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The race for the nuclear exit

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In the wake of the Fukushima nuclear accident, many countries are undertaking major reviews of their energy strategies – with Germany announcing the most ambitious intentions. David Elliott looks at the radical changes that are afoot.

Germany's move away from nuclear power

There has been strong opposition to nuclear power in Germany since the 1970s, when there were major demonstrations against proposed new plants. Anti-nuclear and pro-renewable energy policies were at the core of the emerging Green party, and were reinforced by the Chernobyl disaster in 1986. Subsequently, with the Greens becoming part of a coalition government in 1998, a nuclear phase-out policy was established, based on limiting the life of existing plants. In parallel, Germany embarked on a major expansion of renewable energy – becoming a world leader in wind and solar power. Wind generation capacity expanded from less than 3 gigawatts (GW) in 1998 to more than 27GW in 2010. During the same period more than 17GW of solar photovoltaics (PV) were installed.[1] These were facilitated by an innovative feed-in tariff support system. Around 370,000 jobs have been created in the renewable energy industry as a whole, with many more expected in the future. The recent growth of the German renewables sector is shown in Figure 1 (see p.20).

However, with the rise of centre-right politics, and the Greens out of the coalition, Angela Merkel's government sought to soften and delay the nuclear phase-out and also started cutting back on the feed-in tariff – although there was never any suggestion of a nuclear new-build programme.

But then, in March 2011, the Fukushima nuclear disaster in Japan changed the situation dramatically. With regional elections due and massive demonstrations in favour of a complete and rapid nuclear phase-out, the German government immediately shut down all of Germany's oldest nuclear plants. In the event, despite its temporary nuclear moratorium, the government still did badly in the elections. Polls also showed that public support for nuclear, already very low at around 10%, had fallen to 5%. As the government undertook a review of its energy options, the Deputy Environment Minister publicly stated that the eight oldest nuclear plants would be shut down permanently by the end of the year, followed by a rapid phase-out of the remaining nine.[2]

This policy was backed by the German Association of Energy and Water Industries (BDEW). It called on the government to set everything in motion to speed up the transition toward a stable, ecologically responsible and affordable energy mix without nuclear power.[3] The association represents about 1,800 utilities, among them the operators of the

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A few words from the Director

The military-industrial complex, the war on terror, and war in Libya

2011 marks the 50th anniversary of the warning, given by US President Eisenhower, of the dangers of the 'military-industrial complex'.[1] It seems fitting to reflect on this warning as we pass the tenth anniversary of the September 11th attacks, and the so-called 'war on terror' that it spawned, and also as Western leaders brag about the role the NATO air campaign played in the overthrow of Libya's Colonel Gaddafi.

In his 1961 speech, Eisenhower said: "we must guard against the acquisition of unwarranted influence, whether sought or unsought, by the military-industrial complex. The potential for the disastrous rise of misplaced power exists and will persist".[1] Eisenhower was no pacifist – indeed, he was Supreme Commander of Allied forces in Europe during World War II. Nevertheless, he was very concerned about the political power that could be wielded by a large military supported by a major arms industry. Perhaps, no better example of this case was the response to the September 11th attacks, which was dominated by a huge military mobilisation as part of Bush's newly declared 'war on terror'. Hundreds of thousands (if not more) died in the ensuing wars in Afghanistan and Iraq, while military spending, especially in the USA, mushroomed, and the arms companies made enormous profits. Many – including SGR – had argued that such a response was likely to fuel the cycle of violence, making us all less safe, and sadly we were proven right. Even the former head of MI5, Eliza Manningham-Buller, recently stated that the Iraq war had fuelled the terrorist threat against the UK.[2]

The role of the western military-industrial complex in the Middle-East and North Africa has also attracted far too little criticism. As David Cameron and other NATO leaders boast about the role of their forces in helping to depose Gaddafi, they say far less about the millions of euros of arms sales that western companies made to the regime between 2004 and 2011 (see p.5). They also say little about the military technology sold to other oppressive governments in the region. With tens of thousands dead in the Libyan war, and the protests in countries like Bahrain brutally suppressed, while arms companies gear up for re-supplying, it is not difficult to see who the biggest winners are. On top of that, the latest technological developments in areas such as military robotics are truly chilling (see p.6).

The events of the last ten years have demonstrated starkly the problems of the "misplaced power" of a large military-industrial complex and how, far from making us safer as our political and military leaders claim, it fuels the cycle of violence and threatens us all. Major cuts in spending – and not just the minimal 8% currently being phased in by the UK government – are long overdue.

Reallocating resources

There is no shortage of alternative ways to spend the billions saved constructively if the size of the military-industrial complex is sharply reduced. The shift to the green economy, for example, provides many possibilities. More finance could go to developing the renewable energy sector – although (at least in some countries) it has received a major boost due to the collapse in support for nuclear power (see p.1). Some claim geoengineering, shale gas 'fracking' and other similar emerging technologies might provide significant benefits – but, in reality, they are much more likely to make things worse (see p.10, p.12 and p.16). Arguably – as we see on p.7, p.8 and p.17 – the strongest candidate for extra support is for economic, social and technological change leading to a significantly lower consumption of energy and material resources while still providing a good quality of life. There is much scope here for natural scientists, social scientists, engineers, designers and architects to work together in this area.

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The new National Co-ordinating Committee

The election for SGR's National Co-ordinating Committee (NCC) for this year was held during the Annual General Meeting on 21 May (see report on p.24). The new NCC is as follows:

Chair: Philip Webber
Treasurer: Alasdair Beal
Secretary: Harry Tsoumpas

Committee members:
Martin Bassant, Roy Butterfield, Tim Foxon, David Hookes, Genevieve Jones, Tom Woolley

**Kate Macintosh stepped down from the NCC this year after six years as Vice Chair of SGR, and over 20 years as the Chair of Architects for Peace and then Architects and Engineers for Social Responsibility. She remains one of our honoured Sponsors.*

SGR

Some of the NCC and staff (from left to right): Harry Tsoumpas, Kate Macintosh*, Stuart Parkinson, Kate Maloney, Genevieve Jones, Tim Foxon, Philip Webber, Martin Bassant, and David Hookes

‘Commit universities to peace’ campaign

Early in 2011, INES – the International Network of Engineers and Scientists for Global Responsibility – began a new campaign, ‘Commit Universities to Peace’. SGR has been helping with the campaign.

The international campaign was founded due to concerns about the growing militarisation of academic research, not only in engineering and natural sciences, but also in the social sciences and humanities. The first stage of the campaign was an appeal – which has already been signed by several Nobel Laureates – calling for universities to support the promotion of peace and understanding among the peoples of the world by rejecting research and teaching for militaristic purposes. One method that some universities in Japan and Germany have used to carry out this idea is the inclusion of ‘civil clauses’ within university statutes. The appeal can be found online at: http://www.inesglobal.com/commit-universities-to-peace.phtml Please do add your signature, if you haven’t already.

Following on from the launch of the appeal, INES organised an international seminar in Germany in May, entitled ‘Experiences and Know-how in Opposing Military Research at Universities’. Stuart Parkinson spoke at this event about SGR’s experiences in challenging military involvement in UK science and technology. The INES newsletter, published to coincide with the seminar, included an article by Chris Langley on military involvement in UK universities. (The newsletter and all the presentations can be downloaded from the web page above.) The international seminar was followed by the first national congress on military-related research in higher education in Germany for 20 years.

In June, INES and SGR sent a joint letter to the incoming committee of the International Association of University Presidents (IAUP) – which was about to hold its triennial meeting in New York. In this letter, we reminded the university leaders about their responsibility to guarantee that universities serve the interests of society as a whole and to end the unfortunate influence of the military-industrial complex on academic work.

The campaign continues.

Security and disarmament activities

SGR has continued to be very active on a range of security and disarmament issues in the months since the last newsletter. We have especially focused on promoting arms conversion, and supporting campaigns against nuclear weapons and armed drones.

Stuart Parkinson gave four presentations making the case for arms conversion for a sustainable society at three events around the UK. These events were the National Justice and Peace Conference in Derbyshire, an academic seminar at Liverpool Hope University, and a public meeting in London as part of the first ever *Global Day Against Military Spending*. Stuart used the current war in Libya to highlight many of the key arguments. An op-ed article based on material from these presentations was published in *Engineering and Technology* magazine in March. SGR was also quoted in a related article in *Professional Engineering*. In the same month, SGR took part in a roundtable discussion organised by the Campaign Against Arms Trade to discuss how the case for arms conversion to low carbon industries could be used more widely by peace campaigners. Stuart also gave a lecture at York University on ethical career alternatives to the arms industry. Finally, during the spring, SGR supplied material on arms conversion to be used in campaigns by student groups and Christian groups.

Abi Haque

Stuart Parkinson speaking to students at York University

Our campaigning on nuclear weapons also continued, co-ordinated through regular meetings with other peace campaigners. With the high-profile launch of *Countdown to Zero*, a new film on nuclear weapons, Philip Webber took part in a panel discussion following the cinema showing in Leeds. In June, SGR co-signed a letter, co-ordinated by Nuclear Flashpoints, to ministers of the five official nuclear weapons states urging them to de-alert their nuclear weapons. We also endorsed a new Japanese-led appeal for a global ban on nuclear weapons. Finally, SGR sponsors, Tom Kibble and Keith Barnham co-authored (with Jenny Nelson and David Caplin) a submission to the Trident Commission, set up by the British American Security Information Council (BASIC).

In addition, SGR increased its activities challenging the rapidly growing development and deployment of armed drones. As well as a keynote lecture on armed drones by Noel Sharkey as part of the SGR conference in May (see p.24), we have begun working together with other peace campaigners on this issue in preparation for future protests at factories involved in manufacturing these weapons.

Finally, SGR was one of over 30 organisations which signed the ‘Charter for the Recognition of Every Casualty of Armed Violence’ organised by the Oxford Research Group.

Energy and climate change activities

With the Fukushima nuclear emergency in Japan causing an international rethink on nuclear power (see p.1), SGR has contributed to the debate, especially highlighting the alternatives.

In the days and weeks following the Japanese tsunami and onset of the emergency at the Fukushima-Daiichi nuclear power plant, SGR took part in numerous related activities. Stuart Parkinson wrote an article for the SGR website, about the technological and social issues raised by both the wider devastation caused by the tsunami and the Fukushima disaster. We also supported a CND call for a move away from nuclear power. As environmental journalist, George Monbiot decided to take this opportunity to come out in favour of nuclear power, several SGR members with expertise in energy issues wrote to him challenging his views. The 25th anniversary of the Chernobyl nuclear disaster fell little more than a month after the tsunami, and Stuart was interviewed on TV news station, *Russia Today*, in a special programme on the anniversary. We also co-signed a letter of complaint to the BBC over a *Radio 4* programme it broadcast that markedly understated the health problems due to the Chernobyl accident. In June, Harry Tsoumpas and several other SGR members attended a parliamentary seminar organised by the Nuclear Consultation Group, which focused on the drawbacks of nuclear power. Later in the summer, Stuart took part in an NGO roundtable event with the Office of Nuclear Regulation to discuss concerns about nuclear safety in the wake of Fukushima. This was especially timely, as this body continues its safety evaluation of proposed reactor designs for new nuclear power stations in the UK. SGR also made a submission to a government consultation criticising its proposals for financing radioactive waste disposal.

In parallel with this activity SGR took part in numerous activities to support energy conservation and renewable energy. First, as the government's new Energy Bill began its passage through parliament, we joined the 'Demand a Better Energy Bill' campaign, which is focused on trying to get much stronger commitments for energy efficiency measures for households and businesses. We signed several joint letters to ministers and MPs in support of this campaign. We also wrote to the government to raise concerns about inadequate funding for marine energy and ill-thought-out cuts to financial support for solar photovoltaics. In addition, we responded to a request from Green Party campaigners for information to counter myths about wind energy. Finally, SGR was quoted in an article on renewable energy in *Professional Engineering* in April.

We have also carried out a number of other activities related to energy and climate change. In July, we wrote to the Energy Secretary, Chris Huhne to express our concerns about shale gas, in particular methane leakage due the extraction process (see p.16). An article on climate science and climate myths by Stuart Parkinson – which appeared in the last *SGR Newsletter* – is being reprinted in a textbook for A-level students. Finally, the SGR conference this year included a keynote lecture on geoengineering given by Joanna Haigh (see p.24).

In brief

- In February, Stuart Parkinson gave two lectures on ethical issues in science and technology: one on a course for science teachers in Rochdale; and one on an IT course at Birmingham University.
- In March, Tom Woolley gave a lecture on natural building materials to the Swedish branch of Architects Sans Frontieres in Stockholm.
- In June, SGR co-signed a letter to the European Commission raising concerns about growing corporate influence as negotiations begin on the new multi-billion euro Framework 8 research programme.
- Alan Cottey, Richard Jennings, Christine Titmus and Richard Tregear ran an SGR stall at an ethical careers fair at Cambridge University.
- Stuart Parkinson gave a presentation at the RadStats annual conference in Leeds on corporate influence on science and technology. Several other SGR members also attended the conference.
- Philip Webber took part in the Big Sustainability Summit in London, which was the final event organised by the Sustainable Development Commission before its funding was cut by the government.
- Some SGR Committee members were among a large group of academics who signed a letter published in Times Higher Education criticising the government higher education reforms.

SGR sponsors update

SGR is pleased to welcome four new sponsors:

- Pauline Harrison CBE, who is Professor Emeritus at the Department of Molecular Biology and Biotechnology, University of Sheffield;
- Ursula Mittwoch, who is Professor Emeritus of Genetics at University College London;
- Daphne Wasserman, who is a forensic engineer and a Fellow of the Institution of Mechanical Engineers; and
- Jane Wernick, who runs her own engineering consultancy and is a Fellow of the Royal Academy of Engineering and the Institutions of Structural Engineers and Civil Engineers.

