

## Science in the Trump-May era



**Stuart Parkinson, SGR, outlines key challenges to progressive science from the Trump and May governments.**

It would be safe to say that no one predicted that both Donald Trump and Theresa May would become leaders of their respective nations in 2016. But now they have, what does this mean for the funding and management of science and technology within their countries – and how much of their agendas are shared?

### Trump's attacks on science

Trump's disdain for evidence-based science is well illustrated by his comment that "the concept of global warming was created by... the Chinese... to make US manufacturing non-competitive". Since his election, he has followed through this thinking by nominating hard-line climate sceptics to key posts in his administration, including Scott Pruitt as head of the Environmental Protection Agency and Rex Tillerson, former CEO of ExxonMobil, as Secretary of State. Not only is there the real possibility that government support will be shifted from renewable energy to fossil fuels and the US will withdraw from the Paris Climate Agreement, there is the concern that NASA's earth science programmes – which include some of the world's most extensive monitoring of climate change – could be cut. Some scientists within that programme are so worried, they have begun creating back-ups of key climate data on independent computer systems.

But things are even worse. The new Secretary for Education is Betsy DeVos – a religious hardliner who reportedly does not believe in evolution. The damage she could do to standards of US science teaching are enormous.

One funder of research, however, is likely to benefit considerably from the Trump presidency: the military. US military R&D spending is already huge – amounting to more than 50% of the total federal science budget, including a large fraction for the 'modernisation' of nuclear weapons – but Trump has promised even more.

### How different is May?

On the face of it, Theresa May's government has a rather more progressive approach to science and technology. There is an acceptance of the major threat of climate change, the budget for the UK's 'science base' has been increased in the wake of the Brexit vote, and national targets for carbon emissions are stronger than for most industrialised nations.

However, there are still significant problems – which could grow as political and economic ties increase as Brexit proceeds. Military R&D spending is increasing again – with nuclear weapons being the largest component – while policies for tackling climate change remain inadequate. The government is also trying to push through parliament a controversial bill on higher education and research which could fundamentally undermine the independence of British universities (see p.9).

## Contents

### SGR News .....2

A few words from the Director .....2

Nuclear disarmament activities .....3

Science4Society Week .....3

Peaceworker.....3

Tom Kibble 1932 - 2016.....4

Derek Sugden 1924 - 2015 .....5

### Feature articles.....6

Could Trident be hacked? .....6

Get it from the Sun: expanding renewable electricity.....7

Universities, democracy and science.....9

Britain's nuclear addiction?.....11

The landmine ban: 20 years on .....13

Fracking and public health.....15

Arms and fossil fuel industries in schools: undermining the next generation?.....17

Devonport and nuclear submarines: what are the risks? .....18

### Reviews.....20

Universities for sale? .....21

Islam and the West .....22

The winning of the carbon war .....23

The marked shift in the governments of the USA and UK in the last year present an enormous challenge to the progressive science agenda in both countries. Scientists, engineers and their allies will need to work harder than ever to change these retrograde policies.

**Dr Stuart Parkinson is Executive Director of SGR**

References are available online - at <http://www.sgr.org.uk/resources/science-trump-may-era> - or from the SGR office - contact details on back page.

## A few words from the Director

2016 was a tough year. It's sobering to reflect on what future historians will consider to be its most significant events. The election of Trump or the Brexit vote – both harnessing rises in aggressive nationalism. The horrendous loss of life as the Russian-backed Syrian government forces advanced against the rebels, or the Western-backed Saudi forces bombed Yemen indiscriminately. The global temperature rise smashing historical records<sup>1</sup> – with new evidence pointing to it being the hottest period for over 115,000 years.<sup>2</sup> Perhaps they will point to the UK parliamentary vote to back renewal of the Trident nuclear weapons system.

Or will there be a different emphasis in history books? Perhaps they will highlight the overwhelming vote in the UN General Assembly – little noticed at the time – to begin the first formal negotiations on a global ban of nuclear weapons.<sup>3</sup> They may point to the growing domination of the global renewable energy industry – especially wind and solar – where investment in new capacity during the year was double that in fossil fuels and ten times that in nuclear power.<sup>4</sup> Leading commentators highlighted the similarities between the exponential growth in (especially) solar photovoltaics and battery technology with the early years of the microprocessor and mobile phone revolutions.<sup>5</sup> At the same time, the size of funds committed to divesting from some or all fossil fuel industries reached a massive \$5 trillion.<sup>6</sup>

Then there was the news that more UK electricity was generated from wind than from coal over the whole year for the first time in history.<sup>7</sup> All this contributed to the continued halt in the growth of global greenhouse emissions – flat for the third year in a row – despite continued economic growth.<sup>8</sup> Perhaps historians will highlight Poland becoming the latest country to destroy its stockpile of anti-personnel mines, meaning 158 nations now hold no stocks.<sup>9</sup> Or Sri Lanka's declaration that it is now malaria-free – against the background of a large fall in recent years in the global number of deaths from the disease.<sup>10</sup>

There is little doubt that 2016 was a tough year, with many policies and trends heading in the wrong direction. And the initial signs from Donald Trump indicate that his time in office will present a huge challenge across a whole range of peace, social justice and environmental issues. But we should take heart from where important progress is still being made – and redouble our efforts. There is too much at stake to lose hope.

**Dr Stuart Parkinson, Executive Director**

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## The new National Co-ordinating Committee

The election for SGR's National Co-ordinating Committee for the coming year was held during the Annual General Meeting on 19 November 2016 (see report on p.20). The following were elected:

Chair: Dr Philip Webber  
Vice-chair: Dr Jan Maskell CPsychol  
Treasurer: Alasdair Beal CEng

Committee members:

Martin Bassant MPhil; Gwen Harrison MSc; Dr David Hookes; Dr Paul Marchant CStat, Dr Charalampos (Harry) Tsoumpas

Martin Bassant has since been co-opted to the post of Secretary.



Most of the NCC and staff:

(upper rows, left to right): Paul Marchant, Philip Webber, Harry Tsoumpas, Gwen Harrison, Alasdair Beal  
(lower rows, left to right): Stuart Parkinson, Vanessa Moss, David Hookes, Jan Maskell, Philip Wood

## Nuclear disarmament activities

In recent months, SGR has worked with local, national and international campaigners to challenge nuclear weapons.

SGR's summer activities were, of course, dominated by the parliamentary vote on renewing Trident. Although long promised, the vote was announced by incoming Prime Minister Theresa May with less than two weeks' notice. Nevertheless, we worked quickly with CND, ICAN and other peace groups to raise the profile of the issue in the media and to pressure MPs.

Our highest profile activity was a letter signed by Prof Stephen Hawking, Nobel Prize recipient Prof Peter Higgs and 12 other leading scientists and engineers calling for MPs to vote against renewal of the nuclear weapons system. The letter was published in the *Daily Telegraph* and achieved a great deal of coverage via social media. The coverage led to over 20,000 visits to the SGR website alone.

SGR's Chair, Philip Webber, Director, Stuart Parkinson, and Office Manager, Vanessa Moss, also took part in a parliamentary lobby shortly before the vote, distributing our Trident report to MPs and campaigners. Committee Member, David Hookes, spoke at an anti-Trident rally in Liverpool the day of the vote. He also attended conferences discussing

new technical evidence about Trident's potential vulnerabilities to underwater drones currently under development. Despite all this effort, the parliamentary vote was lost – but our arguments reached a wider audience than ever, and we will not give up our struggle against these weapons of mass destruction.

During the summer and autumn, we worked with ICAN and Nukewatch to highlight the risks of UK nuclear weapons – especially their transportation by road convoy through the UK from the AWE in Berkshire to Faslane naval base not far from Glasgow. Stuart Parkinson spoke at public meetings in Preston and Lancaster – two of the cities on the route – as well as being interviewed on BBC Radio Lancashire. The meetings led to local councillors in Lancaster raising concerns with emergency planning bodies.

SGR also took part in campaigning activities centred on the UN vote in October on whether to start formal negotiations on a treaty to ban nuclear weapons. We co-signed a letter to Foreign Secretary Boris Johnson calling on the UK to support this multilateral initiative. The UN vote emphatically went in favour, but Britain and most NATO countries decided to join Russia in voting against. Notably China, India, and Pakistan abstained and North Korea voted in favour. The

## Lobby your MP

Join the parliamentary lobby on 1st March calling for the UK to support a global nuclear weapons ban treaty at the UN

Details from: [cnduk.org](http://cnduk.org)

formal negotiations will begin in March and SGR is continuing to work with other campaign groups to help achieve a successful outcome.

With Donald Trump now US President and the latest revelations about the 'misfire' of a UK Trident missile last year, the risks of the continuing deployment of nuclear weapons are again the public mind.

### Other activities

- In October, SGR responded to the Liberal Democrats' policy review on nuclear weapons.
- In November, David Hookes gave a presentation on Trident in Stockport.
- In December, Philip Webber supplied research material on the nuclear winter to a project run by the British American Security Information Council.

## Science4Society Week 2017

SGR is once again gearing up for Science4Society Week, this year running from 13th to 19th March. The project now has a dedicated website – [s4s.org.uk](http://s4s.org.uk) – where a wide range of teaching materials can be downloaded. These cover six topics – energy, food, water, transport, health, and materials – with resources searchable by subject, age group or type of activity. The types include debates, problems solving activities, games, practical activities and quizzes. All resources are designed to be compatible with the national curriculum. In addition, we are running a competition and visits to eco-projects.



Testing home-made water turbines

For more details, see the website above, or contact Jan Maskell on [<janm@sgr.org.uk>](mailto:janm@sgr.org.uk) or via the SGR office (see back page).

## Peaceworker

In the autumn, we welcomed a new project worker, Philip Wood, whose post has been generously funded by Quaker Peace and Social Witness under their 'peaceworker' scheme. His project is focused on the links between science and engineering organisations and the arms and fossil fuel industries. A report will be published later in the year.

He is looking for help for this work from SGR members, especially if you are also a member of a professional science and engineering institution. Please contact Philip at [<pwood@sgr.org.uk>](mailto:pwood@sgr.org.uk) or via the SGR office (see back page) if you can help, or would like more information.



## Tom Kibble 1932 - 2016



We were deeply saddened by the death, on 2nd June 2016, of Professor Sir Tom Kibble, KBE, FRS, celebrated physicist, active SGR member and one of our long-standing patrons. He was also a founder member of the Martin Ryle Trust (MRT), associated with SGR.

Tom played a major part in the theoretical physics leading to the search for and eventual discovery of a long-anticipated particle, now known as the Higgs boson, discovered at CERN in 2012 and for which several close colleagues were awarded the Nobel Prize.

### Socially responsible scientist

Tom Kibble joined the British Society for Social Responsibility in Science (BSSRS) soon after it was formed, and was a member of its National Committee from 1970 to 1977, and chair from 1974 to 1977.

In 1973 he was one of five far-sighted authors of an Oxford Economic Paper rebutting a wild attack by economist Wilfred Beckerman against 'Limits to Growth'. They end their response with "It is surely astonishing that someone who claims to be more interested in human beings than are the natural scientists can contemplate with apparent equanimity the prospect of a world in which country after country suffers a catastrophic decline of population through starvation and disease ... If this is their idea of humanity, God save us from humane economists!"

Many of us in SGR first got to know Tom in the 1980s through the formation of SANA (Scientists Against Nuclear Arms, SGR's predecessor). He was on the

National Coordinating Committee from 1981 to 1991 and chair from 1985 to 1991. He was also a trustee of the Science and Society Trust and, to the end of his life, of the Martin Ryle Trust.

Tom was always a most modest man but one who had a quiet and persistent commitment to social justice and peace. All of us were impressed at how such an eminent physicist was prepared to take a public stand on issues of common human concern. He believed that the duty of scientists is not only to discover but to ensure that our discoveries are applied to benefit and protect mankind and its common future.

Back in the 1980s the chief concern during the Cold War was the imminent possibility of nuclear destruction. As time went on these concerns included the so-called Star Wars project (SDI, or Strategic Defence Initiative), climate change and opposition to the UK nuclear weapons system.

