons.

***Review by Prof Roger Orpwood**, University of Bath. Roger previously worked as a design engineer in the aerospace industry, before moving into medical engineering. He is Director of the Bath Institute of Medical Engineering.*



Warheads to windmills: preventing climate catastrophe and nuclear war

Timmon Wallis; Indispensable Press; 2023; ISBN: 9798218319540; 322pp.

Timmon Wallis' book is well-written and well-referenced, providing a wealth of useful information and arguments on major aspects of the climate crisis and nuclear weapons, explicitly linking these two main threats facing the world. It recognizes the need to totally eliminate fossil fuels and nuclear weapons, ensure that renewable energy generation systems are constructed using renewable materials and energy sources, and move to a circular economy with minimal waste.

As a US book, it has a strong focus on that country, which seems justified by the USA's dominant political role. However, this may be responsible for its insufficiently strong collective focus and lack of attention to funding the green transition through taxation. Wallis points out that the USA spent more than $10.8 trillion (2023 dollars) on nuclear weapons in the period 1940–96. Hence, Greta Thunberg's quote on fossil fuels also holds for nuclear weapons: "our future was sold so that small numbers of people could make unimaginable amounts of money."

While recognising the need to reduce energy consumption, for instance, through less air travel or improved building insulation, the book focuses on the additional electricity generation needed to eliminate fossil fuels, including by switching to electric cars and air-source heat pumps supplied by renewable energy.

Wallis criticises carbon capture and storage as a way to continue fossil fuel use indefinitely, and nuclear power for its unresolved radioactive waste disposal problems and very high life-cycle energy requirements. His proposed solution by 2030 involves replacing fossil fuels for electricity generation, road travel and heating buildings by renewables, as well as converting low temperature industrial processes, and phasing out hydrofluorocarbons. Renewables, particularly hydroelectric power, wind and solar photovoltaics already provide more than a quarter of electricity generation globally. Existing renewable energy technologies can meet future electricity needs and pay for themselves through reduced costs. However, caution is needed as expansion of hydroelectric power involving flooding large areas would cause unacceptable local environmental damage.

Wallis also points out that natural carbon sinks will need to be expanded to absorb excess carbon dioxide from the atmosphere, including a massive programme of reforestation and land restoration.

The huge risks of nuclear weapons are described, including 'near misses' such as the 1962 Cuban missile crisis and 12 similar incidents which could have led to nuclear conflagration. These include several crashes of planes carrying nuclear weapons, and 50 nuclear weapons which have fallen to the sea floor. Also discussed are alcohol and drug abuse among military personnel, and poor health and safety procedures. Since a 'deterrent' needs to be usable to be meaningful, nuclear-armed states are no more likely to 'win' disputes. To date, nuclear arms control treaties have reduced the total number of weapons, but the destructive capability of individual warheads has increased.

However, the 2017 Treaty for the Prohibition of Nuclear Weapons (TPNW) bans all development and deployment of nuclear weapons, making use in any circumstances illegal, and challenges the concept of deterrence. Wallis argues that global nuclear disarmament could be led by the USA – which has the world's most powerful military. If the US president signed the TPNW they could lead negotiations with the other nuclear states, with a phased disarmament programme being pursued over the following several years. However, the book was written before Trump's re-election.

The book also discusses the stand-off between India and Pakistan; nuclear-armed nations in a state of constant armed readiness, with a history of several previous conflicts. Even a 'small scale' nuclear war between them could cause two billion deaths. Their ties with Britain means that UK disarmament could encourage India and Pakistan to disarm.

Nuclear war and the climate crisis are interconnected. A US-Russia war would be especially catastrophic, with up to 150 million tonnes of soot blasted into the upper atmosphere blocking out the sun for years, leading to global temperatures plummeting by up to 7°C and more than five billion deaths. In addition, the climate crisis caused by greenhouse gas emissions could destabilise nations, increasing the likelihood of international conflict, including nuclear war. The USA, China, Russia, UK and Europe cause more than three quarters of global carbon emissions. They need to work together to save the planet, but instead have nuclear weapons pointing at each other.

Wallis also discusses the particular need for science, technology, engineering and mathematics (STEM) skills to be used in the development and deployment of renewable energy. He points out that many STEM jobs in the USA are in nuclear weapons. However, there is significant potential for a transition to green jobs especially in areas such as engineering, computing, and the physical sciences.