We also offer our congratulations to long-time sponsor, Alan Baxter who has recently been awarded a CBE for services to engineering.

More information about SGR's sponsors can be found on our website at:
http://www.sgr.org.uk/pages/sgr-sponsors

War in Libya – the role of the arms and oil industries

The UK and other NATO countries claim they took military action in Libya for humanitarian reasons. Stuart Parkinson asks whether the situation was really that simple.

Western leaders such as David Cameron have been engaging in a great deal of triumphalism following the fall of the Gaddafi regime after six months of NATO military involvement in the Libyan uprising. Rather less attention has been given to the roles that the UK and other democracies played in supporting the Gaddafi regime over the previous six years – not least through the activities of their arms and oil industries.

Oil for weapons

According to the most recent figures from OPEC,[1] Libya has the eighth largest proven oil reserves in the world, and the largest in Africa – some 46 billion barrels. Oil exports earned the country a massive $31bn in 2009, with 75% going to European Union countries. Numerous western oil companies had exploration contracts in the country.

Income from oil sales had been the main revenue for the Gaddafi regime for most, if not all, of its 42 years in power, allowing it to make major purchases of weaponry. However, international arms embargoes – imposed because of the regime's links to international terrorism – had restricted procurement until late 2004.[2] The change in policy followed Libya's announcement that all its programmes related to weapons of mass destruction had been terminated. From this point on, imports of military equipment rapidly increased, including large orders from the UK and other NATO countries. According to data from the European Commission,[3] EU countries exported a total of €763m worth of military equipment to Libya from 2005 to 2009 inclusive. This included €278m worth of military aircraft – mainly from France and Italy, two of the countries most involved in the NATO air campaign. Britain, for its part, exported €119m worth of military equipment, including armoured vehicles and tear gas allegedly used in Gaddafi's attempts to suppress the rebellion.[4]

After the uprisings across the Arab world began in early 2011, the British government quickly shifted its position, revoking over 150 military export licenses to Libya, Bahrain and other Middle Eastern countries.[5] However, as the uprisings were in full swing Cameron still decided to embark on a trade mission, including representatives from UK arms companies, to several Arab nations.[6]

In light of these trade deals, it is clear that industrial interests were to the fore in the late 2000s. Yet during this period, Amnesty International had continued to severely criticise the Gaddafi regime for its human rights record.[7] While a case can be made for gradually improving economic ties as a way of reducing hostility between nations, the trading patterns of many NATO countries with Libya can only be described as highly irresponsible. As one security analyst pointed out, if the military sales still under negotiation at the start of 2011 had gone ahead earlier, NATO forces would have had much more serious problems in their military campaign.[8]

The role of the oil industry should not be forgotten either. While it had helped the regime generate a huge income, it had not been silent over the potential for generating greater profits for itself. According to official US documents posted on the Wikileaks website, US oil companies had been vociferously complaining to the Obama government about the restrictions Gaddafi had placed on them.[9]

Criticisms of the NATO strategy

While some mainstream commentators accept that past arms sales to Libya have been irresponsible, they still argue a humanitarian justification for using NATO forces to oust Colonel Gaddafi. However, there are serious flaws in this argument.

Firstly, the death toll from the seven months of conflict (so far) is not small. Rigorous assessment is yet to take place, but Libya's National Transitional Council has estimated it to be "at least 30,000".[10] NATO – which gave a key justification for its involvement as the need to protect civilians – has not been counting. Yet it has carried out over 9,000 'strike sorties' (as of the end of September).[11]

Furthermore, while UN Security Council Resolution 1973 gave permission for "all necessary measures... to protect civilians... excluding a foreign occupation force",[12] it did not give explicit permission for regime change. This led to the rejection of proposals to find a negotiated settlement – including proposals from the African Union – by the anti-Gaddafi forces and NATO countries. Negotiating peace with Gaddafi would not have been easy, but the ensuing war has hardly led to the quick, low casualty victory that was expected.

A further problem with the broad interpretation of UN Resolution 1973 by NATO countries was that it soured relations within the UN Security Council. Attempts to agree subsequent resolutions on, for example, economic sanctions against the Syrian government for its brutal suppression of an uprising have so far failed.

And there is the wider issue about the prioritisation of resources. The NATO military campaign has cost billions.[13] But much smaller sums are still required, for example, to help provide food aid to the 12 million people in need as drought and famine spread across East Africa during the course of 2011. The UN has warned that without more help 750,000 could die between September and December.[14]

Given this evidence, it is hard not to conclude that economic and industrial interests – rather than humanitarian interests – have had the greatest influence over the policies followed by NATO countries, both in the years before the war in Libya and in the decision to help depose the Gaddafi regime.

Dr Stuart Parkinson is Executive Director of Scientists for Global Responsibility.

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Automating warfare is ethically dangerous

Noel Sharkey outlines the disturbing trends in military robotics.

War-fighting is currently undergoing a factory-style revolution. The use of robotics platforms for carrying weapons is coming on track at an increasing rate. US plans from all of the armed forces indicate a massive build up of military robots, and I have personally tracked and validated 51 countries that have either bought them or have development programmes. Currently all armed robots in war are remotely piloted by humans, so called 'man-in-the-loop' systems. Humans are responsible for both target selection and decisions about lethal force. But this is all set to change.

Since 2004, all of the roadmaps and plans of the US forces have been pushing the development and deployment of autonomous battlefield robots.[1] The UK Ministry of Defence Joint Doctrine Note,[2] published in 2011, follows suit. Fulfilment of these plans is well underway. There will be a staged progression towards autonomous operation; first for flight (take-off, navigation, obstacle avoidance, etc.) then for target selection. The end goal is robots that operate autonomously to locate their own targets and kill them without human intervention.[3]

It is said, perhaps too often, that for now a person will remain somewhere in the loop. But their role will shrink to vanishingly small: "humans will no longer be '*in* the loop' but rather '*on* the loop' – monitoring the execution of certain decisions. Simultaneously, advances in AI [artificial intelligence] will enable systems to make combat decisions and act within legal and policy constraints without necessarily requiring human input."[4] So, essentially a person will be on the loop to send in the autonomous swarm and possibly call it off again if radio or satellite contact is available.

Autonomous systems that can select targets and kill them are likely to face a number of ethical and legal problems.[5,6,7] In brief, no autonomous robots or artificial intelligence systems can discriminate between combatants and innocents.[8] International humanitarian law and the laws of war state clearly that belligerents may not attack civilians, wounded soldiers, the sick, the mentally ill, or captives. There are no visual or sensing systems for robots that are up to that challenge. Current sensing apparatus and processing can just about tell if something resembles a human but little else.

USAF

Armed drone on patrol: MQ-9 Reaper

A computer can understand any procedure that can be written in a programming language. We could, for example, give a robot a programmed instruction such as, "if civilian, do not shoot". But there is no precise definition of a civilian. We certainly cannot get one from the laws of war. The Geneva Convention requires soldiers to use common sense. But computers have no common sense.

Even if there was a precise computational definition of civilian, and robots were equipped with the appropriate sensing apparatus to discriminate, it is not appropriate to kill enemy combatants in all circumstances. Both discrimination and appropriateness require the kinds of real-world reasoning that AI systems are notoriously bad at.

Another problem is the 'principle of proportionality', which requires balancing the risks of civilian death with the military advantage to be gained. Again, there is no computational reasoning that would allow a robot such a determination, nor is there any known metric to measure objectively needless, superfluous or disproportionate suffering.[9] It requires human judgement. And yes, humans do make errors and can behave unethically, but they can be held accountable. Who is responsible for the lethal mishaps of a robot? Certainly not the machine. There is a long causal chain associated with robot mishaps: the manufacturer; the programmer; the designer; the department of defence; the generals or admirals in charge of the operation; the robot operator; or the enemy.

Before automating war, lessons learned from the current use of remotely piloted armed robots need to be considered.[10] There is an illusion of accuracy that is leading to the inappropriate expansion of the 'battle space' where many civilians are dying and there are frequent illegal targeted killings by the CIA that allow no chance for surrender or trial. Even worse is the adoption of the technology by so many countries without any kind of international discussion about rules of use, or how the many complex algorithms will interact.

Action

You can help advocate international control of robotic armaments by adding your voice of dissent at: www.icrac.co.uk

Noel Sharkey is Professor of artificial intelligence and robotics and Professor of public engagement at the University of Sheffield. Twitter: StopTheRobotWar

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Millennium *Consumption* Goals: guiding the rich to contribute to sustainability

Mohan Munasinghe recently proposed a progressive development concept at the UN, that would mirror the Millennium Development Goals for the poor with a complementary set of targets for the rich, enabling them to contribute towards sustainable development.

Unsustainable patterns of consumption, production and resource exploitation have led to multiple problems threatening the future of humanity – such as poverty, resource scarcities, conflict and climate change.

The global economy, driven by consumption, already uses ecological resources equivalent to 1.3 planet earths, which is unsustainable. The 1.4 billion people in the richest 20th percentile of the world's population consume over 80% of global output – 60 times more than those in the poorest 20th percentile.[1] Meanwhile, the Millennium Development Goals (MDGs) seek to raise consumption levels of over 2 billion poor people. Clearly, the rich are "crowding out" the poor. Instead of viewing the affluent as a problem, a more positive outcome might result from persuading them to contribute to the solution – using the novel concept of 'Millennium Consumption Goals' (MCGs).

What are MCGs?

The MCGs seek to provide consumption targets designed to motivate the world's rich to consume more sustainably. MCGs for the rich would complement MDGs for the poor.

The MCG idea was recently proposed during preparations for the UN Conference on Sustainable Development 2012 (or Rio+20), in Brazil.[2] The MCGs would be a set of benchmarks (not necessarily mandatory), to which the more affluent could aspire. These targets would encourage a range of voluntary actions, supported by enabling government policies promoting sustainable consumption and production. Existing and planned research provide a basis for already setting both targets and policies.

Addressing underconsumption by the poor, the very first MCG should ensure that basic human needs are met worldwide. Next, addressing overconsumption by the rich, several measurable MCGs would target: GHG emissions; energy; water; land and biomass; ores and industrial minerals; construction minerals, and polluting discharges. Additional MCGs might cover: food security and agriculture; health, diet and obesity; livelihoods and lifestyles; economic-financial-trade systems; and military expenditures.

MCG pathway

There are many advantages to a complementary MCG-based path to global sustainability.

First, they would apply worldwide, cutting across developed and developing country boundaries, and reducing the potential for deadlock due to nationalistic and regional self-interest. Second, relatively small reductions in rich peoples' material consumption (using existing technologies, laws and best practice), can even improve their well-being, while significantly lowering environmental harm and freeing up resources to alleviate poverty. Third, MCGs can be implemented using a soft, inclusive, multilevel strategy. A bottom-up approach is galvanising civil society and business to 'act now', involving pioneering individuals, communities, cities and firms, who are already declaring and implementing their own voluntary MCGs. MCGs often provide a meaningful 'umbrella' for already existing ad-hoc goals. A parallel top-down effort is pushing the MCGs forward more slowly on the UN agenda, creating a global mandate and benchmarks. The MCG concept is both fractal and subsidiary, because the basic idea remains unchanged (like a snowflake) at finer levels of detail, and effective implementation is still possible.

Fourth, rich individuals and communities could be motivated to act effectively in their own enlightened self-interest, since they are better educated, have more influence and command more resources. Fifth, MCG-MDG twinning is possible – e.g., by linking an MCG in a rich community/country with an MDG in a poor community/country. Sixth and finally, MCGs could mobilise, empower and link sustainable consumers and producers (including associated global supply chains) into a 'sustainable cycle'. The same advertising that now promotes over-consumption and waste could be used to encourage more sustainable consumption. Over a period of time, values and habits could be changed society-wide to favour more sustainable behaviour (like the gradual change in attitudes towards smoking). MCGs would "empower the person to define meaningful consumption rather than permitting meaningless consumption to define the person."

MCG Initiative and sustainomics

The Millennium Consumption Goals Initiative (MCGI) was launched by a broad coalition of stakeholders called the MCG Network, to move this idea forward.[3] The MCGs are a key practical tool within an overall strategy for sustainable development, which supplements ongoing initiatives like sustainable consumption and production (SCP) and green economy (GE). All these steps may be linked to a holistic, practical framework for making development more sustainable that I proposed at the 1992 Rio Earth Summit, called 'Sustainomics'. The sustainomics framework[4] provides a set of core principles that help identify and correct unsustainable policies and practices immediately, while balancing economic, environmental and social goals, and transcending traditional thinking and introducing sustainable values especially among the youth. It would be fitting if the MCG idea became part of the agreements and programmes that emerge from UNCSD 2012.

Concluding ideas

The MCGs will encourage consumers and producers to behave more sustainably without lowering their quality of life. There are many existing examples of best practice and we do not need to wait for new agreements. By acting together now on the MCGs, we will make the planet a better and safer place for all our children and grandchildren.

Professor Mohan Munasinghe shared the 2007 Nobel Prize for Peace, as Vice Chair of the UN Intergovernmental Panel on Climate Change. He is Chair of the Munasinghe Institute for Development (MIND), Colombo, Sri Lanka, and holds professorships at several universities, including Manchester and Peking.

This article is an updated version of one that first appeared in 'The Island', January 2011.[5]

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Why we must prepare for a low energy society

Mandy Meikle suggests that the focus on a low carbon future is sending us down the wrong path.

Since the Rio Earth Summit in 1992, the focus for tackling climate change has been on ways to reduce carbon emissions. The 2010 figure for the annual atmospheric CO_2 level is 390ppm, a rise from 356ppm in 1992.[1] Our focus on emissions is failing.