Tom was Chair of the Organising Committee of the Second International Scientists' Congress, held at Imperial College in 1988. It was a bold initiative by organisations (the International Network of Engineers and Scientists; and, locally, SANA) with little money but strong commitment. Major figures present included Robert McNamara, a former US Secretary of Defense who turned from poaching to gamekeeping, and, from the USSR, Roald Sagdeev, who worked with Mikhail Gorbachev to reverse the nuclear arms race. Tom was also a co-editor, with John Hassard and Patricia Lewis, of the published proceedings: *Ways Out of the Arms Race* (1989).

### Distinguished physicist

In 1970 Kibble was appointed Professor of Theoretical Physics at Imperial College, London, and was Head of the Physics Department from 1983 to 1991. He retired in 1998 and was Emeritus Professor and Senior Research Fellow until his death. He was elected a Fellow of the Royal Society in 1980, awarded a CBE in 1998 and a knighthood in 2014.

His main research studies were in quantum field theory and elementary particles. He played a major part in the application, in the mid-1960s, of symmetry-breaking to the Standard Model of the elementary particles. This work potentially resolved a major problem in that model (that all particles 'should' have zero mass) but it required the existence of a new particle, unobserved because its mass lay beyond the reach of the particle accelerators of the time.

The long-anticipated particle, known as the Higgs boson, was discovered at CERN in 2012. Tom commented on the excitement generated by this discovery "It felt quite surreal, actually. To find that something we'd done that long ago was again the focus of attention is certainly not a normal experience."

Later he was a pioneer in the study of topological defects and phase transitions in the early universe and in condensed-matter physics.

He received many prestigious physics and theoretical physics awards, including, posthumously, the Isaac Newton Medal. Two other recognitions of Tom reveal his generous nature. In 2005 he was one of two winners of the first Nature/UK National Endowment for Science, Technology and the Arts (NESTA) awards for mentoring in science; and in 2008, he was named an Outstanding Referee by the American Physical Society.

In 2016, Tom had been unwell after what he casually referred to as a "routine" heart procedure, which however had various knock-on health impacts. He nevertheless continued working until May with other Trustees towards the first Martin Ryle Trust Annual Lecture which took place at Conway Hall in London on 14th September. Those of us working closely with him were profoundly dismayed and shocked when he was taken ill and died in early June. The Trustees dedicated the talk given by Sir Michael Atiyah to his memory.

Tom is greatly missed.

Alan Cottey and Philip Webber

## SGR patron wins top science award

SGR patron Prof Jenny Nelson, Imperial College London, has been awarded the prestigious Michael Faraday Medal by the Institute of Physics. This is for her pioneering work in the physics of photovoltaic devices, advances which lay the foundations for cheaper solar cells.

For more details, see: [http://www.iop.org/about/awards/gold/faraday/medallists/page\\_67610.html](http://www.iop.org/about/awards/gold/faraday/medallists/page_67610.html)

## Derek Sugden 1924 - 2015

Derek Sugden, who died at the age of 91 on Christmas Eve 2015, became a sponsor of Architects for Peace soon after the formation of that organisation in 1981. Through subsequent mergers, the architects became part of SGR in 2005, and Derek continued in this role.

Derek trained as an engineer at Westminster Technical College, joining Ove Arup in 1953. He was one of the founding fathers of the inter-disciplinary practice, Arup Associates in 1963. He was dedicated from his earliest professional life to providing a decent humane environment, whatever the building type or function. Like Ove Arup himself, Derek was a life long socialist and totally supported Ove's commitment to "integrated design". Because of his close collaboration with architects and great contribution in the field of acoustics, in 1992 he was elected an honorary Fellow of the Royal Institute of British Architects (RIBA). He believed that hearing "provide definition of the nature of space".

His memorial celebration was held appropriately in the Hawksmoore masterpiece, Christ Church

Spitalfields. Derek had advised on the acoustics in the early 1980s, during the restoration of this, his favourite London building. At this event, Jane Wernick related how, when she was employed within Arup, she was troubled by the proposed acceptance of a commission for Arup engineers to design part of the Polaris nuclear missile base in Coulport. Though this had met with some opposition within Arup Associates (the architectural wing of the Arup empire) the engineers seemed untroubled by this departure from the Arup ethic, as set out in Sir Ove's Key Speech. Feeling isolated, she wrote a letter to all the partners setting out her concerns. From this initiative sprang support and a lasting friendship with Derek.

Derek is particularly associated with the conversion of the Snape Maltings and later its re-building in 42 weeks after it burnt down in 1969. His great love of and understanding of music led to a close collaboration with leading composer Benjamin Britten. At a time when engineers (and most architects) were totally without any training in respect for the value of old buildings, Derek and his team approached this old structure with great sensitivity.

He wrote of the "realisation of ideas inherent in a building".

Other projects requiring an expert understanding of acoustics followed, notably: Holy Trinity Church Southwark, converted as Henry Wood Hall; the reconstruction of the Theatre Royal Glasgow for Scottish Opera; and the Music School for the University of East Anglia.

In 1980, Derek founded Arup Acoustics as a consultancy together with Richard Cowell. This set up its base in Winchester, where I had the benefit of their advice for the school hall of my design for Solent Infants. The sound in the hall proved excellent for both speech and music.

Derek was a rounded man of wide interests, who maintained his curiosity, generosity and joie de vivre throughout his 91 years.

**Kate Macintosh**

## Other peace activities

SGR's other activities supporting the peace and anti-militarist agenda have focused on two main areas in recent months: the militarisation of science and technology; and arms conversion.

In the autumn, SGR joined with other peace campaigners to speak out against proposals for a new EU budget for military R&D. This was planned to total 90m euros over the next three years. SGR's criticisms were carried by leading science journal *Nature* and the *Science Business* website. However, the European Parliament still voted to approve this spending.

Stuart Parkinson spoke about military influence on UK science and technology at the World Congress of

the International Peace Bureau in Berlin, and also at the Peace Pledge Union's AGM in London. David Webb covered similar issues in a presentation to international peace campaigners in Geneva. He also spoke about scientists and war at a peace history conference in Bradford.

In December, the House of Commons' Science and Technology Committee launched a call for suggestions for topics for future inquiries. SGR's submission made the case for investigating military influence on UK science and technology.

Regarding arms conversion, in November, SGR supported a conference to mark the 40th anniversary

of the Lucas Plan, a set of proposals presented by workers at Lucas Aerospace to convert the factory from manufacturing arms to building renewable energy technologies and other socially-useful work. Stuart Parkinson spoke at the event on recent UK experience in arms conversion. SGR also provided information for a trade union pamphlet on arms conversion.

Other activities:

- In October, SGR was a signatory of a civil society statement on armed drones presented to the UN General Assembly First Committee.
- In January, SGR made a submission on armed forces involvement in schools to the Scottish Parliament's petition committee.

## Climate and other activities

- SGR supported campaigns led by Art not Oil against oil industry sponsorship of high profile museums, including Statoil's support for the Science Museum and BP's sponsorship deal with the British Museum.
- Stuart Parkinson spoke at a workshop on rapid transitions at the Tyndall Centre for Climate Change Research, Manchester University.

- Numerous SGR members signed a petition to the American Geophysical Union regarding its sponsorship by ExxonMobil.
- SGR supported the campaign by the Solar Trade Association against the abolition of a tax break for the UK solar photovoltaic industry.
- SGR provided inputs to two European academic groups concerning ethical issues in science.

- SGR supported an international call for a moratorium on 'gene-drives' at negotiations under the UN Convention on Biodiversity.
- Stuart Parkinson took part in a debate on BBC Radio 5 Live on the ethics of spaceflight. In particular, he highlighted the large environmental impacts of human spaceflight.

## Could Trident be hacked?

**Aleem Dattoo, British American Security Information Council (BASIC), outlines just how vulnerable the UK's nuclear weapons system is to cyber security threats.**

Following global trends, UK military operations are increasingly dependent on a range of interconnected cyber networks. Cyber security for these military systems needs continuous assessment. The UK's Trident system<sup>1</sup> is particularly susceptible as a high-value target to a potential adversary and its elaborate design. All military systems have cyber vulnerabilities, and Trident is no exception.

The term 'cyber' comprises all components that relay digital information including both software and hardware and the human control, and a cyber attack is one that disrupts cyber dependent systems. Contrary to popular belief, the short history of cyber warfare has already proven<sup>2</sup> that 'air gapping'<sup>3</sup> a system is no assurance of invulnerability. A cyber attack can involve the introduction of malicious software or hardware at any point during operation, construction, overhaul or maintenance. A particular piece of malware can lay dormant and undetectable by the operators until it is activated by time delay, algorithm design or remote trigger.

The diversity of infection points, the vast number of computers, lines of code and pieces of hardware that form Trident's cyber system mean the vulnerability is real. A Cyber Primer published by the British government reported that in 2008 that a cyber worm from Ukraine penetrated all systems using Windows operating systems including those in the Royal Navy, the MoD's administrative systems and the House of Commons.<sup>4</sup> Royal Navy submarines use 'Windows for Submarines',<sup>5</sup> significantly more susceptible to malware than a bespoke system based upon Linux.<sup>6</sup>

The Trident system receives regular maintenance and patch-ups involving updating both the software and hardware, and this is when it is most vulnerable to the introduction of malware. This vulnerability will extend to the Successor submarines – now named 'Dreadnought' – whilst their software programs are written and hardware components are being designed by several private companies. Infiltration may not be immediately apparent and would likely involve remote or pre-programmed activation,<sup>7</sup> making an attack both difficult to identify and defend against. The effects that malware could have are varied. Its purpose could be to gather information, such as design details or

the location of the submarine (rendering its stealth qualities futile). It could even impact or neutralise the basic function of the submarine or missiles.

Countermeasures are not simple. It is possible to build rigorous software defences against penetration and use 'red teams' to identify holes to be patched, but dealing with millions of lines of code based on a stock Windows system it is impossible to guarantee the system.<sup>8</sup> It is possible to reinforce the security of hardware design and maintenance, but much of this is conducted outside the UK or within private organisations not explicitly accountable for UK Trident's cyber security.<sup>9</sup>

According to the US Defense Science Board (DSB), the annual cost of reinforcing its cyber vulnerabilities is \$500 million.<sup>10</sup> In a 2013 report, they claimed "most of our [nuclear deterrent] systems have not been assessed against a [high] tier cyber attack," and will look to address the military cyber vulnerabilities through the Third Offset Strategy.<sup>11</sup>

UK Defence Secretary Michael Fallon's attempts to give assurances in the context of growing concerns around cyber security for Trident in early 2016 rang somewhat hollow. "As for cyber-attack, while deployed, submarines operate in isolation. It is hard to think of a system [Trident] less susceptible to a cyber-attack."<sup>12</sup> Despite the UK's 2015 Strategic Defence and Security Review that promised £860 million for cyber security,<sup>13</sup> and despite the tests and inspections conducted on Trident systems by the Royal Navy,<sup>14</sup> Fallon's comments suggest a lack of understanding around the nature of cyber vulnerabilities.

States are directing significant resources into their offensive and defensive cyber capabilities. This, coupled with a critical lack of rules of engagement and mechanisms of attributability, necessitate an attention for all nuclear armed states to invest heavily in cyber defences for their systems, though it will never be possible to provide complete cyber security. The UK needs to conduct continuous and thorough assessments of the vulnerabilities to Trident, and the cyber dimension feature more in its decision making over the Successor Program. The danger that Successor submarines could become a significant security liability for the UK is real.

**Aleem Dattoo is a researcher with BASIC, and lead author of a briefing on Trident's cyber vulnerabilities.<sup>15</sup>**

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## Get it from the Sun: expanding renewable electricity

**Keith Barnham, Imperial College London, outlines plans for an exciting new campaign to encourage continued expansion of electricity from renewable sources in the UK.**

A proposal for a new campaign *Get it from the Sun* (*GIFTS*) is currently being circulated to interested parties. The aim is to maintain the expansion of renewable electricity in the UK despite the removal of most of the subsidies that in recent years had successfully stimulated an exponential rise in demand and supply.<sup>1</sup>

The responsibility for maintaining this expansion now falls on the individuals, communities and companies that are primarily motivated by the imperative to halt climate change rather than a guaranteed income. At the local level, community energy and transition groups, schools, colleges, town councils and local authorities continue to strive to overcome the barriers that the government has erected in its attempts to halt the expansion of solar photovoltaics (PV) and onshore wind by 2020.<sup>2</sup> Additionally, all-renewable electricity supply companies continue to grow in strength and in number. Furthermore, some environmentally aware commercial investors can see beyond the loss of a secure income stream to the long-term growth of renewable power demand as the effects of climate change become more obvious and more severe.