The book's main proposal for campaigning for change is putting pressure on the 'profiteers' through divestment and boycotts, including of consumer products. This is motivated by the disproportionate corporate influence on decision-making in the US Congress and the limited role for influencing politicians directly.

***Review by Dr Marion Hersh**, senior lecturer in biomedical engineering at Glasgow University (**Dr Stuart Parkinson**, executive director of SGR, assisted with the writing of the review).*

Defusing carbon bombs: how do we stop remaining dangerous fossil fuels from being burned?

SGR CONFERENCE AND AGM; 16 OCTOBER 2024; ONLINE

Summary by Stuart Parkinson

The conference took as its starting point the problem of 'carbon bombs': massive fossil fuel extraction projects, each capable of releasing at least one billion tonnes of carbon dioxide if its contents are burnt completely. There are currently over 400 such projects worldwide, which are still being pursued even though climate scientists have pointed out the extreme risks of continuing their exploitation.

We again held the conference online to maximise participation from around the country and internationally, as well as minimising our carbon emissions and our costs. About 85 people attended on the day – with hundreds more watching the videos online later. There were four main speakers, with the conference chaired by Andrew Simms and the AGM chaired by Jan Maskell. Technical support was provided by Emily Heath.

The four main presentations can be viewed on SGR's YouTube channel, with any associated 'powerpoint' slides also available to download. For more details and full links, see: www.sgr.org.uk/events

Main speakers

The first speaker was **Prof Peter Newell**, University of Sussex, whose topic was 'A treaty to keep carbon underground: the rising tide of supply-side policies'. He argued that, among the proposals for restricting fossil fuel extraction, one of the most promising was the 'Fossil Fuel Non-Proliferation Treaty' (FFNPT). This would deal with a loophole in the Paris Agreement, which did not explicitly mention fossil fuels. Nations signing up to the FFNPT would halt exploration activities and begin a rapid phase-out of all fossil fuel extraction, not least carbon bomb projects. There is now an international campaign to agree the treaty through the United Nations. 16 nations, 130 cities, 4,000 organisations (including SGR), and over 1 million individuals have so far endorsed the treaty.

Next up was **Dr Veronica Wignall**, Co-director of the campaign organisation, Adfree Cities, who spoke on 'Ending the social licence for overconsumption'. She focused on the very damaging role of the advertising industry, which shamelessly promotes high carbon products and activities, including SUVs and air travel. She pointed out that behaviour change among the wealthier groups in society was potentially one of the fastest ways of reducing carbon emissions, but it is neglected by both policy-makers and environmental campaigners. Dr Wignall then summarised the 'Badvertising' campaign which advocates the banning of high carbon advertisements. SGR is a supporter of this campaign, including through our research projects.

The third presentation was by **Dr Stuart Parkinson**, Scientists for Global Responsibility, whose topic was 'Military carbon emissions: how can we stop them rising?' He started by summarising the recent research on the size of global military carbon emissions, an area in which SGR has played a leading role. The evidence points to a carbon footprint of around 5.5% of global emissions – but that figure does not include war-related impacts, such as ecosystem damage, destruction of infrastructure, or post-war reconstruction. He then reviewed historical data, pointing out that major falls in emissions mainly happen when military activity shrinks, rather than because of technological development. Indeed, the military sector is one of the most difficult to decarbonise, meaning that rapid falls in their emissions are only likely if we find more peaceful ways of resolving conflict, rather than through the current path of militarisation.

The final speaker was **Prof Mark Jacobson**, Stanford University, who assessed 'Which technologies are most effective in the transition away from fossil fuels?'. He summarised the extensive research that he and others have carried out on the potential for a combination of wind, water, and solar (WWS) technologies to supply the world's energy. Major electrification of sectors such as transport, heating and industrial processes would be a key element of this transformation, as would the introduction of a range of energy storage and energy efficiency technologies. He pointed out that this transition is well underway with, for example, the exponential growth of solar photovoltaic systems and wind farms. He argued that technologies such as nuclear power, carbon capture and storage, and biomass technologies had serious drawbacks, making them unsuitable for a rapid, environmentally-friendly transition. These drawbacks included slow deployment rates, persistently high costs, significant environmental side-effects, and security concerns. He pointed to the huge benefits of a WWS transition, not only for climate protection, but also for curbing air pollution and reducing economic costs.

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