Even though the renewable energy industry is growing, renewable technologies are barely making a dent in carbon emissions, not least because of the pace at which they are being outrun by the rising demand for energy. Countries such as China, India and Brazil have rapidly growing economies; economies grow by using energy and most of that energy comes from fossil fuels. Unless we change direction, the trend will continue.

Compounding this situation is the fact that the search for new sources of fossil fuel is taking us further offshore and into ever more hostile environments, where the costs of extracting energy sources – financial, environmental and in terms of energy itself – escalate quickly.

We have confused talking about tackling climate change with actually doing it. I suggest that we cannot solve climate change by trying to 'decarbonise' our society or even our economy because our society and economy are defined by high levels of energy consumption, and specifically by a dependence on energy-dense, carbon-based sources for that energy. Climate change is the symptom of our unhealthy and unsustainable relationship with energy. We will need to revisit and radically alter the nature of this relationship to solve it.

More than carbon

The tough reality is that renewable energy technologies cannot power the industrialised world in its existing form. In 2008, the total amount of 'primary' energy the world used was 12.3 billion tonnes of oil equivalent and of this, 81% was energy from fossil fuels.[2] In an effort to come up with more understandable numbers, researchers at SRI International, California calculated that the world consumes roughly one cubic mile of oil (CMO) per year.[3] This figure was then used to quantify comparable energy outputs from alternative energy sources with startling results.[4] The study claims that the amount of energy contained in one CMO is equivalent to 50 years of continuous output from four dams the size of the Three Gorges dam, or 52 nuclear power plants, or over 90 million solar panels.

The point of this exercise is not to belittle renewable energy but to wake us up as to just how energy-dense oil is and to how dependent our global infrastructure is on fossil fuel energy, especially from oil. Moving to renewables will not replicate this output. It is not enough to build wind farms wherever the grid can support them, or to transport solar power from the deserts. We need to consider that the future will entail less available, affordable energy for us all.

Many consider nuclear power to be a solution, including the environmental journalist George Monbiot, who made the point recently that it is too much to expect renewables to replace the output from nuclear power plants (around 2% of final energy consumption[5]) as well as from fossil-fuelled power plants. I agree; but argue that, rather than simply accepting nuclear, which has its own problems, we need to reassess our attitudes to energy. The days of cheap, plentiful energy from fossil fuels are coming to an end and neither nuclear power nor renewables nor a combination can replace what fossil fuels have provided for us.

Of this we have had plenty of prior warning, from Hubbert's 1956 paper on the peak production of fossil fuels[6] and the 1972 report *The Limits to Growth*,[7] to extreme weather events, economic collapse and the soaring cost of oil. Yet we are ignoring these warnings.

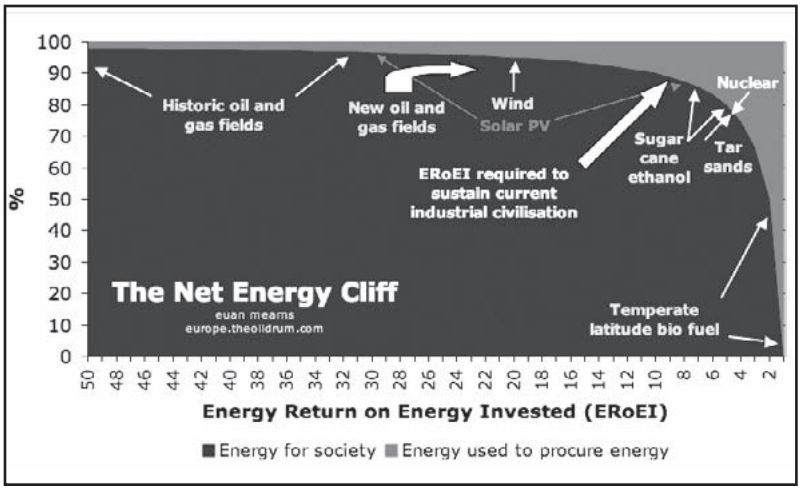
Falling energy returns

A good way to gain a deeper understanding of why a major shift is inevitable is to consider net energy. Current ideas about how to 'de-carbonise' our energy systems either fail to acknowledge the associated fossil fuel input (every device other than those produced by hand from hand-prepared, locally sourced natural materials and dragged to site by horse or human has a fossil fuel input) or fail to actually reduce energy use (for example, carbon capture and storage requires additional energy to run, thereby reducing the energy available from the coal itself) – or both.

Net energy return or Energy Return on Energy Invested (EROEI) – the amount of usable energy 'produced' compared with the energy used to acquire that usable energy – provides an important measure. As the quality of the coal and oil extracted falls, more energy must go into accessing and processing the fuel than was previously the case. In the 1930s, some of the best returning US fields produced oil with an EROEI of 100,[8] meaning that one unit of energy invested in extracting these shallow, onshore reserves produced 100 units of energy – a 99% net energy return. Today the average is about 11.[9] This is still a good return but as the quality falls and as we move to more hostile environments to find new oil, the net energy returns fall. While the debate rages over the size of remaining fossil fuel reserves, their quality receives much less attention.

It is important to recall that industrial societies emerged in the context of energy returns in the high double digits – 50 or more (a 98% return). Today, 20 (a still respectable 95% return) is about as good as it gets (see Figure 1). This might appear to strengthen the position of nuclear power, but the problems of supply and falling quality also apply to uranium supplies.[10]

Relatively little work has been done on EROEI calculations and the figures are hotly debated. Added confusion arises because some authors account for invested energy in financial terms and also because



Energy returns from various sources expressed as % energy returns and EROEI (NB. EROEI are sometimes expressed as ratios, e.g. 50:1 is 50)

of other factors (the return on biofuels, for example, is affected not just by the technology but on local agricultural methods – see Table 1). However, it is clear that historically, oil returned more energy than it does today. The best of the alternatives produce electricity, not liquid fuel, and liquid fuel alternatives do not produce sufficient net energy returns to sustain current industrial civilisation.[11]

Beyond the imagination?

The impossibility of infinite growth and the peaking of all non-renewable resources[13] is something we should be working diligently to address. As Herman Daly puts it, "The closer the economy approaches the scale of the whole Earth the more it will have to conform to the physical behaviour mode of the Earth. That behaviour mode is a steady state – a system that permits qualitative development but not aggregate quantitative growth".[14] In 2010, the New Economic Foundation published *Growth Isn't Possible: Why We Need a New Economic Direction*[15] in which it considers a hamster that does not stop growing at puberty but instead continues to double its weight each week. By its first birthday this 'impossible hamster'[16] weighs nine billion tonnes. There is a reason why in nature things do not grow indefinitely.

A steady-state economic system that maintains, not drains, resources is not a new idea. John Stuart Mill, one of the founders of classical economics, argued that once the work of economic growth was done a "stationary economy" should emerge, in which we could focus on human improvement.[17] Mill was speaking in 1848, before the commercial exploitation of oil unleashed the glut of energy that we have spent the last 150 years expending to develop our complex and populous society.

I would argue that stationary growth is finally here, but it has not been planned as Mill proposed. Rather, it is being imposed by nature because there are limits to growth, whether we like it or not. However, there is great resistance to this perspective. A few years ago, I was talking to a well-respected geologist about the need to stop focusing on a low carbon future and move to a low-energy system. He said, "I can imagine a low-carbon future; I cannot imagine a low-energy one". There are many studies of how society can move away from fossil fuels (such as the Centre for Alternative Technology's *Zero Carbon Britain 2030*[18]) but these are dismissed as idealistic and unworkable.

Energy supply is intrinsically linked to economic growth. To argue that energy supplies are constrained, regardless of the reason, is to argue against the continuation of economic growth. As we in the industrialised world do not have a workable alternative to global capitalism, such arguments are dismissed as scaremongering. Is it that we cannot imagine a low-energy future, or that we do not want to?

Fuel/technology	EROEI
Oil and gas together	19 (2005 global average)
Coal	50 to 85 but in steep decline
Tar sands	1.5 to 7
Oil shale	1.5 to 4
Nuclear power	1.1 to 15
Hydropower	11.2 to 267 (highly site variable)
Wind power	18.1 to 24.6
Solar photovoltaics (PV)	3.75 to 10
Geothermal energy (indirect)	2 to 13
Wave energy	15 (Portuguese Pelamis device)
Ethanol	0.57 (from sugar cane, Louisiana) to 10 (sugar cane, Brazil) 2 to 36 (from cellulose)
Biodiesel	1.93 (from soya) to 9 (palm oil)

Table 1: EROEI values for a range of technologies[12]

What kind of future?

First and foremost, a low-energy future will be a localised future and waste will be a misnomer. While it may satisfy market economics, shipping food around the world is not a viable option in an energy-constrained world. Many people react to arguments against growth-based economics with horror; getting the message across that the current system of endless consumption and economic growth will cease is not going to be easy.

The more I have looked into the energy crisis, the more I feel that the next big leap forward will not be technological, but psychological. We must re-examine our relationship with nature, for all resources come from nature. We need to stop talking about outcomes like saving ecosystems without also asking why we are destroying ecosystems in the first place. As Paul Kingsnorth points out, this squabble between worldviews is not about numbers at all – it is about narratives.[19] We have many cultural narratives to address, but our relationship with energy has to be the first.

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Emerging technologies and risk: the social, cultural and political dimensions

Bronislaw Szerszynski argues that when it comes to new technologies, technical risk assessment is not enough.

We are living at a time in which the pace of technological innovation seems unprecedented. Indeed, some futurologists predict that by the end of the current century, developments in areas such as genetics, robotics, information technology and nanotechnology will have produced a step change in humanity's capacity to control its destiny.[1] But such grandiose narratives often neglect the lessons of history – that technologies rarely, if ever, simply deliver their promised benefits; they also change the world both materially and socially in complex and unpredictable ways. New technologies, then, are risky.

But how should we understand risk? Fundamentally, risk is a particular way of thinking about and handling situations where the outcomes of our actions are uncertain – either just because our knowledge is incomplete, or because the outcome is genuinely unpredictable. Formal, technical risk assessment tries to domesticate such situations by the use of probabilities: we may not know which of the possible outcomes will occur, but if we know their probabilities we can use this knowledge to guide our actions. In this way of thinking, risk is defined as the probability of a negative impact multiplied by the size of that impact: so, for example, if a hazard has a 1% chance of producing 100 deaths, it is equivalent in risk terms to another hazard that has a 50% chance of producing two deaths.

However, the sociology of risk suggests that this is too narrow a view, and that we need to think about risk and new technologies in a more complex way. Firstly, not all situations fit the criteria for risk thinking. The logic of risk assessment is arguably well suited to situations where we are dealing with familiar hazards with known impacts and known probabilities. But the more a situation departs from this ideal, the less helpful risk calculation becomes. In some situations, although we might be confident what possible impacts might follow, we might be unable to assign reliable probabilities to them. In others, we might not even be confident that we have identified all the relevant impact pathways that we ought to be concerned about, let alone their probabilities. This, with hindsight, was the situation that scientists were in when chemicals such as CFCs and PCBs were introduced, and is arguably the case today in respect of emerging technologies such as geoengineering. Under such conditions, conventional risk management is inadequate, and responsibility requires that one proceeds in a precautionary manner, in order to reduce the possible impact of surprise.[2]

Secondly, we might want to question the basic definition of risk as 'impact-times-probability'. It is well known from social psychology that members of the public tend to rate technological risks in a rather different way.[3] They are not only interested in the quantitative characteristics of risks, such as the likely number of casualties over a particular time period; they also respond to qualitative characteristics, such as whether the hazard is familiar or unfamiliar, whether the risks are voluntarily taken or imposed by others, and whether they are fairly distributed. It is important to recognise that it is legitimate to have different priorities and concerns in relation to technological risk.

Thirdly, there is also a danger that the social authority granted to risk as a way of governing technological innovation might result in the neglect of a whole range of other kinds of concerns that people might legitimately have. These include, for example, global equity, the concentration of power, and the subtle shaping of human wants and aspirations. There are many concerns that people might have about new and emerging technologies that cannot be reduced to physical harm to humans or other organisms. Risk talk can *itself* be risky if we allow it to delegitimise such concerns.

Culture and the technological fix

An examination of the role that technology plays in society shows us that it does not simply serve as a means to an end. It also carries complex cultural meanings, both individual and collective. This is a commonplace observation in relation to the public; the public, it is complained, do not react to the real risks of technologies such as nuclear power or genetic modification; instead, they react to meanings that they have projected onto them.

But it is important to insist that cultural meanings and narratives are in play on the *supply* side of technological innovation as well. Institutions involved in all aspects of innovation – science, industry, investment, regulation – are all shot through with their own imaginaries of the future, guiding narratives, values and symbols.

Here I want to focus on one such cultural syndrome: the 'technological fix', also known as the 'magic bullet' or the 'silver bullet'. This is the persistent belief in the possibility of solving complex systemic problems with narrowly technical solutions. The term was originally popularised by the American nuclear physicist Alvin Weinberg in a 1967 book in which he identified what he saw as cheap and effective fixes for a number of complex social problems, ranging from the population explosion, the threat of war between east and west, and social unrest in the inner city.[4]

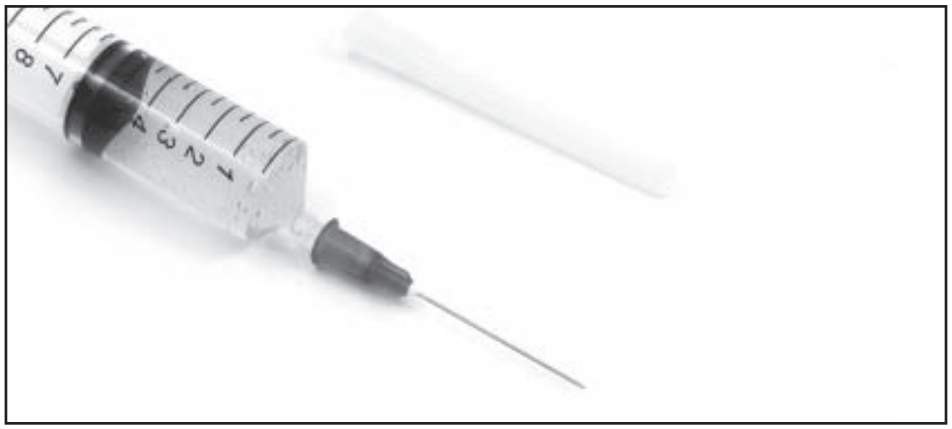
Many have since pointed out the over-simplistic nature of such approaches.[5] Yet the syndrome refuses to go away.