*GIFTS* will aim to facilitate information exchange and cooperation amongst the local groups and between them and all-renewable supply companies and environmental investors. The Nuclear Free Local Authorities (NFLA) have already given support and advice to *GIFTS*. Discussions are underway with other campaign groups and local authorities.

The main proposal to stimulate new demand is a national challenge to identify the local region of the UK that is first to achieve a truly all-renewable electricity supply. There will be awards in several categories: for example, the first school, first town, first local authority or first home country to reach a certain percentage of renewable energy penetration. Below I sketch out how such a competition could be implemented and refereed.

### What is an all-renewable electricity supply?

The German *Kombikraftwerk* project<sup>1</sup> was the first to demonstrate that the electrical power demand on the national grid can be met every hour of the day and 365 days a year with approximately 80% of PV plus

wind power, as long as the remaining 20% is provided by flexible power generators, ideally bio-electricity. Less than 5% storage power is necessary. In co-operation with the Centre for Alternative Technology (CAT), a spreadsheet (the *GIFTS* software) has been written that confirms this important result for the UK national grid.

Scotland has set a 2020 target to generate as much electrical energy in a year from renewable sources (in particular, wind) as the amount of electricity energy consumed in Scotland in that year. An hour-by-hour, 365 days-a-year, all-renewable electrical power target is more challenging. In fact, Wales and Northern Ireland could be first to achieve this stricter goal as Scotland is some way from its bio-electricity target. Also, Wales and Northern Ireland have higher sunshine resources (Northern Ireland through its new power link with Eire).



### *GIFTS*: The Programme

The *GIFTS* software is based on, but much simpler than, the two German *Kombikraftwerk* projects. It is an 8,760 row Excel spreadsheet, one row for each hour in the year. One column contains the total electrical power demand on the UK grid for each hour. The next column contains the UK wind power resource for that hour followed by a column in which this wind resource is scaled to a chosen value for the total installed wind power capacity. The next two columns repeat this calculation with solar resource data, to give the UK PV power resource scaled to a chosen PV power capacity. The next column sums the wind and PV contribution and so represents nature's *GIFTS* of power to the UK hour by hour.

It is very impressive to see that, if the installed wind and PV power capacities are chosen to be appropriate to an all-renewable UK, how many hours of the year nature's gift of wind plus PV power is a reasonable first approximation to the electricity

demand. On most days in the year the PV contribution peaks around mid-day as does daytime electricity demand.<sup>3</sup>

The remainder of the spreadsheet performs calculations to determine how much storage and flexible bio-electrical back-up is needed to ensure that renewable supply is greater or equal to electrical power demand every hour of every day. If PV plus wind supply is greater than demand, the excess is stored, if there is capacity to take it. If electricity demand exceeds PV plus wind supply, the deficit is made up either from storage or by flexible bioelectric power. Hence the spreadsheet ensures electrical power supply equals (or surpasses) electrical power demand every hour of the year – and the lights stay on.

This relatively simple programme agrees with the much more sophisticated *Kombikraftwerk* analyses. The electricity demand of Germany and the UK can be met by around 80% wind power and PV. The ideal back-up is 15%-20% of flexible bio-electrical power and 0%-5% storage.

### How to enter the *GIFTS* Challenge

The following suggestions for the rules of the competition are being circulated to a sample of potential competitors for their feedback.

The data required for the *GIFTS* software that will referee the competition is the cumulative total of locally owned PV and onshore wind power installations plus the amount of electrical energy supplied to residents and organisations generated by an all-renewable electricity provider in the current year.

Competitors responsible for waste collection in their area can also submit a figure for the electrical energy equivalent of the total of bio-degradable waste they have sent for anaerobic digestion to bio-methane in the year in question. Competitors not responsible for waste collection can submit the electrical energy provided by all-renewable electricity suppliers in their area as their flexible back-up to wind and PV.

In local areas where hour-by hour power demand is not measured, the demand of the larger region which includes this area can be scaled by the relative populations.

With this data the software will be able to issue certificates stating the proportion of their electrical



# Feature Articles

power demand provided by renewables in that year. Awards will be made to the first competitor in each category to reach the 10%, 20%, 30%... levels of renewable penetration.

## How soon can we expect a winner with 100% renewables?

Given data for earlier years, *GIFTS* software will be able to predict how long it will take to reach the all-renewable target. It may be that the 100% target is closer than expected. Before renewable subsidies were cut the renewables were expanding exponentially in the UK. PV and wind power were expanding so fast that, had the subsidies not been cut, they would have achieved their individual targets by 2022.<sup>1</sup> Bio-electricity was expanding more slowly, but an all-renewable electricity supply could have been achieved in the whole of the UK by 2025. Given the cuts, this is now very unlikely. However, pessimistic assumptions about future expansion rates suggest it should still be possible by 2030.<sup>2</sup>

In local regions of the UK it could be much earlier, particularly as the *GIFTS Challenge* rules allow the power contributions from all-renewable electricity suppliers to individuals and institutions in the area to count as flexible back-up. This is in practice the situation in households, schools and organisations with PV who have switched to an all-renewable supplier.

There will need to be three categories for schools: those that have installed PV; those where installation is in progress; and those who haven't yet started. To have a truly all-renewable electricity supply, all those in the former category have to do is to switch their back-up to an all-renewable supplier. There may be a winner out there already! The winners in the other categories will have to install their PV and probably switch back-up supplier. There could be two exciting contests in the next year or so!

## What can be learnt from successful internet campaigns

Internet campaigns and NGOs played a major part in the success of the Paris climate negotiations. The *Keep it in the Ground* campaign (run by the environmental organisation, 350.com) has been successful in achieving large levels of divestment from fossil fuel companies. However, the UK government has ploughed on regardless, cutting renewable energy subsidies and boosting those for fossil fuels while planning a UK electricity supply system for 2030 with a carbon footprint above the recommendation of its own advisory body, the Committee for Climate Change, and certainly in no way consistent with the Paris Agreement.<sup>2</sup>

*GIFTS* will be complementary to *Keep it in the Ground* as it will concentrate on reducing the demand for fossil fuels rather than the supply. *Keep it in the Ground* could support *GIFTS* by encouraging the switch to an all-renewable electricity supply by institutions that have divested.

The *RunonSun* campaign supported by Friends of the Earth and the *SolarSchools* campaign of 10:10 played a major part in the extremely successful expansion of PV in schools when feed-in tariffs operated. *GIFTS* aims to step into the gap left by the winding-up of both campaigns. Local authorities will be encouraged to organise to bulk purchase electrical power for schools at lower rates freeing up more funds for teaching.

## Scope for local participation

One of the advantages of the *GIFTS Challenge* is the scope for participation in monitoring local performance. For example, using real-time hourly output of local wind and PV generators would help to make targets and performance more realistic, particularly if local demand figures can be used as well.

School pupils will be able to compare the output of their PV (with the software usually supplied by the PV installer) and the school demand hour by hour. Students will be able to study how often daytime supply and demand have similar hourly variation. They can also work out in which months their PV system produces more electrical energy than the all-renewable flexible backup.

Interest in the renewables in junior schools can be enhanced by playing the games which demonstrate how solar cells and silicon chips work, described in the animation *Quantum Theory is Child's Play*.<sup>3</sup> *GIFTS* could coordinate a competition to see which junior school could produce the best video of the final game, which explains how solar cells power electric cars.

Recent press reports describe artificial trees carrying many small vertical axis wind turbines. These are not only elegant but particularly suitable for the urban environment<sup>3</sup> which surrounds most schools. For a school that already has PV and an all-renewable back-up, the addition of one of these trees would

enable them to study the complementary nature of wind and PV resources, and check for themselves whether they together can provide 80% of the power requirements of their own school.

**Keith Barnham is an Emeritus Professor of Physics and Distinguished Research Fellow at Imperial College London, London. He is author of *The Burning Answer*,<sup>3</sup> and also a Patron of Scientists for Global Responsibility.**

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## Get involved

I would be interested in feedback on the planned campaign and suggestions for potential improvements. Contact: [k.barnham@ic.ac.uk](mailto:k.barnham@ic.ac.uk)



## Universities, democracy and science: the UK Government's neo-liberal knowledge regime

**John Holmwood, University of Nottingham, critically examines the increasing commercialisation and privatisation of UK universities, as demonstrated by the new Higher Education and Research Bill.**

The UK Government's Higher Education and Research Bill<sup>1</sup> is currently passing through Parliament. It completes the radical transformation of higher education set out by the coalition Government in 2011. The explicit intention was to reduce public spending after the financial crisis of 2008 by shifting its costs from tax payers onto students via loans (and, of course, onto the same students as future taxpayers once the repayment shortfall becomes a cost on the exchequer).

The passage of the Bill has not been delayed by the vote to exit the European Union, notwithstanding that the vote promises to severely disrupt higher education with respect both to the recruitment of overseas and EU students and EU funding for research. Perhaps this sanguine attitude on the part of Government is to do with the very intention of the Bill which is to 'disrupt' higher education by a radical programme of marketisation and privatisation.

### Dismantling a world-class system

The Bill was preceded by a White Paper,<sup>2</sup> which described higher education in the UK as world-class, with "globally renowned teaching and cutting-edge research and innovation." Yet it proposed fundamental changes to the very frameworks that have hitherto guaranteed this success and threatened the wider public goods that universities provide.

The only benefits that the Government recognises are the private benefit deriving from investment in human capital – hence 'student beneficiaries' should pay through fees – and the contribution to economic growth. But this economic growth is not inclusive. Indeed, the Government's version of a knowledge economy has made the UK the most unequal country in the European Union (and one of the most unequal in the world).

The minister, Jo Johnson, has expressed his concern for social mobility and the need to increase the number of students from disadvantaged backgrounds at what he calls the 'top' universities. However, the Government has also ended

maintenance grants for the poorest students, replacing them with loans. At the same time, it wants to increase provision by for-profit providers, institutions that, wherever they are found, are associated with poor student outcomes, with spending more on marketing and profit-sharing than on teaching, and with targeting students from low income backgrounds and returners to education.

The Bill proposes to allow for-profit providers to have access to the full range of fees and to have the title of university, with degree-awarding powers. It seeks to speed up the process by which they gain such recognition. They call this the creation of a 'level playing field', yet private providers are relieved of obligations to conduct research or to contribute to their local communities. At the same time, they are allowed to put existing universities with those functions under direct competitive pressure. The level playing field is open to 'free riders'. This is the context in which the Government 'expects' the closure of institutions – indeed, it regards such closures as the sign of a healthy market.

The Government makes much of the importance of institutional 'autonomy'. However, this is not the 'autonomy' traditionally associated with the independence of university teaching and research, but that of a market-based corporate agent. At the same time, neo-liberal public policy also requires strong centralised direction which is precisely what the Bill provides.

Teaching and research are to be divided between two regulatory offices, the Office for Students and UK Research and Innovation (UKRI), a separation made necessary by the entry of for-profit, teaching only institutions. Privy Council Charters of older universities are to be revoked,<sup>3</sup> as are the Royal Charters of the Research Councils. The provisions for each office give powers to the Secretary of State to intervene directly (and by nominee) in their direction. These will be executive powers unconstrained by scrutiny by Parliament, or by Privy Council. In the case of teaching, it includes powers that go beyond quality assurance of teaching standards to influence the content of the curriculum. We have also seen Government indicate a willingness to use the new Teaching Excellence Framework as an instrument of immigration policy by proposing to limit overseas students to institutions and courses in line with their TEF 'medal' score.<sup>4</sup>

In the case of research, the Secretary of State has reserved powers to determine decisions about research funding. Notwithstanding debate about the precise meaning of the 'Haldane Principle',<sup>5</sup> it was recently affirmed as entailing; "that researchers are best placed to determine detailed priorities; that the government's role is to set the over-arching strategy; and that the research councils are 'guardians of the independence of science'."<sup>6</sup> In the Green Paper and White Paper that preceded the current Bill, the Haldane Principle was affirmed along with principle of dual-funding, but there is no mention of it in the Higher Education and Research Bill. This is unsurprising given that the role of Research Councils as 'guardians of the independence of science' is now under the direct authority of the Secretary of State.