- For example, we know that *food insecurity* is exacerbated by a complex matrix of factors, including the integration of indigenous agro-food systems into global technological and economic flows, resulting in the loss of local knowledge, varieties and agronomic viability. Yet policy responses tend to focus disproportionately on trying to increase crop productivity through high-tech interventions such as GM crops.[6]
- In *health*, too, the emphasis has been on knowledge-intensive forms of medicine such as genomics. Yet experiments in less industrialised countries suggest that developing better health systems, which target resources in line with the local 'burden of disease', can be a far more effective way to improve health levels and life expectancy.[7]
- The rise of *geoengineering* as a serious contender to join mitigation and adaptation as a major element of climate policy also suggests the enduring allure of narrowly technical solutions to complex socio-technical problems.

Why does this way of thinking persist? As Lily Kay commented, one answer, at least, seems to lie in the need of social elites to feel that they can cut through the complexity of the world and find a simple lever that they can pull and change the world.[8]

The role of capital[9]

Innovation is, of course, also shaped by the search for profit, a dynamic that has been strengthened and transformed by the post-1978 rise of neoliberalism, a political ideology favouring markets, trade, property rights and deregulation. In particular, neoliberalism has shifted relations between science, state and markets, encouraging scientists to adopt the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entrepreneurial and utilitarian cultural codes of the private sector, and repositioning universities as would-be engines of a new, knowledge-based economy.

However, this new economy has failed to provide the sort of innovations that could return Western economies to the conditions enjoyed during the 'long boom' that lasted from 1945 to 1973. Those decades saw a massive improvement in productivity, health, and standard of living as a result of the final fruition of a cluster of hugely significant inventions that had emerged in the late 19th century: electric light and motors; the internal combustion engine; the chemicals industries including petroleum, plastics and pharmaceuticals; communication and media technologies; and plumbing and sanitation.[10]

By contrast, despite the proliferation of consumer electronics, the contemporary new knowledge economy has so far not produced anything equivalent to those 'killer' technologies. For example, the application of information technology to industry and office work has seen diminishing returns in terms of productivity.[11] In addition, although the 'biotech revolution' has accelerated drug discovery, this has not followed through into drug development and clinical practice, so has failed to reverse the decline in productivity of the pharmaceutical sector.[12]

The clash between this 'innovation crisis' and capital's endless need for profit has had a perverse effect on the course of technological innovation, with consequences for risk.

- Firstly, it has seen companies going for 'low-hanging fruit' to gain rapid returns on their R&D investment by releasing suboptimal technologies with debateable risk profiles, such as herbicide resistant GM crops.
- Secondly, it has shifted science and technological innovation towards an economy of promise and financialisation, with all the attendant dangers of speculative bubbles.
- Thirdly, the continuing difficulty in obtaining significant profits from conventional commodity production, or by investing in new production technologies, has led companies to seek other ways of increasing profits, by capturing value produced elsewhere in the economic system. Examples here include strategies of concentration (witness Monsanto purchasing large parts of the seed industry) and the 'primitive accumulation' involved in the private appropriation of knowledge produced outside the profit system, for example in indigenous societies or the university system. Such developments involve a different kind of risk, through the undermining of commons, the further impoverishment of the global poor who cannot compete or transform their agriculture, and the increased power of corporations.

Conclusion: letting the public in?

Such observations suggest important roles for the public and civil society in shaping the direction and pace of technological change. Past experience of the introduction of new technologies shows that the 'core sets' of technical experts involved in the development and regulation of technologies are prone to a misplaced confidence in the reliability and comprehensiveness of their knowledge. Taking relevant lay and local knowledge seriously can help scrutinise the robustness of knowledge bases, reduce blind spots, introduce a wider set of values and framings, and help to reduce institutional obstacles to learning.[13]

The rise of neoliberalism has, if anything, moved things in the opposite direction, encouraging a scientisation of risk regulation in which a narrow ideology of 'sound science' is used to exclude the consideration of wider values or precautionary concerns. It is important that such developments are resisted, so that the power to shape our technological future, currently highly concentrated, is more widely distributed in society. Following this latter path could constitute a genuine democratisation of technological change, by bringing into play a wider set of visions of the future and ideas of risk, grounded in the worldviews and experience of the many, not the few.[14]

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Geoengineering the climate

Joanna Haigh outlines the range of options currently being investigated by researchers and technologists to modify the climate system to try to prevent dangerous climate change – but finds that there are no 'magic bullets' here.

By trapping infrared radiation, naturally occurring greenhouse gases maintain the Earth's average surface temperature at about 33°C warmer than it would be without an atmosphere. About two-thirds of this is due to the presence of water vapour and about one-third carbon dioxide, with other gases playing much smaller roles. As the concentrations of man-made greenhouse gases (particularly carbon dioxide and methane) increase so does the trapping of heat radiation so that, in the current state of the climate, the global average surface temperature increases approximately in proportion to the logarithm of the CO_2 concentration.

The most obvious means of slowing down or preventing further warming would be to reduce emissions of greenhouse gases. Concerted international action in this direction, however, has been slow and, currently, there appears to be no credible emissions scenario that could produce a reversal in the upward temperature trend within the next century. Indeed, unless global greenhouse gas emissions are reduced by 2050 to below 50% of their 1990 levels, then it seems likely that global surface temperature will rise by more than 2°C this century. This level of warming has the potential to cause climate change with severe impacts on human activity and the natural environment.

Options for geoengineering

In the absence of sufficient reductions in greenhouse gas emissions, or in order to buy time to reduce emissions, various schemes have been proposed for large-scale intervention in the climate system. These schemes for 'geoengineering the climate' can be divided into two fundamentally different approaches, as follows.

1. Carbon Dioxide Removal (CDR) techniques remove CO_2 from the atmosphere.
These include:

- *Land use management, afforestation*. Careful planting can help limit the growth of CO_2 concentrations, has relatively few side effects (except possible land use conflicts, demands for water or implications for biodiversity) and could be implemented immediately and cheaply. The scope for significant impact is, however, small.
- *Sequestration of biomass*. Crop waste or charcoal can be buried on land or in the deep ocean. Crops grown for bioenergy and biofuels (although with potential adverse impact on food production) might be utilised with CO_2 capture and sequestration (CCS). The potential impacts on ecosystems of all sequestration methods need to be assessed. Methods for sequestration of CO_2 from ocean gas platforms in utsira-formations (layers of sand and brine under the sea floor) have already been designed, and might be implemented for other sources, but the costs are high and the longevity and leakiness need to be better understood.
- *Enhanced weathering*. For this, the absorption of CO_2 by silicate minerals (e.g. olivine) would be accelerated and the resulting solid carbon stored on land or in the ocean. This would involve mining, treatment and transportation of the minerals, with significant energy implications. It would also be slow to take effect.
- *Chemical capture of CO_2 from the air*. 'Artificial trees' have been designed to extract atmospheric CO_2. The technology appears to be feasible, but again must cope with the problems associated with CCS.
- *Enhancement of the take-up of CO_2 by ocean plankton*. This would be achieved by enhancing photosynthesis by increasing the availability of the necessary nutrients – either by 'fertilisation' of the ocean with iron, phosphorus or nitrogen or by (wind or tidal-driven) pumping of deep ocean water to the surface. There is currently insufficient evidence to determine if this would be effective. An important consideration is the potential for undesirable ecological side effects.

2. Solar Radiation Management (SRM) techniques reduce the amount of solar energy absorbed at the Earth's surface by enhancing global albedo (reflectivity) and thus returning some solar radiation back to space. These include:

- *Space-based reflectors*. Proposed schemes include the launch of trillions of small refracting disks up to the L1 (equal gravity) point between the Earth and the Sun or the manufacture on the Moon of refractors made from lunar glass.
- *Stratospheric aerosols*. Sulphate particles released into the stratosphere would simulate the effects of massive volcanic eruptions, which have been shown to introduce temporary reductions in global mean temperature. Of concern here would be the indirect effect on stratospheric ozone concentrations and atmospheric acidity.
- *Enhancement of cloud reflectivity*. It is proposed that this might be achieved by the injection of sea salt particles into clouds (or potentially cloudy regions) from specially designed ships. The salt particles would act as condensation nuclei for cloud droplets and the resulting cloud, composed of more numerous but smaller droplets than might otherwise exist, would have higher reflectivity and, probably, longevity.
- *Enhanced land surface albedo*. This might be achieved through the use of more reflective crops, or by covering deserts with highly reflective material, or by painting urban settlements white. These schemes tend to be very expensive and may produce undesirable local ecological impacts.

CDR techniques may be viewed as preferable to SRM techniques in that they attempt to return the climate to a more natural state and they would, in general, be safer. However, they tend to be very slow to take effect and very costly if they are to make significant impact. Furthermore, the methods for the carbon sequestration required as part of most of these schemes are not well proven to be without undesirable environmental side effects. SRM techniques are inherently less safe than CDR methods in that, while they provide a correction to the global radiation imbalance introduced by the greenhouse gases, they do not return the atmosphere to its natural state. They do nothing to reduce other effects of high CO_2 concentrations, such as ocean acidification, and they place the climate in an unnatural 'High CO_2 Low Sun' state under which regional weather patterns may be quite different, impacting on water or food resources. SRM schemes would, however, be easier than CDR methods to implement (or reverse) swiftly. But if they were introduced with a view to long term mitigation of global warming then humankind would be committed to maintaining them into the indefinite future: any sudden cessation of the SRM would plunge the world very fast into the much warmer state associated with higher CO_2 concentrations.

Ethical issues

While the scientific and technical issues posed in the development of geoengineering methods are challenging, possibly an even greater problem would

come in addressing ethical and political issues. Some of the schemes, such as capture of CO_2 from the air, might be regulated with existing national legislation such as pertains, for example, to air pollution. Other geoengineering methods, such as space-based reflectors, would throw up much greater challenges. There are no clear mechanisms to govern the implementation, operation or control of geoengineering activities as yet.

Another ethical aspect that is frequently cited is 'moral hazard', whereby the potential existence of geoengineering schemes discourages concerted action to reduce CO_2 emissions. I fear, however, that that cat is already out of the bag, and hence we find a surge of international interest in this issue. No geoengineering method has been identified which can address the issue of climate change in a timely, safe and affordable way and the problems of international governance may be insurmountable. It must be reiterated that the safest and most reliable way to combat climate change is to attack the problem at source, to identify alternative sources of low-carbon energy and to use existing energy sources as efficiently as possible.

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New Anglo-French nuclear weapons treaties threaten disarmament

Peter Nicholls highlights how two new 50-year treaties could undermine nuclear disarmament.

Two treaties – known as 'Teutates' (after a Celtic war god)[1] – have been agreed between France and the UK for sharing nuclear weapons research facilities. They were signed in autumn 2010. One is for Defence and Security Co-operation,[2] with the other "relating to Joint Radiographic/Hydrodynamics Facilities".[3] The texts were 'laid upon the table' in the House of Commons but there was no demand for a debate. So under the Ponsonby rule they were cleared for ratification, which has recently taken place. So much for democracy and the alertness of our elected representatives – because these treaties raise serious questions about the willingness of both countries to adhere strictly to the terms of the NPT (Nuclear Non-Proliferation Treaty) and to consider steps towards disarmament.

Their official purpose includes exchange of classified information on nuclear weapons and the creation and operation of joint radiographic/hydrodynamics facilities. The radiological facility in France (Teutates EPURE) will be built at Valduc. The UK Teutates Technological Development Centre (TDC Facility) will be built at the Atomic Weapons Establishment, Aldermaston. The radiographic/hydrodynamics facilities will permit design of new generations of nuclear weapons. This is at odds with the spirit of the Comprehensive Nuclear Test Ban Treaty as well as the NPT. Cooperation between the UK and France is agreed to continue for the next 50 years – beyond the life expectancies of all the signatories including even our youthful Prime Minister. In 1996, the International Court of Justice said: "There exists an obligation to pursue in good faith and bring to a conclusion negotiations leading to nuclear disarmament in all its aspects." This obligation has already been in existence for 43 years. Another 50 years brings us beyond the lifetimes of the initial NPT signatories' children.

There is also a possible loss of UK independence in making any moves towards nuclear disarmament and consequently to alter the focus of research at Aldermaston to purely maintenance, verification and transparency measures instead of warhead development. Information and technical transfers between the UK and France may well conflict with the letter as well as spirit of the NPT.

Absent a Parliamentary debate, the UK and French Abolition 2000 groups held a joint London meeting in February to discuss the consequences of the treaty and our responses to it. We looked at the treaties' technical, legal and political aspects. Outputs of this meeting are available to download.[4,5] The discussions continued at a Paris meeting in June, with outputs being transmitted to our representatives at the meeting of the 'P5' nuclear weapons states, also held in Paris at the end of that month. We are cautiously optimistic that, although ratified, the Teutates treaties' scope will be limited if 'civil society' concern can be demonstrated.

Peter Nicholls is Chair of Abolition 2000 UK, and a Visiting Professor at the University of Essex.

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European security research – it is time for change

Martina Weitsch shows how arms companies – including those from Israel – have obtained public EU research funds, despite military research being specifically excluded from the formal R&D framework.

The European Security Research Programme (ESRP) is part of the European Research Framework Programme Seven (FP7). FP7 amounts to €53 billion over seven years (2007 to 2013), with the ESRP having a €1.4 billion share (2.6%). While this may appear to be only a very small part of the overall funding for research, it nonetheless constitutes a significant amount of public money.

The objectives of the ESRP are specified as: "to develop the technologies and knowledge for building capabilities needed to ensure the security of citizens from threats such as terrorism, natural disasters and crime, while respecting fundamental human rights including privacy; to ensure optimal and concerted use of available and evolving technologies to the benefit of civil European security, to stimulate the cooperation of providers and users for civil security solutions, improving the competitiveness of the European security industry and delivering mission-oriented research results to reduce security gaps."[1]

The programme was a new addition to the Research Framework Programme in 2007. Prior to this, security had not been an explicit part of these programmes. However, during the period 2004 to 2006 a so-called 'Preparatory Action for Security Research' had already allocated €65 million to some 39 projects under the general theme of security.[2]

The Preparatory Action and the ESRP stem from discussions that took place in 2003 in a so-called 'Group of Personalities' led by two European Commissioners.[3] This group had 21 members, of whom eight were representatives of major defence contractors and two were from ministries of defence (listed as research institutions). Yet both the discussion and the subsequent programmes were said to be only about security for citizens and not about national defence or military research, which is specifically excluded. We at the Quaker Council for European Affairs (QCEA) are concerned about dual-use technologies and whether such technology could fall into 'the wrong hands'.

QCEA's analysis[4] of the 114 projects so far financed under ESRP (excluding the Preparatory Action from 2004 to 2006) shows that organisations (and their subsidiaries and associated companies) who were originally in the Group of Personalities are participating in 47 projects: 41% of the total. In terms of EU funding, they represent 53%. A breakdown by organisation is given in Figure 1. (Only organisations with the largest involvement are shown.)

But that is not where our concern ends.

Unlike the Preparatory Action, the ESRP – as part of FP7 – includes associated and other non-EU countries. In other words, research on security technology undertaken by consortia including and sometimes led by participants from non-EU countries is funded from EU public funds. Our analysis of the participation by non-EU countries shows that by far the most significant level of participation comes from companies and organisations in Israel.

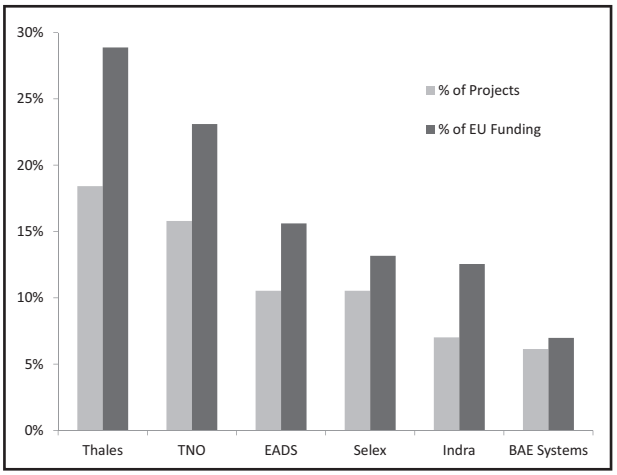

Figure 1 - Participation in the European Security Research Programme by organisations – such as arms companies – represented in Group of Personalities

A total of 30 Israeli organisations are involved in the European Security Research Programme, participating in a total of 24 projects. That represents 21% of all the projects so far funded. No other associated country is involved in so many of the projects. Indeed, seven projects out of the total 114 so far funded are led by Israeli companies. Again, no other associated country leads more projects.

Two Israeli military contractors – Elbit Systems and Israel Aerospace Industries, both of whom produce unmanned aerial vehicles or 'drones' among other military hardware – participate in the programme. Both are involved in different ways in the occupation of Palestinian Territories, notably by supplying technology for the Separation Wall that Israel is constructing in part at least on Palestinian land. Their inclusion in any European programme and their benefiting from any European public funding raises serious legal and ethical questions.

Now is a moment when the scientific research community – along with civil society and political actors – can do something to bring about change. FP7 comes to an end in 2013, and discussions are underway on the preparation of the next Framework Programme.

Now is the moment to raise the key concerns:

- the significant level of involvement of defence contractors in setting the agenda and benefiting from funding for security research and the implication this has for the focus of the programme;
- the high level of access to funding on the part of industries whose representatives were involved in developing the programme and the lack of citizen and civil society participation; and
- the benefit that Israeli actors who are involved in the occupation of Palestinian Territories derive from the programme.

Given that this is public money being spent, there should at least be an open and public debate about these concerns.

Action:

Write to your MEP raising the above concerns.

Martina Weitsch is a representative of the Quaker Council for European Affairs.

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The impact of university research: public or private good?

Philip Moriarty asks whether the practices now followed by UK research councils are doing little more than enabling the government's policy to further commercialise academic research.

In his first keynote speech as Universities and Science Minister back in May last year, David Willetts' words on the societal role of academic research were markedly, and encouragingly, out of line with the prevailing wisdom of the UK research and funding councils: "I'm all in favour of curiosity-driven research whose applications may take time to emerge, if [they do] at all. Intellectual enquiry is worthwhile for its own sake – whether it's devoted to engineering or to Shakespeare..."[1] (Note the all-important proviso: "if [they do] at all").

The idea that academic work might not necessarily have an impact outside a particular discipline, or that there is an intrinsic, non-utilitarian value associated with university research is now anathema to Research Councils UK (RCUK), the umbrella organisation for the seven UK research councils.[2] RCUK has, since 2009, required that all grant applicants submit a 'Pathways to Impact' statement along with their proposal, which should predict how the research proposed will impact on "global economic performance, and specifically the economic competitiveness of the UK; ... the effectiveness of public services and policy; ... the quality of life, health and creative input".[3]

Unsurprisingly, Willetts was back on message only a few months later, stating[4] that "we have to accept that people are looking for a long-term economic return" – the intrinsic value of intellectual enquiry and exploratory research is not a concept easily sold to the Treasury (nor, rather more worryingly, to the research councils). There are, of course, intriguing parallels here with the Coalition's stance on other aspects of higher education. Just as tertiary education is now viewed as a private, rather than a public, good and its value discussed only in terms of the return-on-investment for a student, university research increasingly must demonstrate strong potential for short term (socio-)economic impact for it to be considered worthy of funding.

RCUK argues, of course, that the 'Pathways to Impact' component of grant applications will not affect in any way the funding of fundamental, non-applied research and that it is simply designed to encourage academics to think about the societal and economic impact of their research. The research councils annually distribute of order £3 billion of taxpayers' money, so what could be wrong with expecting those funded from the public purse to consider the wider implications of their work?

This is, at face value, an argument with which few, especially those who are concerned about the societal responsibilities of academic scientists, could quibble. It is essential, however, before blithely accepting the RCUK party line, to examine the motivations for, and the minutiae of, the impact assessment strategy.

The 'Pathways to Impact' requirement was not introduced because RCUK suddenly became concerned that academic researchers were not engaging with the public or not considering the impact of their research on wider society. It is straightforward to source the origins of RCUK's impact drive: the Warry Report,[5] the Lambert Review,[6] and the Leitch review[7] (among other government reports over the last decade) all stressed the need for academic research to become significantly more business-facing. For academic science in particular there was a clear imperative to 'change the culture' so as to encourage entrepreneurship.

The RCUK 'Impact Champion', David Delpy, has used precisely this language, arguing that the research councils need to "shorten and strengthen the innovation chain", that university research would have to be "taken further down the innovation pathway", and that a "culture change" in academia is required.[8] There has thus been a rapidly growing focus on the importance of 'user-targeted research', to the extent that a defining principle of the scientific method – disinterestedness – is disturbingly being eroded.

The number one tip in RCUK's *Top Ten Tips on Completing the Pathways to Impact Statement*[9] reads as follows: "Draft the Impact Summary very early in your preparation, so that it informs the design of your research." That single sentence speaks volumes. It proposes that academics first identify their beneficiaries and users, and *design their research project accordingly*. That strategy is simply not compatible with fundamental scientific research. It is not science. It is instead a description of the 'D' component of 'R&D', or, at best, of highly targeted applied research, and thus, rather conveniently, better suited to the delivery of near-market objectives than the pursuit of exploratory research. RCUK has been particularly canny in marketing its impact agenda as a mechanism to enhance the public value of research when it was primarily devised to improve the responsiveness of academia to private sector requirements.

As Scientists for Global Responsibility highlighted in its influential 2009 report, *Science and the Corporate Agenda*,[10] key defining elements of the ethos of academic research are being progressively eroded by RCUK and HEFCE.[11] What is perhaps most frustrating about these developments is the supine manner in which universities align their strategies with RCUK/HEFCE policy, with little concern for the long-term health of academic disciplines. SGR and, for example, the recently established Campaign for the Public University[12] therefore have an essential role to play in building consensus and coordinating activities to reclaim the public good character of academic research.

Philip Moriarty is Professor of Physics at the University of Nottingham.

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Shale gas: will it undermine progress on tackling climate change?

Martin Quick critically examines the rapidly expanding shale gas industry, in particular its claimed role in helping to reduce carbon emissions.

The discovery of huge global reserves of shale gas has been hailed by many as a solution to energy security problems. Some also see it as a significant part of a strategy to mitigate climate change by substituting low-carbon gas for high-carbon coal, especially if it can used in conjunction with Carbon Capture and Storage (CCS) technologies to deposit the carbon emissions underground.

However, shale gas has its downsides, not least the significant levels of methane leakage that occur during extraction. This could critically undermine the claim that it is a low-carbon fuel.

Shale gas and climate change

Shale gas (comprising mainly methane, CH_4) is extracted from shale rock formations by hydraulic fracturing ('fracking'), using large quantities of water and various chemicals (many of them toxic) injected into the rock under high pressure. While the problem of local water pollution has received a lot of attention, in this article the focus is on methane leakage into the atmosphere. The nature of the extraction process means that it is difficult to prevent such leakage, so there could be serious implications for climate change.

Methane has a global warming potential (GWP) of about 25 times that of CO_2, assessed on the basis of the cumulative effect on the climate system over a 100-year timeframe.[1] CO_2 stays in the atmosphere throughout this timescale, but methane has a much shorter 'life' – thus its warming effect is much greater in the short term than that of CO_2.

Methane also leaks from conventional gas and coal extraction and there is considerable uncertainly associated with estimates of all methane leakages. Robert Howarth and colleagues at Cornell University[2] have compiled ranges for the percentage of gas leaking into the atmosphere through extraction, transport and distribution. These are 3.6%—7.9% for shale gas and 1.7%— 6% for conventional gas.

Assuming that, in the longer term, best practice measures minimise gas escapes, and taking Howarth's lower values in assessing climate change implications, methane leakage from shale gas production is about twice that from conventional gas. We can use these figures to compare the total greenhouse gas emissions (adjusting for different GWPs) for shale gas, conventional gas and coal.[3] This calculation reveals that the total greenhouse gas emissions of shale gas are about 70% of that of coal, compared with the figure of 50% generally claimed for conventional gas.[4]

The effects of methane leakage are most noticeable on a 20-year time frame, so the warming effect of this leakage will be felt earlier than the effects of CO_2 emissions. Oceans warmed by this front-loaded methane in effect absorb less CO_2 and so result in a positive feedback loop that exacerbates the effects of the CO_2 emissions. The result is an increased time-integrated temperature rise.

Shale gas and CCS

Deploying CCS at the point of combustion is often presented as a major component of an energy portfolio that includes fossil fuels yet enables suppliers to deliver large greenhouse gas emission reductions. So far, the main emphasis has been on CCS for coal combustion, but gas-fired plants incorporating CCS are also now being considered, including one in the UK. Although many of the individual components and systems have been tested, no large-scale experience of CCS in practice yet exists.

In any case, significant methane leakage in the extraction and transport of the fuel before it reaches the power station or plant will significantly reduce the effectiveness of CCS in minimising greenhouse gas emissions. Assuming CCS captures 90% of the CO_2 emissions from the plant, and accounting for emissions from leaks before that point, the total greenhouse gas emissions from shale gas electricity generation with CCS would be about three times greater than from the CO_2 emissions alone and around 30% greater than for coal,[5] even allowing for the greater efficiency (approximately 20% lower heat input) of gas-fired power stations. For conventional gas, the equivalent calculation gives total emissions slightly less than those from coal generation with CCS. These are shown in Figure 1.

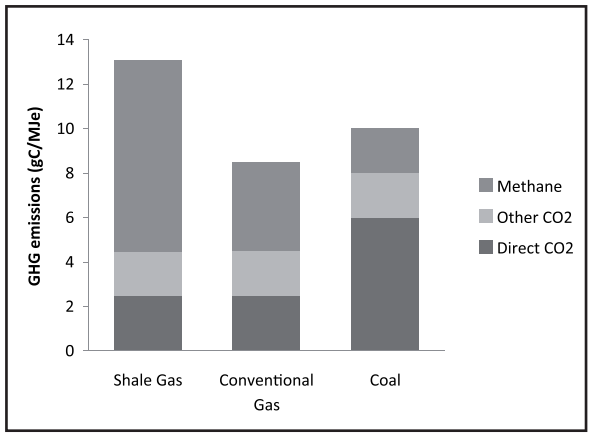

Figure 1: Total (direct and indirect) greenhouse gas emissions per unit of electricity output from power stations burning shale gas, conventional gas and coal, all incorporating CCS.

Implications for future energy policy

The indications are that huge quantities of shale gas could be available globally. However, analysis suggests that methane leakage from shale gas between extraction and combustion is significant enough almost to negate the claimed advantages of shale gas using CCS and could even make the climate change impact of shale gas comparable with that of coal.