The merger of Research Councils and Innovate UK within UKRI also indicates that the over-arching strategy will increasingly be 'outcome-oriented' and concerned with economic impact. Paradoxically, despite the emphasis on a knowledge economy, investment in research and development has declined, with the UK once leading such investment (in terms of proportion of GDP) in the OECD to now one of the lowest.<sup>7</sup> In the context of wider neo-liberal policies, Government has fewer levers to increase necessary investment in the private sector. In consequence, universities are now to be directed to resolve the failure of private investment, notwithstanding the claim that markets are efficient and need only to be facilitated in their operation.



**John Holmwood points out the flaws in the Higher Education and Research Bill at the 2016 SGR conference (see p.20)**

It is precisely the short-term orientations to profit and shareholder value associated with neo-liberal policies that explains the decline in private investment. However, the impact agenda for university research is itself designed to shorten the time from 'idea' to

# Feature Articles

'impact' ('income'). Yet as both Philip Mirowski<sup>8</sup> and Marianna Mazzucato<sup>9</sup> have shown that not only do neo-liberal policies seek to socialise risks while privatising rewards, but they also encourage university research to re-direct their research toward activities that can provide short term returns favoured by venture capital.

With the emphasis on competition for funding, university strategies are directed toward research-grant capture and mirroring of (Government-approved) strategic priorities. There is convergence on 'challenges' that do not derive from the curiosity of researchers, but from the setting of targets and framing of topics by senior research policy-makers within universities and within Research Councils. Increasingly, all universities direct their research toward the same thematic priorities, including an emphasis on applied problem-solving interdisciplinary research. This undermines the significance of the very dual-funding system by aligning funding based on past research with funding for future research and puts both in the hands of managers whose own interest is revenue over research.

## Where are the defenders of the public university?

I began this piece with the UK vote to leave the European Union. One of the key moments of the debate was Michael Gove's declaration that people have "had enough of experts". *The Times Higher Education* has recently referred to "a populist politics hostile to campus culture",<sup>10</sup> and many within universities have, indeed, felt the chill of populism directed against evidence-based argument. But what of 'campus culture'?

Part of the problem is that there has been a failure to defend the university as an independent institution of the public sphere serving public debate. Government has defined the benefits of the university in terms of private economic benefit (and, in the impact agenda, contribution to Government policy). University vice-chancellors have sought to maximise income and, therefore, have avoided direct public criticism. The

Russell Group has supported all policies that might increase the proportion of income it receives.

The Campaign for the Social Sciences, for its part, produced a report, tellingly called *The Business of People*,<sup>11</sup> designed for politicians and policy-makers prior to the last election in which it made no reference to the role of social science in democratic debate.<sup>12</sup>

Responsible science requires responsible publics and knowledgeable citizens. This should be one of the prime functions of universities. Yet recent government policy is designed to undermine that

function and place universities under government direction. And university leaders increasingly see their role as securing the bottom-line and protecting their brand.

Even as the Bill was receiving its third reading in the Lords, universities were already making their submissions to the new Teaching Excellent Framework arrangements that the Bill prefigured. Their mood was summed up by the Vice Chancellor of Warwick, Stuart Croft, in a letter to the Times Higher Education,<sup>13</sup> which was unusual only in making explicit what is at stake, "...the government has us over a barrel. It has linked the TEF to tuition fees and, potentially, our ability to recruit international students. The risks are too high. We submitted in both senses of the word." He writes further that the measures in the Bill, "threaten the very nature of the autonomy in universities that has made UK education the global success it is. The proposed measures treat education as if it is a commodity, just like any other."

Who now will defend the integrity of the university and its culture?

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## Write to your MP

Further information about the campaign on the Higher Education and Research Bill, including guidance for writing to your MP, can be found on the Convention for Higher Education website: <https://heconvention2.wordpress.com/>

## Britain's nuclear addiction?

**With official approval for renewal of the Trident nuclear weapons system and the Hinkley Point C nuclear power station coming within weeks of each other, the links between the military and civilian nuclear industries in the UK are again in the spotlight. Stuart Parkinson, SGR, investigates.**

Within a couple of months of taking office, the government of Theresa May firmly attached itself to pro-nuclear policies in both the military and energy sectors.

The first parliamentary vote of the new session in July 2016 gave the government the large majority it sought to give the final go ahead for the next generation of four nuclear submarines to carry the UK's Trident weapons. These submarines – now officially named 'Dreadnought' class – are expected to come into service from the early 2030s. The firepower of each vessel will be similar to the current generation – i.e. greater than all the bombs dropped in World War II, and sufficient to cause a nuclear winter.<sup>1</sup> The government has earmarked a budget of £41 billion for the construction of the submarines (including a £10bn contingency fund). Once annual running costs, new warheads and decommissioning are included, the total lifetime cost for the system is estimated to be about £200bn.<sup>2</sup>

Meanwhile, after a very short review completed in September, the government approved the contract with French energy corporation EDF to build the new Hinkley Point C (HPC) nuclear power station. This plant is planned to have a capacity of 3.2 gigawatts (GW), thereby supplying an estimated 8% of the UK's current electricity demand.<sup>3</sup> The construction cost of the plant is currently budgeted at £18bn – which could make it the most expensive object ever built on Earth. [3] This figure does not include an estimated £6.5bn of financial transaction costs or a wide range of government subsidies.<sup>3</sup>

Questions are increasingly being asked about whether the two programmes are connected – with a new study from the University of Sussex providing important new evidence. But before we examine that, it is worth reviewing whether HPC and the rest of the UK's current nuclear power programme is justified on its own terms.

### Hinkley – no economic case?

A report published by the National Audit Office (NAO) last July<sup>4</sup> is the latest in a long line of analyses that have concluded that the costs of HPC are

exceptionally high. In particular, the NAO warned that the current 'Contracts for Difference' subsidy scheme, which guarantees a minimum price for the plant's electricity, could cost energy consumers an extra £30bn over the 35-year lifetime of scheme – more than four times the estimate when the deal was agreed in 2013. A range of other subsidies – for example, for dealing with spent nuclear fuel, decommissioning and major accident insurance – will add further to the eventual bill. Meanwhile the costs of alternatives, such as wind and solar power, have fallen considerably in the last few years and are now well below those of nuclear. These downward trends look set to continue. The NAO report summarises the government's latest cost estimate for UK electricity generation in 2025.<sup>4</sup> Onshore wind and large solar will be about half the unit cost of nuclear, with offshore wind comparable in cost. Indeed, further analysis by Greenpeace shows there is good reason to believe that offshore wind will also be cheaper by then.<sup>5</sup>

But supply-side options are obviously not the only alternatives. Energy conservation options have long been neglected and should be a central aspect of national policy. Much has been written about the failings of the government's domestic energy conservation schemes since 2012 – including by SGR. Nevertheless, despite such failures, the government still projects that the UK's total electricity demand in 2025 will have fallen by 77 terawatt-hours (TWh) – which is three times the energy that HPC would produce.<sup>6</sup>

Then there is the issue of whether HPC will be built on time or to budget – or even at all. As we have discussed previously in the SGR Newsletter, there are many technical, legal and financial obstacles still to overcome. EDF is currently involved in building four other plants of this type – known as the EPR – around the world. The two under construction in Europe – in Finland and in France – are, respectively, nine years and six years late (to date), with construction costs in each case currently projected to be about *three times* the level estimated when the build began.<sup>7</sup> Furthermore, in the French case, the reactor pressure vessel is undergoing safety tests due to suspected weaknesses and, in the Finnish case, there is an unresolved legal dispute over the construction. The two other reactors currently under construction in China are four years late under a significantly less stringent safety regime.<sup>8</sup>

EDF's financial position is also precarious – which has led to its international credit rating being

repeatedly downgraded and calls into question its ability to deliver on HPC. EDF's net debt is more than 37bn euros, and it is already committed to carrying out reactor upgrade programmes on the French nuclear fleet currently valued at a massive 100bn euros,<sup>9</sup> as well as buying a controlling stake in ailing reactor company, Areva. In the last few months, another scandal has engulfed the corporation as the French nuclear regulator has found evidence that some safety records have been falsified.<sup>10</sup> 18 nuclear plants were shut down while new safety checks were undertaken. There are also outstanding European legal cases against the generous subsidies available to HPC.

Factors such as these have led leading financial commentators (not to mention political and environmental ones) to call for HPC to be scrapped. In particular, *The Economist* – not known for an anti-nuclear stance – dubbed the plant 'Hinkley Pointless' in an editorial.<sup>11</sup>

### ...and the rest of the UK's planned nuclear programme?

In total, there are currently proposals for 18GW of new nuclear power stations at six sites around the UK.<sup>12</sup> But the history of nuclear power in Britain over the last 60 years is one of repeatedly grand promises and repeatedly poor delivery – see Box. In 2006, Tony Blair announced that nuclear power "was back on the agenda with a vengeance",<sup>13</sup> but it has taken ten years simply for the government to sign a contract for construction to start on the first power station. Given the current situation with HPC, there seems little reason to be more optimistic about the whole programme this time around. Not only are costs likely to be as high as HPC, the other consortia involved also have serious problems. NuGen – which is planning to build at Moorside in Cumbria – is owned by Toshiba and Engie. Toshiba's financial problems are so major, it has just announced it will stop taking orders for new nuclear plants, throwing the whole project into doubt.<sup>14</sup> Horizon – which is planning a plant at Wylfa in Wales – is owned by Hitachi, which has major liabilities related to the Fukushima disaster. Compounding all this is the recent announcement that the UK will withdraw from the Euratom treaty as part of its Brexit plan – which has serious implications for the regulation and promotion of the industry.

In contrast, since Blair's infamous quote, the percentage of electricity from renewable energy sources in the UK has grown from just over 4% in 2006 to just under 25% in 2015.<sup>18</sup>

One argument often used to justify the extra costs of nuclear is its ability to provide constant 'baseload' electricity, in contrast to renewables such as wind and solar which are variable in their output. However, this argument has many flaws – not least that recent experimental and practical experience in countries such as Germany show that combinations of a range of renewable and storage technologies can and do provide a reliable supply.<sup>19</sup> Indeed, this is becoming cheaper and easier to do as the costs of these technologies fall. For example, the costs of lithium-ion batteries – one of the leading storage technologies – have been falling at a rate of 14% per year since 2007.<sup>20</sup>

Such experience is providing the basis for more projections of a non-nuclear future. For example, a study published in the leading science journal *Nature*,<sup>21</sup> has laid out yet another pathway towards 100% UK electricity generation from renewable energy sources, specifically wind, solar, biogas and storage technologies. New tidal power schemes, such as that proposed for Swansea Bay, increase the options further.

Even the government's own National Infrastructure Commission sees more promising options outside of nuclear. Its recent report on the UK's electricity system<sup>22</sup> recommends measures in three key areas – international interconnectors, energy storage, and energy demand flexibility – and argues these could save up to £8 billion a year in efficiency gains. Demand flexibility measures alone could be used to meet about 15% of peak electricity demand.

## Is there another reason for government and industry enthusiasm?

The UK government's enthusiasm for nuclear power seems out of all proportion to the performance of the industry. Even when we look further afield, this enthusiasm is mystifying. Internationally, there are few signs of the long-promised 'nuclear renaissance'. In Europe, for example, no other country has such ambitious plans as the UK, and even in China, the nation with the world's largest nuclear new build programme, it is dwarfed by the expansion in other energy technologies.<sup>15</sup>

However, the most striking indication of the mismatch comes from leading financial analysts, which shows that the worldwide investment in renewables was ten times greater than nuclear in 2015<sup>23</sup> – even when large hydroelectric plants are excluded. And this ratio looks likely to continue.

So what does the British government believe that others do not?