The oil and gas industry is currently lobbying heavily to greatly expand the exploitation of shale gas in many places around the world, including the UK. While using relatively small amounts of gas could assist in (for example) improving energy security, major reliance on shale gas would be counterproductive, especially as it could squeeze out further development of renewable energy technologies.

Martin Quick CEng is a retired mechanical engineer, and former member of SGR's National Co-ordinating Committee.

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5. As note 4.

Energy conserving buildings – the human factor

With energy use in buildings being a major contributor to carbon emissions, reducing that energy use is a goal that is gaining considerable support. However, Genevieve Jones argues that if there is too much focus on using technology to achieve that goal, and not enough on considering human behaviour, energy use may actually be increased rather than reduced.

> *"Whatever their particular causes, environmental problems all share one fundamental trait: with rare exceptions they are unintended, unforeseen and sometimes ironic side effects of actions arising from other intentions." David Orr*[1]

Energy use in buildings is the result of a number of complex interacting factors including construction materials, structure, location, orientation, user expectations and lifestyle. Most of the emphasis to date has been on reducing energy use primarily by reducing thermal losses through conduction and ventilation, water and space heating and cooling. This is also important for reducing fuel poverty and premature winter deaths.[2] Expectations of indoor comfort have changed over time with increasing indoor temperatures in the winter and use of air conditioning in the summer. The investigators of occupancy behaviour in Dutch residences concluded that an energy intensive lifestyle in a very energy efficient residence can lead to a higher energy use than an energy extensive lifestyle in a less energy efficient residence.[3]

Much of the research and debate on thermal comfort neglects surface temperatures, for example those of walls and floors. If surface temperatures are low, occupants will give off body heat to the surfaces by radiation and conduction. In a British winter, this is likely to feel uncomfortable and therefore, if it can be afforded, the heating is turned up, which in turn increases heat loss through the walls and roof. Obviously, in warm climates or on hot summer days cooler surface temperatures such as those created by stone walls are more desirable. Thus thoughtful design of surfaces can lower the use of energy for heating and cooling.

Sun and daylight

The use of daylight can reduce energy use but the design of windows should take into account the possible uses of the room. Simplistic designs tend to have large south-facing windows to maximise the use of natural heat and light, but this can lead to overheating, glare and unwanted sun. For example, it is rare these days to enter a classroom and find daylight. Usually blinds are drawn and the lights are on long after the sun must have stopped being a problem. The daylight has been shut out with the sun. Changing needs such as the increased use of computers and whiteboards can further increase the use of blinds and electric lighting. Research on offices in Vienna found similar problems. In one office where energy use was monitored it was found that the south side used more electricity than the north side.[4]

A salutary example of the failure of a 'passive solar' design, which actually led to increased household energy use, is that of the conservatory. A survey by Tadj Oreszczyn of University College London examined user behaviour for over 1,800 conservatories.[5] 90% were heated either directly or indirectly in winter, and some were even air-conditioned in summer. So, while building scientists intended the conservatory to provide a temperature buffer for the house, the overwhelming majority of users are not using them in this way.

Passive solar housing: the technical-human interface

Low-energy building design in the Northern Hemisphere uses the sun for space and water heating and maximises daylight. High levels of insulation in walls, floors and roofs reduce thermal losses through conduction. Strategies for reducing heat through ventilation solutions involve careful detailing to stop accidental air leakage through joints, junctions and service intakes. Designs for fresh air however vary from user-controlled windows to the PassivHaus solution[6] of mechanical ventilation with heat recovery, which is usually automatically controlled.

A design that relies especially heavily on new technologies is the Sigma house, intended to comply with the UK government standard for zero carbon homes.[7] However, the concern is that these dwellings will require specialist servicing in order to maintain their design performance and users will be restricted from making internal alterations or repairs in case they compromise the airtight seals.

Researchers at Oxford University have noted that "Comfort may… be achieved in a wider range of temperatures …when it is something that individuals achieve for themselves… Ventilation controls... must not become so sophisticated that they are unintelligible to the people who must live with them day by day. This is a recipe for losing the potential gains from properties that are highly energy-efficient on the drawing board but lose most of those gains when in use".[8]

There is also a related concern that the low levels of ventilation required in these buildings can lead to health problems because of mould growth where humidity is high and from toxic off-gassing from furnishings and construction materials.[9]

Conclusion

Technical fixes aimed to reduce energy use, but that ignore human expectations and behaviour, can actually cause the opposite to happen. Part of the solution is to educate users but energy use in buildings should be reduced by increasing comfort through robust construction, without unnecessarily technical 'eco-bling'. This should include high levels of insulation, bio-regionally appropriate design,[10] low levels of accidental ventilation and simple user controls over their environment.

Genevieve Jones recently retired as a lecturer in sustainable design and technology at Robert Gordon University in Aberdeen. She has designed and built her own low energy house.

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The Luddite uprisings – lessons for technology politics now

It is 200 years since the Luddite uprisings in northern England. David King argues that the motivations of the Luddites have been misrepresented, and that we need to look again at their legacy.

The 200th anniversary of the Luddite uprisings stretches from November 2011 until January 2013. These uprisings resulted from the imposition of new technologies, which put many out of work. Today, science and technology raise a wide range of social, environmental and ethical concerns but, from genetically modified crops to climate engineering, these concerns are rarely addressed properly, partly because anyone who raises criticism is denigrated as a 'luddite'. History has been written by the victors and the Luddites are portrayed as opposed to all technology and progress. It is ironic, however, that while the ideology of progress through technology has hardened into a rigid dogma – which condemns all critics as 'irrational' or 'anti-science' – the Luddites were very selective about which machines they destroyed, and opposed only machines 'hurtful to Commonality', i.e. the common good.

The Luddite uprisings

The Luddites were textile workers in Nottinghamshire, Yorkshire and Lancashire. They were skilled artisans whose livelihoods and communities were threatened by the new factory system, with its combination of machines, such as shearing frames and power looms, and other practices that had been unilaterally imposed by the aggressive new class of manufacturers who were driving the Industrial Revolution.

In 1799, the Combination Acts had banned trade unions, while wages were being cut and unapprenticed youths being employed. In 1809, laws that prohibited machines that displaced labour were repealed. Workers feared unemployment, which often meant destitution and starvation. The situation was made worse by major reductions in the cloth trade due to the wars with France.

The uprising began in Nottingham in November 1811, and spread to Yorkshire and Lancashire in early 1812. The Luddites first warned mill owners to remove the frames. If they refused, the machines were smashed in nocturnal raids. For nearly a year, despite flooding northern England with spies and more troops than were deployed to fight Napoleon in Spain, the authorities made few arrests.

Then, in February 1812, the Frame Breaking Act introduced the death penalty. In Yorkshire, attacks had been highly successful in the smaller workshops. But the most famous attack, by around a hundred men on William Cartwright's Rawfolds Mill in April 1812, was unsuccessful since Cartwright had hidden troops in the mill. Two of the Luddites were killed. After these deaths, for the first time the Luddites turned to assassination, killing William Horsfall, another large mill owner. After this, the Luddite attacks on machines declined, and some Luddites turned to night-time raids on armouries, in the hope that a general armed insurrection could be mounted. But in October 1812, the authorities finally arrested George Mellor, a key leader of the Yorkshire Luddites. He and 13 others were hanged together at York in January 1813. By the end of the uprisings thousands of frames, a significant proportion of the total number in England had been smashed.

The cause of the Luddite uprisings was the imposition of the new free-market/industrial regime. These uprisings can be seen as the last gasp of the old order against the coming Industrial Revolution or, as Kirkpatrick Sale puts it, "a rising not against machines but against The Machine."

The politics of technology today

This anniversary comes at a timely moment because, at the beginning of the 21st century, the negative consequences of the industrial capitalist system are becoming so severe that they can no longer be ignored. From climate change, resource depletion and biodiversity loss to epidemics of mental illness, drug addiction and crime, the downsides of this system are leading to disillusionment with the conventional narrative of 'progress'.

While many of these problems are widely accepted as being due to the unregulated free-market, the crucial role of science and technology is often not well understood. As the great apologist for industrialism, Andrew Ure, wrote in 1835, "This invention confirms the great doctrine already propounded, that when capital enlists science in her service, the refractory hand of labour will always be taught docility." Because the Luddites exposed this best-kept secret of industrial capitalism, they have been portrayed not merely as another bunch of troublemakers, but as opponents of progress who 'want to go back to the stone-age'.

Since the Industrial Revolution, science and technology have become the crucial drivers of capitalism, which has in turn driven massive social change. The result has been an endless cycle of 'technological fixes' – normally in the form of a product that can be sold by corporations – rather than a process of democratic decision-making about the central processes by which our society develops. This democratic deficit has often led to a backlash against specific technologies, such as GM crops.

But while more democracy is essential, the crisis of industrial society forces us to address the question of which technologies and economic and social structures we need for a sustainable and just world. While the Luddites were not anti-technology, their example calls to us to look for paths away from industrial capitalism. Our task is to go forward, but in doing so we should not be afraid to (in part) seek inspiration from the technologies and social forms of pre-industrial society. However, in our times the challenges are different, and so will require new technologies, but those appropriate to a world in which a key value is the fostering of Commonality.

Scientists and engineers have a key role to play in this process, but in order to do so they must abandon the arrogance of assuming that they define what the problems are. Technology must be developed through dialogue with society at large.

Get involved

The Luddites 200 Organising Forum – http://www.luddites200.org.uk – has been set up in order to help celebrate the anniversary and to encourage debate on the politics of technology now.

Dr David King is Director of Human Genetics Alert.

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After the tsunami

Michael Poteliakhoff was visiting Japan when the Tohoku earthquake and tsunami struck on 11th March. Luckily, he was not caught in any of the danger zones, but gives his impressions of the first few days as the devastation became apparent and the emergency at the Fukushima nuclear plant began to unfold.

My wife and I had travelled to Japan on 3rd March to visit my wife's family and take a holiday. We were lucky that, when the earthquake and tsunami struck on 11th March, we were on Kyushu, the southern-most of the main islands – over 1,000 kilometres from the epicentre. My wife rang her sister in Tokyo that afternoon and she told her, "I'm holding on to the furniture – there's been a terrible earthquake." In our hotel, we watched TV coverage with scenes of houses, cars and boats being thrust inland by torrents of black water, of people desperately fleeing to higher ground, and of the stricken Fukushima no. 1 nuclear plant. Another guest said the problems at the plant looked serious. It was unclear how many people had been killed in the earthquake and tsunami, but obviously it was going to be a large number.

But despite the devastation, I had the sense that people knew what to do. The Japanese people have been well-drilled in earthquake and tsunami preparedness and disaster response and they seemed to get on calmly with the task in hand. Yet the scale of the disaster was immense. For a few days, stranded survivors had to write out messages such as "No water" in school playgrounds in an effort to attract the attention of spotters in helicopters. But the rescue and relief effort rapidly scaled up. The mood of the nation shifted. Keep on with life as normally as possible, but avoid self-indulgence. Celebration events were cancelled and TV channels stopped broadcasting commercials.

We returned to Tokyo on 16th March but, due to the disruption to train services, we were not able to reach my wife's sister in the suburbs and so we stayed with friends near the centre of the city. Over the next few days, events at Fukushima – less than 100 km away – became our main worry. With memories of Chernobyl, I feared the worst.

Michael Poteliakhoff

Shelves are empty as food is diverted to disaster areas

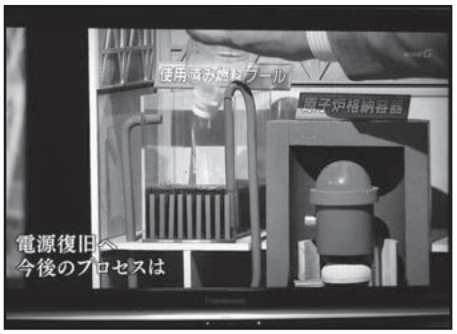
The next day I cycled along the almost deserted national highway no. 1 to the local 'conbini' (convenience store). I grabbed a few precious cartons of yoghurt and a newspaper. Headlines read "Radiation fears grow after blasts" and "Radiation levels spike in Tokyo". A kind lady asked if I was okay. Obviously, I was looking worried, but I reassured her in my best (not very good) Japanese that I was fine. Back at my friends' house, we all nervously watched the TV. We discussed whether to tape up the gaps in the windows as a precaution. The SGR email list was useful, with people discussing which might be the most reliable sources of information on the Fukushima emergency (thank you, SGR members!).

It was clear that the officials interviewed on TV did not seem at all confident about bringing the reactors under control. The news media sought out various nuclear power experts to comment. They speculated on the scale of reactor problems and the chances of successful resolution, but they did not seem that confident either. It was striking just how unprepared the Japanese government and industry were for dealing with a nuclear accident on this scale. Helicopters dumped seawater on the overheating reactors, then water cannon were brought in, and finally concrete pumping machinery (some diverted from delivery to Vietnam) was adapted to pump water to try to cool the reactors and the spent fuel ponds. The government took over management of the situation from TEPCO (Tokyo Electric Power Company), which owned the plant. Prime Minister, Naoto Kan was overheard asking TEPCO bosses, "What the hell is going on?"

In the following couple of days, some of the train lines that had closed started to run a 50% service out of Tokyo, so we travelled back to my wife's family. This was worse than central Tokyo as, in addition to shortages of petrol, milk, bread and instant noodles, they had a timed programme of rolling blackouts. But we were all very aware that this was nothing compared to the suffering of the communities hit directly by the tsunami or evacuated from around the Fukushima plant.

A week later we were safely back in London – but it was obvious from the continuing reports on NHK World TV that the Fukushima emergency was a long way from being over.

Michael Poteliakhoff



Status update on the Fukushima nuclear emergency on NHK TV

Of all my observations during this time in Japan, there was one that was the most striking. This was the contrast between the public attitude towards the devastation of the tsunami and that towards the Fukushima nuclear emergency. While the tsunami caused an immense amount of damage and loss of life, it was over quickly, and there was a planned response that was being followed, however difficult. With Fukushima, there was a much greater sense that control had been lost – the government and the nuclear industry did not know how to deal with it safely, and the impacts were continuing and uncertain. With memories of the radioactive pollution due to the nuclear bombs dropped on Hiroshima and Nagasaki being rekindled, the confidence of the Japanese people in the future safety of nuclear power had, it seemed, collapsed.

Michael Poteliakhoff is an architect and a former member of the Executive Committee of Architects and Engineers for Social Responsibility.

The race for the nuclear exit

Continued from p.1

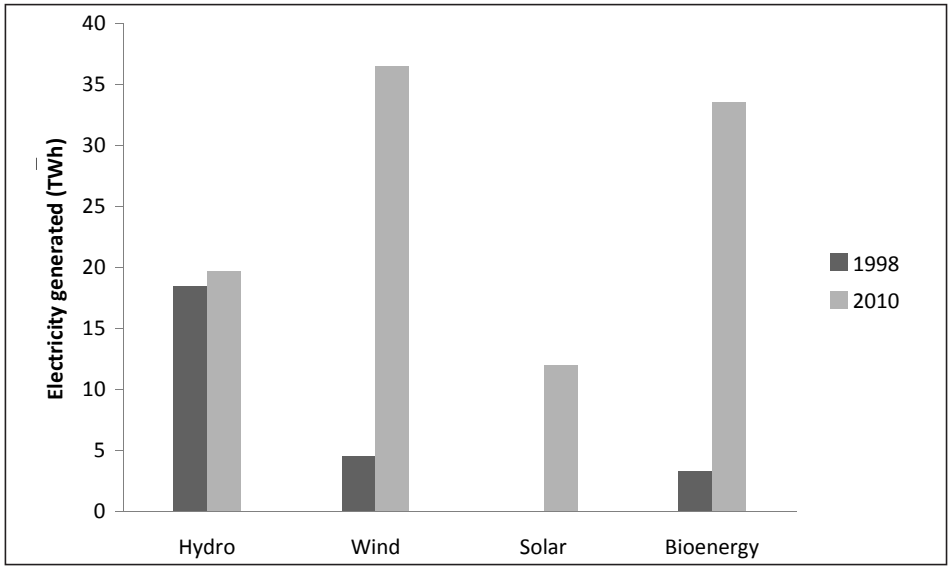


Figure 1 – Electricity generated by renewables in Germany for 1998 and 2010

country's nuclear reactors, which, when all were running, generated 26% of Germany's electricity. The two biggest operators, E.ON AG and RWE AG, opposed the decision, but were outvoted.

On rapid completion of its energy review, the government formally announced at the end of May, that all nuclear power stations would be closed by the end of 2022, and there would be a speedy transition to an energy system based on renewable energy.[4]

Will Germany succeed?

German Environment Minister, Norbert Röttgen, told *Der Spiegel* that he was confident that it could be done, given the rapid growth of renewables and the potential for energy saving, but "everyone will have to invest in the energy turnaround. The expansion of renewable energy, the power lines it requires and the storage facilities will cost money... But after the investments are made, the returns will follow."[5]

So what is envisaged? Röttgen explained: "First we'll have to focus on retrofitting buildings. The €460 million currently budgeted for that program won't be enough." Secondly, there would be a major expansion of renewables, although he said there would be no need to cover Germany with wind farms, as some critics had suggested. "We will achieve the biggest capacities by replacing smaller wind turbines on land with more powerful ones and by generating wind energy in the North and Baltic Seas." He concluded "The events in Fukushima marked a turning point for all of us. Now we jointly support phasing out nuclear energy as quickly as possible and phasing in renewable energies."

In 2010, 17% of Germany's electricity came from renewables, rising to over 20% in the first half of 2011,[6] and the potential for expansion is certainly there in the long term. In addition to backing a nuclear phase-out, last year's *Energy Concept* review, produced by the Federal Environment Ministry (BMU), projected that renewables could supply 35% of electricity by 2020, rising to 80% by 2050.[7] It saw offshore wind as a major growth area – with 25GW in place by 2030 – as well as major new bioenergy projects, with biogas seen as a key new option, replacing imported natural gas. The review also called for primary energy consumption to be halved by 2050, via a major energy efficiency programme. Overall, the review aimed for a 40% cut in greenhouse gas emissions by 2020.

This review has provided the basis for a new German programme, with increased support for renewables, including €5 billion to increase offshore wind power, financed by the German State Development Bank, KfW, and plans for the construction of 'electricity highways' to bring renewable power from windy northern Germany to industrial areas in the south. Some of the existing 7,800 kilometres of high voltage grid run by the German railways may be used for part of this. It also planned major increases in grid integration with the rest of the EU. The Wall Street Journal said the report "marks a significant shift as Germany ceases to debate whether to phase out its reactors and focuses more on how quickly and at what cost".[8]

It won't be easy. But the political will seems to be there to try.

Will Japan follow Germany's lead?

What about Japan? After all, it now has a much more direct and pressing incentive to change its energy policy. The very large anti-nuclear demonstrations in Germany were not matched in size by those in Japan, but then public protest is a rare thing in that country – and getting 7,500 on the street was surprising. According to an Ipsos-Mori poll conducted in May, opposition to nuclear power had risen to 58%.[9]

After many protests concerning the five-reactor Hamaoka complex, on the coast near an earthquake fault around 200km from Tokyo, the operators agreed to close it while sea defences and safety upgrades were installed. A government analysis had predicted an 87% chance of a magnitude eight earthquake in the Tokai region within 30 years with the risk of a major tsunami.[10]

The government has also said that it would abandon its plan to expand nuclear power. Before Fukushima, nuclear power was supplying 29% of Japan's electricity, and there were plans to expand that to 50%. But now the emphasis will be on renewables and energy efficiency.[11]

Japan has no significant indigenous fossil fuel resources and imports most of its energy, and it has downplayed renewables in favour of nuclear power. However, it was at one time a world leader in solar PV production, and it has extensive renewable resources, including offshore wind, wave, solar, hydro, biomass and geothermal.

A 2003 report commissioned by Greenpeace – *Energy Rich Japan* – claimed that Japan could make a full "transition to clean, renewable energy without any sacrifice in living standards or industrial capacity".[12] Technology has moved on massively since 2003, so, although demand has risen, a transition from nuclear should not be out of the question, over time. After all, some of Japan's nuclear capacity has, in effect, phased itself out – very painfully.

Notably, outgoing Japanese Prime Minister Kan said that Japan should "aim to realise a society in the future where we can do without nuclear power stations".[13]

Will others countries follow?

Technology is not really an obstacle to moving away from nuclear power. Many studies have suggested

that the EU and indeed the world could expect to get up to 100% of their electricity and most of their total energy from renewables by 2050.[14] Even the conservative International Energy Agency said that 75% of global electricity generation from renewables is possible,[15] with a recent report from the Intergovernmental Panel on Climate Change estimating that 77% of total energy could come from renewables by 2050.[16] The real issue is thus the political will to focus on renewables and the efficient use of energy, rather than diverting yet more resources to nuclear.

Many countries have already made up their minds. Within Europe, Austria, Denmark, Portugal, Ireland, Norway, and Greece are among those who have never had nuclear plants and remain opposed to the technology, while some others, including Spain, Switzerland and Italy, are implementing phase-outs.[17] Spain already had a nuclear phase-out policy before Fukushima, although it had to some extent stalled. However, major protests there are providing new impetus. This summer the Swiss government decided to abandon a nuclear plant replacement programme, so in effect nuclear power will be phased out by 2035. Italy voted in a referendum in 1987, after the Chernobyl disaster, to close its existing nuclear power plants, but the government had recently pushed ahead with legislation enabling new build to start. However, after Fukushima, public disquiet mounted and the government reverted to a 'no nuclear' policy, with a referendum producing a staggering 94% opposed to nuclear power.

In Sweden, which had recently reversed its nuclear phase-out policy, opposition rose after Fukushima, with 51% opposed to nuclear power.[18] Meanwhile, Finland is still facing major delays and cost overruns in the construction of its new nuclear plant at Olkiluoto.

Even traditionally pro-nuclear France is now wobbling. The new plant under construction at Flamanville has been further delayed as a new safety review is undertaken, while opposition to nuclear power rose to 67% according to an Ipsos-Mori poll in May.[19] The government recently announced that it would carry out a major review of energy policy, which would even include the option of a nuclear phase-out by 2050.[20]

In the USA, support has also collapsed. 71% had favoured nuclear power, according to a survey for the Nuclear Energy Institute carried out before Fukushima, but afterwards support fell to 39%, with 52% opposed, according to the Pew Research Center.[21]

In Asia, Thailand and Malaysia have both abandoned their nuclear programmes, while the Philippines government may 'rechannel' its £100m nuclear budget to renewables.[22] China has halted all new nuclear development projects, pending a review. It should perhaps be noted that China's renewables programme was already much larger than its nuclear programme. It is now the world leader in wind, with 45GW in place, and gets 16% of its electricity from renewables, with plans for massive expansion.[23] It was aiming to get 15% of its total energy (not just electricity) from renewables and other low carbon sources by 2020, whereas it was only planning to expand nuclear from the current 2% of electricity to 4% by 2020 – and that may now change. It has already indicated that it may double its solar PV targets.[24]

India is still pressing ahead with plans for nuclear expansion, although there has been strong opposition. Violence recently erupted at a demonstration against the proposed Jaitapur nuclear power plant, and a protestor died. Russia is also sticking with nuclear power come what may, as are some former Eastern-bloc states.

What about the UK? With some public opinion polls suggesting that roughly equal numbers are for and against, there are still proposals for the largest nuclear new build programme in Europe. This is in a country with some of the world's best renewables resources – most of which are so far untapped. However, city analysts have been scathing about the prospects for new nuclear investment in this country,[25] arguing that the government is being very optimistic. The Scottish government is taking a very different line to Westminster, opting for a new target to generate 100% of its electricity demand from renewable sources by 2020, with no new nuclear.[26]

The nuclear renaissance is looking decidedly shaky.

David Elliott is Emeritus Professor of Technology Policy at the Open University. He is Editor of 'Renew', the newsletter of the Network for Alternative Technology and Technology Assessment - http://www.natta-renew.org/

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This article is an updated version of one entitled 'Nuclear exit: Germany leads the way' published on the SGR website in May 2011.

Continuity/change: rethinking options for Trident replacement

Nick Ritchie, Department of Peace Studies, University of Bradford, June 2010, 95pp.

Review by Kate Macintosh

It is fascinating (if depressing) to read this close analysis of the thinking of the military mind. One quote stands out for me as summarising many of the carefully teased-out findings: "Since the end of the Cold War our force planning has been increasingly capability-based rather than threat-driven". That is, the technology available rather than any perceived threat is driving procurement.

This report is the latest in a series of publications examining the UK's nuclear weapons strategy. It looks at the justifications given for Trident replacement and how it might be scaled down, given that the unilateral disarmament option does not seem to be politically realisable at the moment.

The author sets the context with a history of the development of Trident, the UK's deterrence doctrine (i.e. the theory that deterrence requires one submarine to be on operational patrol at all times) and the destructive power of the missiles.

The report examines the replacement or 'successor' programme, within which we are currently in the 'assessment' phase. This phase concludes with the 'Main Gate' decision, beyond which reversal or change of plan is pretty much impossible. Main Gate was planned to be in 2014 but has, since this report was published, been shifted back until after the next general election. Given the poor state of government finances – especially the military budget – the pressure to reconsider the current plans for the successor programme is high.

One argument for Trident made by the Ministry of Defence is that close cooperation with the US (from whom we lease the ballistic missiles) strengthens the trans-Atlantic alliance.

A further argument, made by industry representatives, is that a nuclear powered ballistic missile submarine (SSBN) or a nuclear powered attack submarine (SSN) should be built every 22 months to ensure that skills are retained. This means, then, that sustaining the industry becomes a political objective in its own right.

In the second part of the report, four intertwined options for moving towards a reduction in our nuclear arsenal are examined, as is the possible reinterpretation of the doctrine of 'minimum deterrence'.

The first of these, 'Trident-Lite', looks at a replacement programme that adheres to current understandings of 'minimum deterrence'. A 2009 analysis of minimum deterrence from the Federation of American Scientists defines this as "requiring only that nuclear weapons be able to impose sufficient costs on a potential attacker to make the initial nuclear attack appear too costly." Based on this definition they argue that "targeting should be on those resources crucial to a nation's modern economy, e.g. electrical, oil and energy nodes, transportation hubs."

During the Cold War, the assumption behind the arming of our fleet of four submarines – each designed to carry up to 192 nuclear warheads, each warhead having an explosive power close to 100 kilotonnes (the Hiroshima bomb was about 14 kilotonnes) – was the so-called 'Moscow Criterion'. This determined that the number of warheads available must be capable of destroying the Soviet decision-making apparatus in the Moscow area, taking into account its anti-ballistic missile defences.

Yet even though the MoD has stated that the Moscow Criterion is no longer operative following the end of the Cold War, no alternative criteria for targeting have been articulated.

Trident-Lite looks at the possibility of reducing the numbers of submarines from four to three (as Gordon Brown suggested in 2009) and at reducing the number of missile launch tubes per vessel, from 16 to 12. This would be facilitated by the design of the new reactor, 'Core H', powering the submarines. Since it would have the same life expectancy as the rest of the submarine, the need for a major refit half way through the vessel's life would be eliminated.