## UK nuclear power programmes – a history of major problems

The UK's nuclear power programmes have had an especially difficult history. They have suffered from long construction delays, major cost overruns and poor performance – as well as environmental problems.<sup>15,16</sup>

The first programme built Magnox reactors between the early 1950s and the early 1970s. In 1955, the scale of the programme was planned to be between 5 and 6 gigawatts (GW), but it was later scaled back to only 3GW due to a variety of problems.<sup>15</sup> The early reactors of this type were dual use, so they could produce both weapons grade plutonium as well as electricity. Such a design would later come back to haunt the industry – for example, North Korea is currently using a similar design to produce plutonium for its nuclear weapons programme, having obtained it on the pretext of building a plant for electricity generation.<sup>17</sup>

The second programme consisted of Advanced Gas-cooled Reactors (AGRs). These power stations were especially beset by major construction delays, cost overruns and poor performance, with the original completion date for the programme being pushed back from 1976 to 1989. Britain remains the only country in the world with AGRs, as no other country wanted to repeat our bad experience.<sup>15,16</sup>

Plans for a third programme were announced in 1979 by the Thatcher government, with the aim of building 15GW. But the poor economics meant only one Pressurised Water Reactor (PWR) was eventually completed in 1994 with a capacity of just over 1GW.<sup>15</sup>

Other British nuclear projects have also encountered major problems.<sup>15</sup> The Windscale Pile 1 facility, used to produce weapons grade plutonium, caught fire in 1957 spreading a plume of radioactive material around the surrounding area. The UK's fast breeder reactor programme – which ran from the 1950s until 1994 – cost many billions and never led to a commercial plant. Nuclear fuel reprocessing – carried out using several facilities – has been a technical and commercial failure. For example, one of these facilities – the MOX production plant – produced only 1% of its planned output and made a lifetime net loss of £2.2bn.

We should also not forget the legacy of radioactive waste. The latest estimate for the total cost of management and disposal is a staggering £110bn – and there is ample scope for this cost to rise further.<sup>15</sup>

A new study from researchers at Sussex University suggests a possible answer.<sup>15</sup> It finds that between 2003 – when the Blair government published a white paper labelling nuclear power "unattractive" – and his 2006 speech, there was intense activity by nuclear lobbyists making the case for a change in direction. Not very surprising, perhaps. But the crucial factor was the involvement of *military* nuclear lobbyists. It seems that they supported the case for a new civilian nuclear programme – together with major investment in nuclear skills – to help head off a shortage in the technical personnel they needed to maintain the UK's nuclear warhead arsenal and especially that needed to develop new nuclear reactors to power the next generation of submarines that would carry the weapons. Since Britain's nuclear weapons are only carried on submarines – and no other military platform – there was a fear that Britain could find itself pursuing nuclear disarmament by accident in the 2020s. Hence the Sussex study has exposed a hidden subsidy that the civilian nuclear programme will effectively provide for the extremely costly nuclear weapons programme.

Indeed, the nuclear interests not only convinced senior figures across the UK political spectrum of the need for new nuclear power using the current generation of large reactors, they also convinced them of the need to rapidly increase R&D funding for 'small modular reactors' (SMRs) intended for electricity generation. The Sussex study discovered that over 40 UK corporations are now active in both civilian and military nuclear work. Although the UK only has limited R&D experience on civilian SMRs, it does have 50 years of experience developing and operating military reactors in submarines – but whether this experience is sufficiently useful remains to be seen.<sup>24</sup>

There are numerous technical hurdles to overcome in bringing SMRs to commercialisation.<sup>24</sup> It is notable especially that other major nuclear nations with much more experience of both civilian and military nuclear reactors – such as the USA – are still at an early stage. The industry, however, appears bullish. But the commercial and technical case is far from convincing.



Gordon MacKerron, a professor of science and technology policy, has described it as “thin”.<sup>25</sup>

## An open debate

The UK government claims that it needs a large programme of new nuclear power to improve energy security, reduce carbon pollution and keep energy bills low. But they continue to fail to make a convincing case – especially when there is a wealth of evidence to the contrary. Now that there is new academic analysis revealing the crucial role of military nuclear interests in supporting this agenda, it is surely time to have a full and frank debate about what really are the best civilian energy options for the UK.

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## The landmine ban: 20 years on

**Steve Wright, Leeds Beckett University, looks at the achievements of campaigners and governments in reducing the casualties from landmines.**

2017 marks the twentieth anniversary of the adoption of the Ottawa Treaty that banned anti-personnel mines, more commonly known as landmines. Upon reaching such a milestone, it is important to reflect on how campaigners succeeded in getting the ban agreed and what has been achieved in the two decades since.

The Ottawa Treaty<sup>1</sup> defines a landmine as “a munition designed to be placed under, on or near the ground or other surface area and to be exploded by the

presence, proximity or contact of a person or a vehicle”. Such a precise definition doesn’t quite capture the horror of an indiscriminate weapon which transforms limbs into offal, and persists years after a military conflict is over, threatening the life of civilians and denying them access to valuable land to grow food, build schools etc. These explosive remnants of war had been placed in their millions – yet, through implementation of the treaty, considerable progress has been made on reducing the threat – see Box.

### Achieving the ban – and progress since

An insight into how the ban was achieved was provided recently when Leeds Beckett University awarded the founders of the Mines Advisory Group

(MAG), Lou and Rae McGrath, Honorary Doctorates of Law, for the tremendous work these brothers had contributed to the campaign to make the Ottawa Treaty a reality. At the award ceremony, Lou said: “The landmine campaign grew from a group of determined individuals with experience of the impact that landmines had on communities throughout the world, knowing it was an indiscriminate weapon that continued to maim and kill long after conflicts had ceased. When it began in 1992, emails were not the norm and there was no social media. Yet by 1997, when the treaty was signed the International Campaign network represented over a thousand human rights, medical, religious, children’s, peace, veterans, development, arms control, environmental, humanitarian and women’s groups from over 60 countries. The Mine Ban Treaty was brought about by civil society responding to a man-made catastrophe and forcing their governments to the table.”

Determination was an absolute necessity for the success of this campaign. In the early days of MAG, the McGrath brothers were working out of a caravan in Cockermouth in northwest England. Their primary focus was the practicalities of de-infesting countries like Afghanistan and Mozambique. Rae’s own book<sup>3</sup> provides a detailed account of the meticulous thought

### The Ottawa Treaty – key facts and figures<sup>2</sup>

Since the treaty came into legal force in 1999:

- 29 nations have been declared ‘mine free’ – out of 61 reported to contain mined areas. The remaining 32 nations have action plans to eliminate their mine-fields.
- 158 nations no longer hold any stockpiles of anti-personnel mines.
- 49 million mines have been destroyed by these nations.
- 162 nations have ratified or acceded to the treaty. However, six key nations – which together still retain stockpiles of tens of millions of mines – have yet to join the treaty. These six are China, India, Pakistan, Russia, South Korea, and the USA.

# Feature Articles



© MAG

De-mining with the Mines Advisory Group

which was put into these dangerous operations. Between 1989 and 2015, MAG achieved:<sup>4</sup>

- Destruction of over 300,000 landmines and over 150,000 cluster munitions;
- Removal of over 4 million other unexploded ordnance items; and
- Clearance of over 5,000 square kilometres of land, which it had released back to communities.

Such humanitarian demining was accomplished inch by inch, with much thought given to employing local de-miners, giving a livelihood especially to those who themselves had been victims of anti-personnel landmines. Women-only teams have been a particular feature.

Networks of non-governmental organisations were involved in this work – united through the International Campaign to Ban Landmines (ICBL) – and by 1999 when the Ottawa Treaty came into effect, production and deployment of landmines had already been halted in many parts of the world. Then, through implementation of the treaty, many of the large stockpiles were destroyed and large areas de-mined (see Box). The ICBL estimates that the annual number of deaths due to landmines fell from over 9,000 in 1999 to below 4,000 in 2014.<sup>5</sup>

This commitment and these results were not won without a price, however. MAG, for example, was at one point heavily in debt, as they expanded operations across the globe to places like Vietnam, Cambodia and Laos (where the US dropped more ordnance than dropped by all sides in World War II). Details of the full extent of the bombing were only declassified by the US in the 1990s.

Horrific pictures of people with their limbs blown off might be vital evidence of the deployment of inhumane weapons but they were so appalling that most of the public wanted to turn away. One of MAG's skills was employing key story-tellers and photographers such as Sean Sutton, who has brilliantly documented how mine-afflicted communities have tried to survive the peace.

The legacy has not just been the return of mine-free land to communities all over the world but also a bench mark on how civil society can actively challenge weapons deemed to be anti-humanitarian – and win. The civil society networks Lou McGrath talked about went on to win a further legal victory with the Convention on Cluster Munitions being adopted in 2008. 119 nations have now joined this treaty.<sup>6</sup>

## Unfinished business

The successes of these campaigns and treaties, however, should not obscure the fact that landmines, cluster bombs and other similar weapons still cause much suffering. For example, figures recently published show that in 2015, there was a large increase in the number of casualties from landmines.<sup>7</sup> The wars in Syria, Iraq and elsewhere has caused an increase in the use of these weapons by both government militaries and non-state groups – the latter often in the form of 'improvised explosive devices' (IEDs). Meanwhile, evidence has emerged that Saudi Arabia has used British-made cluster bombs in its war in Yemen<sup>8</sup> (although sales stopped many years ago), while the USA is still selling such weapons to the regime. So we currently have the depressing spectacle of US-manufactured cluster munitions being used against civilians once again.<sup>9</sup>

Such examples illustrate the key problem that some of the world's largest nations have refused to join the Ottawa Treaty and the CCM. These include China, India, Russia and the USA. It is especially depressing that many members of the UN Security Council will not assume a leadership role on this issue.

Nevertheless, the Ottawa Treaty has taught us that civil society can pressure militaries to drop the use of inhumane weapons. Many of the same NGOs involved in both the ICBL and the anti-cluster-munitions campaign are now involved in efforts to ban autonomous weapons – those which could decide for themselves whom to kill. Although these weapons are still under development, there are understandably huge concerns about their potential impact should they ever be deployed. The main coalition working on this issue is the Campaign to Stop Killer Robots,<sup>10</sup> which is working within UN processes to make progress. Confidence is high that the learning from these previous efforts to ban inhumane weapons will bear fruit once more. Some SGR members – such as myself – are part of this process and look forward to reporting back on the progress of these efforts as they happen.

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## Fracking and public health: research update

**Andrew Watterson, University of Stirling, assesses key academic research published in 2016 on the risks of fracking to public health.**

The public health impacts of hydraulic fracturing, or fracking, in the UK and elsewhere are constantly under review. This article summarises the findings of 17 peer-reviewed scientific papers and a report published in 2016. Month by month scientific publications reveal both problems and ignorance about what fracking and related processes can or may do to public health. Well-documented, well-referenced and regularly revised fracking reports from organisations like Physicians, Scientists and Engineers for Healthy Energy (based in the USA) and Medact (based in the UK) already provide a large and broad body of evidence on public health, global climate change and economics. The papers discussed in this article identify recent research on public health threats and data gaps that support the need for precautionary and prevention principles at community, village, town, region, nation and global levels to protect public health.

### Water issues

UK industry and regulators argue water pollution problems from fracking in the USA (and elsewhere in the world) will not happen here because our drinking water comes from different sources to many American water supplies – and water pollution from fracking was never significant anyway in the USA, and has already been fixed by industry even if it was. As evidence, the 2015 draft report of the US Environmental Protection Agency (EPA) on fracking and drinking water resources has often been cited. The EPA report has, however, been challenged. In January 2016, the EPA's own Scientific Advisory Board (SAB) produced a very detailed critique and concluded evidence was lacking to support the EPA claim of no widespread and systematic impacts on drinking water from fracking.<sup>1</sup> The SAB found regional impacts had not been considered, the water systems – whether ground water or surface water – had not been adequately described; terms such as 'proximity', 'widespread' and 'systematic' had not been defined; baseline data were missing; chemical toxicity and hazard information relevant to fracking were missing; and fracking fluids and flow-back water had not been separately identified. These flaws mean fracking does not have a clean water pollution record despite UK claims to the contrary.

A European review of water use and unconventional gas extraction (UGE) published in October 2016 identified pressing challenges on regulating shale

gas development, on regulating surface water issues, on groundwater and underground injection and on waste water management.<sup>2</sup> European Parliament enquiries revealed existing treatment plants were ill-equipped to treat hydraulic fracturing waste water and might discharge pollutants into rivers and streams. Also, there was uncertainty about fracking impacts because of the potential for aquifer contamination from flow-backs from wells and worries European minimum principles might not be sufficient to regulate activities in specific countries. Post-Brexit, these may be major UK concerns.

In California, treating water produced by fracking and removing fracking chemicals remain problematic. Researchers found data are still missing on 24 of 193 fracking additives.<sup>3</sup> Chemicals of particular concern included formaldehyde polymers, acrylic acid polymers and surfactants. Their chemical fate remains unestablished. Also, researchers investigated the oral toxicity of 1173 chemicals in fracking fluids and 134 chemicals in flow-back and produced waters in the US concluding "the lack of chronic oral toxicity values for many these chemicals highlights the significant knowledge gap that exists to assess the potential human health hazards".<sup>4</sup> Another study<sup>5</sup> examined two specific fracking fluid components (2-butoxyethanol and furfural) and their treatment, finding that these chemical additives might migrate through shale formations and into water resources. Glutaraldehyde has also been the focus of US research linked to fracking chemical changes 'downhole'.<sup>6</sup> The biocide had limited time to control microbial activity in various shales, and could return to the surface through flow-back and produced water in cooler, more acidic, and saline

shales along with its aqueous transformation products.

In Texas, fracking operations near abandoned and converted oil and gas wells have emerged as a potential risk to groundwater.<sup>7</sup> These risks were relatively unknown because few studies had investigated probable 'frack hits' on abandoned wells. Again, there is evidence of potential public health threats in the context of "upward leakage into overlying aquifers, provided migration pathways are present along the abandoned well".

Fracking worker health and safety has been very neglected with US calls for more work on reducing occupational exposure to chemicals.<sup>8</sup> Modelling worker exposure to flow-back water reveals low estimates of exposure to most flow-back chemicals but benzo (a) pyrene and heptachlor exceeded the significant one-in-a-million threshold.<sup>9</sup>

### Air pollution

Researchers have confirmed the presence of elevated benzene and benzene-related compounds levels in the air in areas where fracking occurs.<sup>10</sup> The results present an issue for residential communities: "sensitive populations (children, pregnant women, elderly, immunocompromised) and occupational workers are at increased risk for adverse health effects from elevated atmospheric levels of benzene[s] in residential areas with unconventional shale extraction and processing".

### Soil contamination

Very little is known about sorption, transformation, and interactions of many fracking fluids and oil and



Shale gas pipelines in the USA



gas wastewater constituents in the environment.<sup>11</sup> Fracking chemical spills on agricultural topsoil and their biodegradation and sorption – particularly poly (ethylene glycol) surfactants which could interact with the biocide glutaraldehyde – are not well understood. Hence co-contaminant effects need to be considered when evaluating the risks to the quality of agricultural soils (and therefore crops) and groundwater. Contamination in either medium could obviously impact human health.

## Ecological impacts

27 streams in Pennsylvania were tested for fracking and flow-back fluids because possible mismanagement of flow-back might be a significant threat to surface water resources.<sup>12</sup> There was evidence that “flow-back fluids can reach nearby streams through leaking wastewater hoses, impoundments, and lateral seepage and blowouts, as well as by backflow into the wellhead”. The study found little past research determining effects on aquatic biodiversity and contaminant biomagnification but their new results suggested fracking had the potential to change aquatic biodiversity and methyl mercury concentrations at food web bases. Mercury occurs in most reservoirs where UK natural gas is obtained so a mercury pollution threat exists here from similar aquifer contamination and could possibly involve human health impacts too.

## Public health studies of fracking and coal bed methane extraction

Research on what if any health impacts might result from fracking, and the related process of coal bed methane (CBM) extraction, therefore continues to be highly complex and compounded by this worldwide lack of comprehensive knowledge about potential pollutants and pathways.

All-age hospitalisation rates over at least 15 years in a CBM area of Australia in an exploratory ecological study were compared with a coal mining and a rural/agricultural area.<sup>13</sup> The CBM area showed no significant increases in specific hospitalisation rates compared to the other two areas but showed hospitalisation rate increases compared only to the rural area for neoplasms and blood/immune diseases. There were indications that “certain hospital admissions rates increased more quickly in the [CBM] area than in other study areas, particularly the rural area, after adjusting for key sociodemographic factors”.

A systematic review of associations between oil and natural gas extraction processes and human reproduction examined 45 research papers.<sup>14</sup> It revealed “moderate evidence” of “an increased risk

of preterm birth, miscarriage, birth defects, decreased semen quality, and prostate cancer”. Evidence was low, inadequate and/or inconsistent for a range of other health effects. The researchers observed: “few studies have been conducted to evaluate the impact of unconventional oil and gas operations on human health. The impact of unconventional oil and gas activities may be greater than that of conventional activity, given that unconventional activities employ many of the same approaches and use dozens of known endocrine-disrupting chemicals in hydraulic fracturing”.

A large US study of 35,508 patients with asthma in Pennsylvania found “residential UNGD [unconventional natural gas development] activity metrics were statistically associated with increased risk of mild, moderate, and severe asthma exacerbations” but noted “whether these associations are causal awaits further investigation, including more detailed exposure assessment”.<sup>15</sup> The *Lancet* noted that information about which fracking stage was associated with which data and observations about the lack of respiratory epidemiology studies of fracking complicated by little regulation and rapid fracking development.<sup>16</sup> Another large US study with 7,785 participants found evidence “UNGD is associated with nasal and sinus, migraine headache, and fatigue symptoms in a general population representative sample”.<sup>17</sup>

In addition, one non-peer reviewed report from the University of Bergen looked at the neglected issue of social and psychological factors and negative impacts of fracking plans in Lancashire.<sup>18</sup>

In conclusion, fracking emerges from all these studies as an industry not fully researched with many gaps that regulators cannot currently monitor and with a plethora of serious potential public health risks.

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## Arms and fossil fuels industries in schools: Undermining the next generation?

**The arms and fossil fuels industries are putting a lot of resources into science and engineering educational material for British school children. We should be very concerned, argues Philip Wood, SGR.**

In 2007 the head of the Army's recruitment strategy stated, "Our new model is about raising awareness, and that takes a ten-year span. It starts with a seven-year-old boy seeing a parachutist at an air show and thinking, 'That looks great.' From then the Army is trying to build interest by drip, drip, drip." Industries, crucially the arms and fossil fuels industries, are attempting to do exactly the same thing. They are using the notion of a skills shortage in STEM (Science, Technology, Engineering and Mathematics) to provide STEM 'enrichment activities' as a way of getting in front of and influencing a captive audience of impressionable children.

### Tackling the public image problem

Research indicates that the fossil fuels and arms industries suffer from public image problems affecting younger generations (those born since the mid-1980s).<sup>1</sup> The chief executive of BP Group recently admitted "the millennial generation [born between 1980s to mid-1990s] don't just want career growth; they also expect to make a positive contribution to society".<sup>2</sup>

These generational issues may give some understanding to the motives of the fossil fuels and arms industries' interaction with young people. Shell, for example, currently has a massive public relations campaign called #makethefuture, which talks a lot about innovation and emphasises their social enterprise projects.<sup>3</sup> In a leaked public relations (PR) document, Shell stated that due to the motivations of the younger generations, its aim was to "build Shell's reputation as an innovative, competitive and forward-thinking energy company of the future" and to "support Shell being positioned as a thought leader, actively looking ahead at what it will take to move society towards a prosperous, low-carbon future".<sup>4</sup> This campaign has been a response to widespread criticism, even from leading environmentalists that had previously thought engaging with oil industry was the way forward, but were now dismissing it as "futile".<sup>5</sup>

### STEM education as public relations

Along with more traditional marketing on Facebook, YouTube and TV, corporations are using the narrative

of a STEM skills shortage as a way of entering schools to extend their PR campaigns. When thinking critically about the reasoning behind the industry engagement in schools, especially in the context of their public image problems, the logical conclusion is that the agenda must be about protecting the future of the corporations though PR and shaping the minds of young people. This is given further credence by the PR company behind many industry school programmes, which advertises that its initiatives will "both support pupil learning, while at the same time clearly convey[ing] your organisation's marketing, PR or CSR [corporate social responsibility] message".<sup>6</sup> Shell's 'Bright Ideas Challenge', one of their school programmes, is arguably a good example of this.<sup>7</sup> It focuses on innovation and future ideas for clean affordable energy – but seemingly fails to mention the large-scale impact of their core business on climate change. Hence their programme will create the perception and association of being a forward looking, progressive, thought leader – the aims set out in their PR document.

The reach of these industry-school engagement programmes can be massive. The UK's largest arms corporation, BAE Systems, runs an 'Education Roadshow' (in conjunction with the RAF and Royal Navy) which they claim has reached over 365,000 young people in over 2,200 schools and was expected to reach over 90,000 children aged between 10 and 13 in 2016 alone.<sup>8</sup> Like other STEM engagement programmes, the materials that are available online present a very sanitised message. While there are numerous images and references to military technologies, there is very little about what they are used for, let alone acknowledgement of the serious ethical issues they raise.

STEM programmes are often carried out by other organisations but are sponsored or funded by industry. For example, the Tomorrow's Engineers programme runs an activity called 'Energy Quest'. The programme is heavily funded by Shell who "invested over £1 million in Tomorrow's Engineers, giving 70,000 school children careers information and hands-on engineering experiences".<sup>9</sup> Yet we can find no mention of this funding on the Tomorrow's Engineers website, with the only reference to Shell being buried in a school case study which mentions the presence of Shell STEM Ambassadors at their event.<sup>10</sup> Like the previous Shell programme, the Energy Quest focuses on "future energy solutions". While the activity teaches children that "we could

need an 'energy mix' in the future", by far the largest element is a 6-8 week project on carbon capture and storage.<sup>11</sup> This is a technology which is particularly favoured by the fossil fuel industry, despite having significant environmental and economic drawbacks.

### Time for reform

It might be argued that those industries which benefit from STEM education in schools should contribute to its provision, and there may be merit to that argument. However, the way that corporations – including those involved in arms and fossil fuels – are allowed to operate can lead to significant biases being introduced. A new system with much stricter regulation needs to be formulated to make sure that industry cannot distort education programmes and use them as an opportunity for corporate PR.

**Philip Wood is a project worker at SGR, funded via the QPSW Peacemaker scheme.**

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## Devonport and nuclear submarines: what are the risks?

**Dr Philip Webber, SGR, highlights a range of significant health, safety and environmental risks arising at the Devonport naval base from the storage of several aged nuclear submarines and a recent major submarine refit.**

The Royal Navy has been operating out of Devonport naval base, next to the city of Plymouth (known officially as HMNB Devonport), for over 300 years. In recent decades, it has become the place where Britain's nuclear-powered submarines come for maintenance, refuelling, refitting and dismantling. Here I cover the background to several accidents involving submarine nuclear reactors, how the risks are assessed and managed by the navy and private contractors, and future plans for the radioactive materials.

There are 12 old nuclear-powered submarines docked afloat at Devonport (with a further seven at Rosyth in Scotland). Eight of these obsolete submarines *still contain fuelled nuclear reactors*, with a further four having had their reactors removed.<sup>1,2</sup> In 2002, all reactor dismantling was halted by the official nuclear regulator (ONR) because the site was not judged safe or adequate to do the job.<sup>3</sup> The eight fuelled nuclear reactors are powered down and have to be continuously cooled using external power and water to avoid overheating which could lead to a fire, melt-down and/or a release of radioactive particles and gases. Some have been in this state now for over ten years awaiting a new facility at 14 Dock.

There are also risks associated with the maintenance of the UK's operational submarines. There are 11 of these vessels, including the four Vanguard class that carry Britain's nuclear weapons.<sup>4</sup> When on patrol, these submarines carry eight Trident missiles and 40 nuclear warheads.

### **The HMS Vengeance refit – an example of the technical complexities**

Between 2012 and 2015, HMS Vengeance – one of the UK's four Trident submarines – underwent a major refit at Devonport. It is worth giving some technical detail about this refit to illustrate the complexity and difficulty of the engineering tasks that are being undertaken at Devonport. This description is summarised from several technical summaries.<sup>5</sup>

'Refit' is a rather bland term for what was in fact a major engineering challenge costing £350m inside a

huge dry dock facility managed by Babcock International Ltd<sup>6</sup> and part of a larger £5bn contract to refit all the Trident submarines. HMS Vengeance had its nuclear reactor partially rebuilt following the detection of unexpected levels of radiation in the water-cooling circuit of an identical naval reactor running at the Dounreay nuclear site on the northern coast of Scotland. The existence of unusual levels of radiation in the cooling water indicated that there was a breach between the intensely radioactive nuclear core and the primary high pressure water circuit. This water circuit in turn transfers heat to a steam circuit that drives turbines which provide electrical and motive power. The leak was kept secret for two years until the Defence Secretary announced the refit to parliament in 2014.

Trident missiles and nuclear warheads were removed at the Faslane naval base near Glasgow before the refit began. Once the submarine docked at Devonport, external cooling was fitted to the core ready for shut down. The reactor control rods were then inserted to slow the nuclear reaction and the core cooled down over several hours. Repairs included a great deal of cutting into large metal structures – reactor pressure vessel and associated pipework and valves weighing up to 120 tonnes – using welding equipment and powerful cutting tools. Radioactive cooling water needed to be prevented from escaping.

During the 'refuelling' part of the process, the radioactive fuel rods are completely removed and replaced once the reactor cooling circuits, pressure vessel and shielding have been re-assembled and repaired. Continuous water cooling of the reactor core is required even when it is shut down to avoid dangerous overheating and radioactive gas release. Hence the whole assembly requires a continuous supply of water and electrical power.

The refit also included replacement of electrical and guidance systems, missile and torpedo tubes, testing of hull and other equipment.

### **Dismantling nuclear submarines: ignoring serious risks**

As one might hope, the Ministry of Defence (MoD) produced public consultation documents<sup>7</sup> about the risks of reactor dismantling in the naval dockyard and their plans for dealing with an eventual total of 27 submarines and associated nuclear reactor parts. However, to my surprise, the public reports

concerning submarine dismantling, defueling and refuelling specifically *exclude* the most risky parts of the process. The risks associated with removing and replacing the highly radioactive fuel rods are excluded from the Strategic Environmental Assessments and associated documents on the very dubious ground that the used fuel rods are not 'waste' because they can be re-used as nuclear fuel!

The MoD<sup>8</sup> blandly states that "comments on safety and environmental aspects of defueling are outside the SDP (Submarine Dismantling Project) scope and engagement is best continued through the established channels for HMNB Devonport and Devonport Dockyard." Also "the MoD's position remains that defueling has to remain outside the scope of the SDP. It is a separate and pre-established activity, and upgraded defueling facilities at Devonport are already being built as part of the Future Nuclear Facilities programme. It would therefore be neither feasible nor beneficial to bring defueling within the scope of the project".<sup>9</sup>

The fact that the most risky elements of the dismantling and servicing process were excluded from the risk assessments is of serious concern. But what is of even more concern is that these risks were excluded when there are eight aged nuclear reactors berthed in very close proximity to the population of Plymouth.

The potential risks of an accident or incident are rather starkly set out in the Devonport Off-Site Emergency Plan (DOSEP).<sup>10</sup> This plan includes various contingencies such as: exclusion zones of 2 - 10km, the latter enclosing all of Plymouth (population 326,000); the issuing of potassium iodate tablets; keeping people indoors (including children in schools); closing of major roads and rail links; population evacuation; and farming restrictions up to 30km downwind. Thus while there is a major incident plan covering these very serious possibilities, the MoD public consultation documents deliberately avoid considering the activities most likely to cause them.

But the MoD *did* consider a much worse risk in a document that they presumably thought would escape public attention. In the declassified and heavily redacted minutes<sup>11</sup> of a Defence Board meeting in 2011, recently unearthed via a freedom of information request, the MoD's senior nuclear safety regulator, Commodore Andrew McFarlane stated the following.

“All pressurised water reactors are potentially vulnerable to a structural failure in the primary circuit, causing a rapid depressurisation and boiling-off of most of the cooling water. This results in failure of the fuel cladding and a release of highly radioactive fission products outside the reactor core.

“While the further containment provided by the submarine’s pressure hull may contain the majority of this material inside the submarine, some leakage is likely to occur and, in any event, the radioactive ‘shine’ from the submarine poses a significant risk to life to those in close proximity, and a public safety hazard out to 1.5km from the submarine. Current designs of UK and global civil nuclear power plants have systems for safety injections of coolant into the reactor pressure vessel head and passive core cooling systems. [sentence redacted] UK submarines compare poorly with these benchmarks. [2 page section redacted]”

In the event of such a failure happening in dock in Plymouth, the radioactive ‘shine’ would impact several areas of population. The obsolete submarines are in fact moored only 500m from the dockyard railway station, Morice Town Primary School and residential areas with 32,000 residents.<sup>12,13</sup> It is hard to imagine that this state of affairs has been the case since 2002, or to imagine why the siting of eight aged nuclear reactors in or near a centre of population has not received much higher criticism.

This risk is far from theoretical. During the defueling process the fuel rods have to be removed from the highly radioactive reactor core. At this point a heavy shielding cap has been removed and the reactor core is exposed inside the dry dock. The risk exists of the release of particulate or gaseous matter to the atmosphere. The risk is higher at this stage as the reactor is outside of normal operating bounds and any mistake can be very dangerous. For example, if moderating rods are removed by mistake instead of the fuel rods, the core will become intensely radioactive. This would likely cause an explosion or serious fires, release radiation, and could result in the deaths of personnel. This happened to a Russian Echo class nuclear submarine during nuclear refuelling in Vladivostok harbour in 1985 resulting in 10 immediate deaths and 49 radiation injuries.<sup>14</sup> Rods can also become jammed or breach, releasing their contents with the possibility of localised intense fission reactions (hot spots). This type of risk will be higher for extremely aged reactors up to 10 years old.

## Accidents have already happened at Devonport

There were some serious engineering errors during the HMS Vengeance refit. According to the Office for

Nuclear Regulation, “ONR followed up DRDL’s [Devonport Royal Dockyard Ltd] investigation into an event in November [2012] involving the removal of reactor compartment salvage valves from HMS Vengeance, inadvertently creating a breach in the reactor’s primary containment boundary”.<sup>15</sup> This happened “through a series of misunderstandings regarding the significance of these valves”.<sup>16</sup>

There have also been other serious incidents. For example, on 29th July 2012, there was a failure of both the primary (electrical) and back up (diesel) power to parts of the Dockyard. These power supplies are vital for the continuous cooling of stored reactor core material. For 90 minutes the base had to deploy emergency fire hoses to provide this cooling.<sup>17</sup>

And finally, as if all these deficiencies weren’t worrying enough, the Strategic Environmental Assessment (SEA) discounts the serious risk factor of fire. Fire is a very real risk factor in a complex engineering operation involving high temperature cutting equipment, explosive gas cylinders, angle grinders etc. The SEA states in several places that: “the risk of such an event [fire] occurring is exceptionally low”.<sup>18</sup> They state that the relevant materials are large blocks of steel which are inherently non-flammable and also that there are no liquids that can escape. And, as already stated, the SEA excludes the most serious risks posed by the radioactive core itself.

## Misleading the public?

The MoD response to consultation – dated March 2013 – concluded that “no plausible scenario has been identified by the MoD, or any other party, that results in a meaningful threat to public health from dismantling a de-fuelled submarine”.<sup>19</sup> They certainly did not identify any such plausible scenario – but from my investigations this is a result of a seemingly deliberate avoidance of the most significant risk factors. In my view, the MoD public consultation documents seriously misled the public. The risks due to the planned de-fuelling of eight aged nuclear reactors still berthed in submarines remain critical. This complex and difficult task is expected to take at least another 12 years. As a result, active nuclear risks will continue at Devonport and in close proximity to residents for many years to come.

**Dr Philip Webber is Chair of SGR, and has written widely on risks from nuclear and military technologies for over 30 years.**

*The material for this article was originally compiled for a recent legal case involving protestors at the Devonport naval base.*

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## Universities for sale? The influence of arms, fossil fuels and other industries

SGR Conference and AGM; 19 November 2016; The Gallery, Farringdon, London

Summary by Gwen Harrison and Stuart Parkinson

The aim of SGR's 2016 conference was to explore the nature and extent of corporate influence on academia – and discuss how its detrimental effects could be challenged. Nearly 60 people attended the day. Materials from the conference – including videos and slides of some of the presentations – can be downloaded from: <http://www.sgr.org.uk/events/universities-sale>

### Militarising academia: arms corporations and UK universities



Stuart Parkinson

The first plenary session – involving four speakers – focused on the influence of specific industries on British universities.

The first speaker was Dr Stuart Parkinson, Executive Director of SGR. His presentation drew on SGR's extensive research on the military influence on science and technology, including five reports published since 2005.

First, he outlined the wider links between the military and UK science and technology. The British military equipment budget amounts to massive £178bn over the next 10 years, with the largest category being new submarines, both nuclear-armed and conventionally-armed. The UK is one of the world's largest funders of military R&D, with spending currently at £1.7bn/year and rising. SGR's investigations have shown that the largest area of the UK's military R&D spending is nuclear weapons systems. Such a situation creates serious ethical problems.

The vast majority of the military R&D budget is spent via contracts with the arms industry. Some funding

(around £200m/y) goes to universities via a range of industry and government schemes. Evidence from several studies indicates that virtually all UK universities take some military funding, but that certain ones receive particularly large amounts focused on their science and engineering departments – especially Cambridge, Cranfield, Imperial, Oxford and Sheffield.

Stuart also showed graphs comparing UK military R&D spending with other areas, demonstrating its disproportionate size. Especially striking was the statistic that spending on military R&D is over 20 times higher than that on renewable energy R&D. Stuart concluded his presentation by summarising campaign activities against military involvement in universities. This included international work by INES and partners, which has had some success in Germany and Japan, as well as work in the UK by SGR, Campaign Against Arms Trade (CAAT) and others.

### Investigating fossil fuel industry funding in academia



Maeve McClenaghan

The second speaker was Maeve McClenaghan, senior investigator at Greenpeace UK, who summarised an investigation they carried out last year that looked at industry funding of UK universities. They found that £134m had been provided by oil, gas and coal corporations over the previous five years, some of this going to universities that have committed to divest from the fossil fuel industry. 75% of all such funds came from Shell and BP, with the majority (£100m) going to just four universities – Manchester, Cambridge, Imperial and Oxford. Greenpeace acquired this data from freedom of information

requests to over 130 universities, interviews with academics, and published information. Some universities were co-operative in providing data, but many refused to disclose information by exploiting legal loopholes. Among those which responded, 39 universities said they took some money from the fossil fuel industry. Some top universities, including Oxford and University College London, received more funding from fossil fuel companies than from research councils. The funding from Shell and BP alone was equivalent to one-eighth of all public money spent on energy research. The funding was provided for both research and teaching activities, giving the companies involved significant influence at all levels. Greenpeace even found that at Manchester University BP had helped to develop the curriculum. Conversely, universities specialising in renewables received very little funding from renewable energy companies.

Greenpeace also found that the Natural Environment Research Council (NERC), the main public funder of environmental science research in the UK, had received £6.7m from Shell and other fossil fuel corporations over the previous five years.

Maeve finished her talk by telling us of an undercover investigation Greenpeace carried out in the United States, which exposed climate sceptic academics who were hiding their fossil fuel industry funding.

### He who pays the piper: universities, the oil and gas industry and fracking



David Smythe

The third speaker was David Smythe, Emeritus Professor of Geophysics, University of Glasgow. He began by summarising how UK university research in the earth sciences was funded in the 1970s and how



the situation has changed in the years since, especially due to a marked increase in funding from the oil and gas industry. He also highlighted how the industry's role in collecting geological data can both benefit academic researchers and leave them sharing the industry's 'mindset'.

He pointed to several of his own experiences to highlight key problems. One example was the closure of the geology department at Glasgow University in 1998, at which David was a professor and which also hosted other leading researchers in the field. A year before, he and another senior colleague had appeared as expert witnesses for environmental organisations at a major public inquiry on a proposed new nuclear waste facility in Cumbria. David was criticised by some of his colleagues for this, despite his research showing clear flaws in the proposal. David argued that the departmental closure may have been linked to his acting for the environmental organisations. David took early retirement following the departmental closure, becoming an emeritus professor.

In the last five years, he has been researching hydraulic fracturing (fracking), and has spoken out about its environmental and health risks. He became interested in this field after some French academics had told him they no longer spoke publicly on the issue due to pressure from the industry. Since 2014, as his comments were being reported more widely in the media, pro-fracking academics at Glasgow and elsewhere – helped by some of the press – have tried to discredit David's academic standing. David has strongly rebutted these criticisms, and has highlighted significant links between Glasgow staff and the industry.

Recently, David submitted a paper to the peer-reviewed journal *Solid Earth* concerning environmental risks of fracking in the UK. Shortly after, Glasgow University terminated access to his online university accounts. Emails released under freedom of information law appear to demonstrate that the action was taken because of David's views on fracking. He is currently taking legal action against the university.

## Regulatory 'undersight': policing integrity at the university-industrial interface in medicine

The final speaker of the morning was Dr Aubrey Blumsohn, formerly a senior lecturer in medicine at the University of Sheffield. He pointed out that effective medicine requires honest science, transparent analysis of data and complete transmission of research findings. Pharmaceutical companies and medical device manufacturers sell



Aubrey Blumsohn

products under the banner of science, often with university involvement providing credibility. However, there have been many recent incidents involving the collusion of university academics in the generation and propagation of false or misleading research. The consequent 'scandals' have been associated with many hundreds of thousands of deaths. A variety of statutory, scientific and professional regulatory bodies are interspersed in the relationship between industry and academia. The supposed remit of these bodies is to safeguard integrity. In many cases, he argued, these bodies have failed to understand or support the scientific process, or have even colluded with misconduct. Aubrey gave some examples, highlighting the extent to which government and regulators have colluded with scientific fraud or misconduct at the university-industrial interface.

## Universities, democracy and science: the challenge of the new neo-liberal knowledge regime

The second part of the day covered issues which were more cross-cutting across the disciplines, including the rapidly growing commercialisation of universities, and academia's wider responsibilities to society.

The first of the afternoon speakers was John Holmwood, Professor of Sociology, University of Nottingham, and a founder of the Campaign for the Public University (CPU). John's talk was given against the background of the Higher Education and Research Bill being considered by parliament, which he argued represents the last and most radical step in the process set out in 2011 by government to transform universities into corporate bodies. The Bill, he told us, represents an extension of free market practices and also gives increased powers to university management and government ministers. In particular, it gives ministers the ability to directly influence research agendas and the curriculum. In short, the independence of universities will be seriously compromised.

John argued that in the 1960s higher education was considered a public benefit and had a role in helping to reduce inequality in society. Knowledge generated

within universities was considered necessary to facilitate democratic debate and reform. Since then, we have seen the return of universities that are more like corporations and, in particular, neoliberal corporations.

Neoliberalism involves the prioritisation of short-term economic goals and deregulation. There has long been academic critique of this economic approach – especially its role in increasing inequality – but as the government redefines the role of universities as engines of economic development, the critical role is being seriously eroded.

The neoliberal agenda has also led to education now being considered the private responsibility of individuals, rather than a public good. This change is allowing universities to seek for-profit partners. The Bill would allow businesses to set up their own universities.

In summary, John argued, the government is markedly changing the role of the university from one which makes a fundamental contribution to democracy to one which can be used to undermine it. This needs to be challenged, and he encouraged SGR members to support the CPU and others in campaigning against the Bill.

An article expanding on the issues covered in this presentation is available on p.9.

## Do universities betray reason and humanity? The urgent need for an academic revolution



Nicholas Maxwell

The final speaker was Nicholas Maxwell, Emeritus Reader of Philosophy of Science, University College London. Nicholas began by highlighting global problems, from nuclear weapons to global inequality. His basic claim was that the dominant view of what universities and academic inquiry ought to be – i.e. the pursuit of knowledge – is damagingly irrational from the standpoint of promoting human welfare; indeed it has made our current global problems possible. The basic aim for

universities should therefore be to promote human welfare by helping to solve the very serious global problems we face. He argued, therefore, that universities should pursue 'wisdom', which includes knowledge, but much more besides. Hence, we need an intellectual revolution.

'Knowledge inquiry', which is dominant today, dictates that values, political ideas and policies, and philosophies of life must all be excluded from intellectual inquiry, which should be restricted to the acquisition of knowledge. Nicholas argued that to achieve what is of value in life, the problems we need to solve are those of living and action, rather than problems of knowledge. Even when new knowledge is required, it is what this knowledge enables us to do that is important, not the knowledge itself. Knowledge inquiry fails to give priority to thinking about how to improve our lives.

'Wisdom inquiry' modifies knowledge inquiry so that the task of academia becomes to help people realise – experience and create – what is of value in life. Nicholas argued that universities shouldn't just study society, they should engage to improve it.

Discussion of the presentations was wide-ranging, and ideas for next steps for SGR were collected to be considered by the National Co-ordinating Committee.

## Poster Sessions

Six posters were presented at the conference, covering issues including the links between the arms and fossil fuel industries and scientific bodies, and the influence of Brexit on UK science.

## SGR's Annual General Meeting

The event also included SGR's AGM. The annual report and accounts were presented, and the National Coordinating Committee elected (see p.2), with the session concluding with discussion of current and planned activities.



Nearly 60 people attended the conference

## Islam and the West

### Martin Ryle Trust lecture; 14 September 2016; Conway Hall, London

Review by Vanessa Spedding, on behalf of the trustees of the Martin Ryle Trust



The trustees were honoured to have Prof Sir Michael Atiyah, OM, FRS, deliver the inaugural Martin Ryle Trust lecture.

Entitled *Islam and the West: a personal perspective*, Sir Michael's talk was sweeping and ambitious, yet retained at its heart a straightforward message: that diversity in culture and faith reflects the natural diversity of humanity, and that society is bettered when its people are educated to understand this and make connections, rather than to resist it and make divisions.

Through a series of vignettes through time and space, illustrated with selected slides, incisive observations, and a personal touch informed by his upbringing in Lebanon, Egypt and Sudan, Sir Michael deftly conveyed the ebb and flow of conflicts and collaborations between Christendom and the Islamic world in the Mediterranean region from the 16th century (the time of Elizabeth I) to the present day.

He shed light on key battles, periods of enlightenment and multiculturalism, and of suffering and division, while demonstrating the ongoing struggle for the balance of power, enacted through war, trade, subterfuge, religion and oppression.

"If you see any analogies between that time and the present, you'll have got the message," he said at one point.

Sir Michael offered a countercurrent to the theme of power play in the form of another thread: that of cross-cultural communication, a subject close to his heart. During a diversion into a slice of the Atiyah family history, Sir Michael explained how his great grandfather Yusef, a Christian minister, wrote texts in Arabic to introduce Muslims to Christianity; these are thought to

represent the first non-confrontational engagement between the Christian West and the Islamic world.

These themes, of repeated and violent struggles for power, countered (and often oiled) by cross-cultural links, were discussed further during an enthusiastic post-lecture discussion, which explored the implications of Sir Michael's insights for present day conflicts and prospects for peace.

Chair of the Martin Ryle Trust Dr Philip Webber introduced and chaired the talk, providing background to Martin Ryle and the Trust, to Scientists for Global Responsibility and its forerunners, and of course to Sir Michael himself, who is not only a distinguished scholar but also an outspoken critic of nuclear weapons.

Dr Webber also included a poignant dedication to the memory of Prof Sir Tom Kibble, a fellow trustee who worked on arrangements for the event until his unexpected death earlier in the year (see p.4 for his obituary).

The trustees were delighted that the lecture attracted an audience of more than 150 and would like to thank Sir Michael and all who attended, especially the families of Tom Kibble and Martin Ryle.

A longer version of this review can be read online at: <http://www.sgr.org.uk/events/islam-and-west-personal-perspective>

## Lucas Plan - 40th anniversary conference

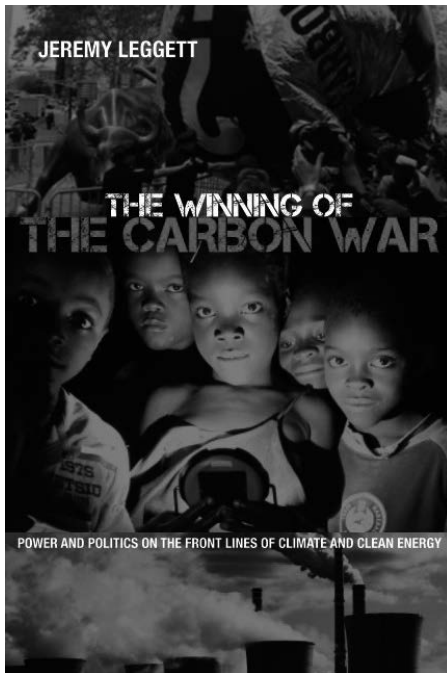
On 26th November, SGR supported and participated in a conference which marked the 40th anniversary of the famous 'Lucas Plan', a 1976 trade union initiative which proposed conversion of a company from arms manufacture to socially useful production.

For outputs, see the conference website: [lucasplan.org.uk](http://lucasplan.org.uk)

## The winning of the carbon war

Jeremy Leggett, Published by Jeremy Leggett under the Creative Commons License, 2016, £9.99,\* 382pp., ISBN: 978-1364485436 (paperback)

Review by Wiebina Heesterman



The 33 chapters of the book cover the period from May 2013 up to and including the Paris climate conference in December 2015, written in the form of diary style entries. These are followed by an epilogue containing Leggett's reflections on the implications of the Paris Agreement, written January 2016. The book covers events, meetings and discussions with some of the most important figures moving in the intersection of the spheres of climate, energy and finance. The account of the ups and downs of the struggle to reach the Agreement makes fascinating reading, made possible by Leggett's knowhow of all three spheres due to his past in the oil industry, as founder of a solar panel company as well as his current position as chair of Carbon Tracker in addition to being an impassioned participant in what he terms the 'war' against climate change. (Carbon Tracker is an initiative by financial analysts to monitor overproduction of fossil fuels and quantify carbon investment risk).

The action flits all over the world to end in Paris, with London and other UK locations in between. As diverse as the locations are the events. Leggett is present at BP's 2014 AGM, the Balcombe fracking protest, the 2015 Solar Trade's Conference and a meeting of headmasters (no headmistresses apparently) somewhere in Kenya to promote the uptake of solar lamps in order to replace dangerous kerosene lanterns. Then there are meetings between Carbon

Tracker and Nordic Pension Funds, and the largest climate change demonstration in New York to date.

The liveliness of the account derives in part from the author's concern over the insidious nature of the climate threat and his reflections and comments on the interactions with financial experts and CEOs of fossil fuel companies, several of which still persist in denial of the risk their products pose. Some of the most interesting sections of the book deal with the discrepancies between the costs of developing oil fields and the fluctuations of the price of crude, and in consequence the risk to the fossil industry of 'stranded assets'. These are interspersed with amusing anecdotes, such as that regarding the sobriquet 'Cash-all-gone,' coined by one company's workers for a rather disappointing oilfield called Kashagan. Other revealing moments are provided by the disclosure of the fact that a supposedly promising oilfield close to Gatwick Airport did not contain any recoverable oil whatsoever. The high expectations had been praised sky-high in the press, the sobering outcome remains unreported. There are highlights, such as a meeting at the Vatican, where the Deputy Bishop of Rome (the Pope being the Bishop of Rome) came wandering in while Leggett was holding forth as well as reports of divestment from fossil fuels by specific organisations, and not least the Papal Encyclical. But there are also lowlights, such as instances of pollution and methane leakage in the Arctic, and closer to home, a critical cash flow problem due to overstocking besetting SunnyMoney, retail division of the SolarAid charity headed by Leggett.

One of the events I found most interesting was a discussion at the Grantham Institute, where the Carbon Tracker Team met with climate scientists and economists of the faculty. A salient fact that emerged was the general lack of attention to the issue of energy efficiency, even on the part of the Intergovernmental Panel on Climate Change in its scenarios for the future. The overarching conclusion was that envisioning a scenario for a low carbon future has to include emission reduction as well as electricity storage and low carbon technologies. To illustrate the fact: it has recently been reported that replacing fluorescent light bulbs by LEDs is making an appreciable difference in the USA.

Although Leggett criticised the tendency of market perception to discuss risk solely in the narrow sense

of financial risk, he still referred to a research report of the Economist Intelligence Unit that does exactly that. The report in question warned that investors might stand to lose over \$4 trillion due to the impacts of climate change, even if the temperature rise could be held at two degrees.

The account ends with the chapters 'Red Alert', the highest air pollution warning in China and 'Act de Triumph,' the signing of the Paris climate accord. In my view the book deserves a place on one's bookshelf, in its mix of reporting of technological advances, discussions of financial implications and, last but not least, as a gripping good read.

*\*Also free to download from [jeremyleggett.net](http://jeremyleggett.net)*

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- Stuart Parkinson
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