The second option looks at ending Continuous-at-Sea Deterrence (CASD). The military's reasons for maintaining CASD are as follows.

1. To provide invulnerability to 'first strike' from an adversary.
2. Under 'reduced readiness' (i.e. with three instead of four vessels) the putting to sea of a submarine could be seen as an escalation in a situation of crisis.
3. The maintenance of operational expertise.

However, following the collapse of the USSR, the need for CASD has been questioned by Lord Guthrie, retired Chief of Staff and Lord Owen, former Foreign Secretary. The maintenance of a nuclear capability is described as serving a 'political' rather than a 'war-fighting' purpose.

It is accepted, in military circles, that the only power that could deliver a pre-emptive strike is Russia, and that the possibility of that happening is close to zero. Furthermore, it is doubtful that the calculations of any potential adversary on the risks of making such a strike would be greatly affected by a reduced risk of retaliation. Indeed, the late Sir Michael Quinlan is quoted as saying in 2006 that "even a modest chance of a huge penalty can have a great deterrent, assuming of course that the aggressor is 'deterrable'."

The report also examines the possibility of dual-use submarines (i.e. a hybrid between SSGNs and SSBNs) with a potential for cost savings and greater flexibility. The expertise required for operating the two types is very similar so this could alleviate the current recruitment problems into the fleet.

This, then, is a hard-headed report, which examines the basic defence criteria used to justify our so-called, one-remaining 'independent nuclear deterrent,' and explores ways in which it could be minimised and reduced in cost, while fulfilling the military objectives. It is hoped that it will be closely examined by both the MoD and the Treasury, as well as proving to be a useful resource for peace lobbyists, before we reach the 'Main Gate' point of no return.

Kate Macintosh MBE was Vice-Chair of SGR from 2005 until 2011.

Nuclear weapons abolition: an idea whose time has come

Rebecca Johnson, Abolition 2000 UK (Blackaby Paper No. 8), April 2010, 20pp., £3.00.

Review by Mario Orsi

In this paper, Rebecca Johnson discusses major issues and future prospects in the international endeavour to ban nuclear weapons. In the world's arsenals there are about 25,000 of these weapons, whose combined power is theoretically sufficient to destroy the whole of humanity instantly. This awesome menace can be ended straightforwardly, in principle, by abolishing nuclear weapons. In reality, however, the implementation of such an idea is proving problematic.

To overcome current and long-standing difficulties, the paper puts forward two main proposals. First, the use of nuclear weapons must become illegal under international law. This would put restraints on potential users, legitimise prevalent public opinion, and motivate world leaders to pursue outright abolition. In particular, it is proposed that any use of nuclear weapons (no matter by whom and with what justification) be legally recognised as a crime against humanity. Second, a global nuclear weapons convention must be instituted. This treaty would detail realistic conditions and timetables for the permanent dismantlement of all arsenals. Initial steps would involve taking all nuclear weapons off alert, and removing warheads from their delivery vehicles. Moreover, it is proposed that all weapons-usable fissile material be secured and managed by an international agency. This would also address the problem of the large stockpiles of weapons-usable plutonium produced by reprocessing spent fuel in nuclear power plants.

Johnson also stresses civil society's fundamental role: an informed public must pressure governments to take concrete measures, and to engage seriously with each other and with the relevant international institutions. Organised popular action is especially needed to counter the powerful interests of the nuclear and military establishments.

An issue that the paper might have considered involves the greatly counterproductive stance of the USA. For example, the USA is the only country deploying nuclear weapons outside its territory;[1] it consistently votes against United Nations resolutions on nuclear disarmament (even in astonishing isolation);[2] and it has been providing essential support to nuclear weapons development in India, Israel and Pakistan.[3] With such policies maintained by the world's supreme superpower, how can nuclear weapons ever be eliminated? This is a problem that abolition strategies should arguably treat as a priority.

Mario Orsi is a Research Fellow at the University of Southampton.

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Our common strategic interests: Africa's role in the post-G8 world

Tom Cargill, Chatham House, June 2010, 47pp.

Review by Martin Bassant

This report was written after the financial 'crash' of 2008 but before the recent uprisings in North Africa and the Middle East. I found it both thoughtful and useful as a reference for those working on issues such as economics, climate change and GM crops.

Even though this is a wide-ranging policy document, authors wishing to publish on climate change would benefit from reading the sections on how the G8 has viewed Africa. In a continent the size of Africa, being aware of which organisations you would wish to influence is of prime importance.

As an up-to-date publication, this document explains the politics of the transition from the G8 to the G20, giving us a better understanding of the G20 countries than we normally glean from the UK media.

There are useful references on how the individual governments of the G20 work with Africa and how they see the continent from both an economic and political point of view. There are a number of tables providing details of trade between G20 countries and Africa, as well as a useful table on the percentage of individual natural resources in that continent.

Of interest to us in the UK, the report highlights how successive UK governments have been tarnished by scandals such as BAE Systems' arms deals in South Africa and Tanzania. In addition, the report views the UK as primarily interested in development and humanitarian issues as well as the position of Zimbabwe. It is also interesting to compare the UK position with that of other EU members.

In the G8 Africa Action Plan of 2002, several commitments were made including: promoting peace and security; fostering trade and economic growth; promoting sustainable development; expanding digital opportunities; health promotion (including in the area of HIV/AIDS); and improving agricultural productivity and water management. There is an annex covering which of these commitments have – or have not – been met. This could prove useful for NGOs in their efforts to bring about change by effective targeting and the use of the 'correct' jargon.

SGR members and other scientific/technological workers may be particularly interested in the references to Western attitudes to Africa and the missed opportunities that have arisen.

I think that this is a useful reference document for some members and I look forward to an update after the outcome of the present struggles in North Africa and the Middle East is clearer.

Martin Bassant is a member of SGR's National Co-ordinating Committee.

Emerging technologies: are the risks being neglected?

SGR conference and AGM 2011, 21 May 2011
The Gallery, Alan Baxter and Associates, London EC1

Review by Tim Foxon

Stuart Parkinson, SGR's Executive Director, welcomed the 55 participants to the conference. He introduced the theme of the event, explaining some of SGR's historical concerns about emerging technologies, including the high uncertainties related to environmental and social effects, and the power of vested interests – especially large corporations and the military – in driving the policy agenda in this area.

Geoengineering the climate

The first presentation was given by Professor Joanna Haigh of Imperial College London, who discussed the challenges raised by proposals for 'geoengineering the climate'. These come in two main forms: Carbon Dioxide Removal (CDR) techniques, which remove CO_2 from the atmosphere through enhancing biological or chemical uptake processes; and Solar Radiation Management (SRM) techniques, which reduce the amount of solar energy that is absorbed by the Earth's surface by enhancing global albedo (reflectivity) and thus returning some solar radiation back to space. She discussed the potential undesirable environmental and social side-effects of these ideas, and problems of global governance that they raise. For example, if solar radiation management techniques were adopted, then they would probably need to be maintained indefinitely, as any sudden cessation would plunge the world very fast into the much warmer state associated with higher CO_2 concentrations. An ethical aspect that is frequently cited is 'moral hazard', whereby the potential existence of geoengineering schemes discourages other actions to reduce CO_2 emissions, such as identifying alternative sources of clean energy and using existing energy sources as efficiently as possible.

Harry Tsoumpas

Professor Joanna Haigh

Robots on the battlefield: ethical and humanitarian implications

The second presentation was given by Professor Noel Sharkey of Sheffield University, who discussed the ethical and humanitarian implications of automating warfare through 'robots on the battlefield'. He noted that the use of robotics platforms for carrying weapons is coming on track at an increasing rate, and that the US, UK and other militaries are increasingly pushing for autonomous systems, with an end goal of robots operating autonomously to locate their own targets and kill them without human intervention. He passionately argued that this raises serious ethical and legal problems. For example, autonomous robots or artificial intelligence systems cannot discriminate between combatants and innocents, including civilians or wounded or captured soldiers, or judge levels of appropriate or proportionate force. Furthermore, their use risks the situation of nobody being held accountable for the lethal mishaps of a robot. Prof Sharkey ended by calling on others to support the International Committee for Robot Arms Control (ICRAC)[1] that he is involved with. (SGR has already signed up in support of this organisation.)

Harry Tsoumpas

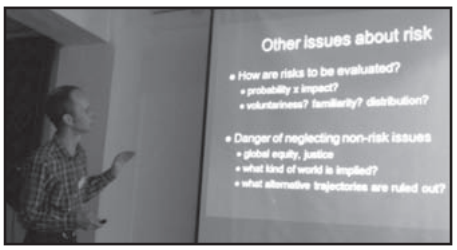
Professor Noel Sharkey

Harry Tsoumpas

Questions from the floor

Emerging technologies and risk: the social, cultural and political dimensions

The third presentation was given by Dr Bronislaw Szerszynski of Lancaster University, who discussed the social, cultural and political dimensions of emerging technologies and risk. He argued that narrow technical assessments of risk are not appropriate under conditions of high social and technological uncertainty, and that a precautionary approach is necessary in order to reduce the possible impact of surprises. He discussed the dangers of the 'technological fix', which is often presented as the 'silver bullet' solution to complex challenges such as food security, health inequalities and climate change. He argued that the growth-based economic system means that capital's endless need for profit has a perverse effect on the course of technological innovation, with consequences for risk. He ended by arguing for greater roles for the public and civil society in shaping the direction and pace of technological change in order to incorporate relevant lay knowledge. This can help scrutinise the robustness of knowledge bases, reduce blind spots, introduce a wider set of values and framings, and help to reduce institutional obstacles to learning.



Harry Tsoumpas

Dr Bronislaw Szerszynski

The three talks were well received, and generated a large number of interesting and informed questions from the audience, though also a recognition of the serious challenges faced in addressing these problems, which are in fact interconnected.

Poster session

Following lunch, the poster session stimulated further discussion of these issues, with posters ranging from the potential hazards of shale gas and GM crops to the inspiration of the Luddite uprisings, which aimed to ensure that the benefits of new technologies were shared equitably by the workers.

Posters

Technologies: their emergence, crises and decay in logarithmic time
Alan Cottey

The 200th anniversary of the Luddite uprisings: implications for radical scientists
David King

GM crops: known problems and future risks
Eva Novotny

Can you indict a robot?
Jason Leake

Shale gas: climate change cure or curse?
Martin Quick

The potential hazards of light at night
Paul Marchant

Adverse effects of electro-magnetic radiation on humans, animals and plants
Patty Hemingway

Ethical and environmentally safe investing: how do we stop misleading promotion and the flow of money to dangerous and unethical ideas?
Tessa Burrington

Harry Tsoumpas

Poster session

Annual General Meeting

The final session of the day was SGR's AGM. This included discussions on SGR's activities since the last conference and future plans, as well as the election of the new National Co-ordinating Committee (NCC). Stuart Parkinson reported on the high levels of activity, including: completing and publishing a new report entitled Science and the Corporate Agenda; giving a large number of presentations on science and ethical issues to academic, campaigner and policy audiences; and working with other organisations to lobby policy-makers. An example of the latter was our support for the Renewable Energy Tariff Coalition, whose actions led to the introduction of the Renewable Heat Incentive for small-scale renewable heat projects. One especially high profile activity was an open letter to the Prime Minister on spending cuts, which was signed by 36 professors, arguing for any cuts in the science budget to come from Ministry of Defence's R&D budget, especially that related to nuclear weapons. Philip Webber closed the meeting by thanking again the staff and officers for their work over the last year, and looking forward to continuing to raise SGR's profile and effectiveness over the coming year with the active assistance of the members.

The conference was the subject of a three-page article in the June 2011 edition of Professional Engineering.

Articles based on the three main presentations can be found on p.6, p.10 and p.12

Dr Tim Foxon is a Reader in Energy Policy at the University of Leeds, and a member of SGR's National Co-ordinating Committee.

References

1. http://www.icrac.co.uk

Harry Tsoumpas

Letters

Letters to the editor should be sent to <newsletter@sgr.org.uk>. Letters longer than 250 words are likely to be shortened depending on space constraints. They may also be edited for clarity.

Limits on solar photovoltaics?

There were several excellent articles in SGR Newsletter 39. The one by David Elliott, *FiT for Purpose? Renewable Energy Funding in the UK*, contained some interesting facts. However I think it could easily mislead, particularly because there was no mention of the all-important 'capacity factors'.

Germany is the nation with the most experience of solar PV. As published in the *Berliner Zeitung*, Stephan Köhler, head of Germany's energy agency DENA, foresees problems in the German grid when PV capacity reaches 30 gigawatts (GW), which is equal to the country's weekend power consumption. The German average power demand is 74GW, so he foresees problems when PV capacity reaches 30/74, about 40% of average demand.

Average electricity demand in the UK (with its smaller population) is about 45GW, thus on the same basis, problems can be foreseen around the point that the UK has 0.40 x 45 = 18GW of PV capacity. So when Elliott mentions "the government's 2050 Pathways Analysis report talked of perhaps 95GW peak," it is entirely misleading, without explaining that this would be quite impossible without some as yet undeveloped method of storing electricity to deal with outputs that would exceed even average electricity demand.

As mentioned, the capacity factors of renewable energy devices are of fundamental importance, and the capacity factor achieved with PV in the UK would be in the order of 12%. Thus the mooted 18GW of PV capacity would only produce about 0.12 x 18 = 2.2GW, which is about 5% of UK electricity demand.

The low capacity factor of PV is a major reason why it would be unwise to install even 18GW of capacity. To do so would leave little room to make use of wind turbines — another renewable energy device that makes uncontrollable inputs into the grid, yet with a capacity factor approaching 30%, wind turbines could contribute a much higher proportion of electricity than the aforementioned 5% from PV.

Andrew Ferguson

David Elliot replies: "It's true that PV capacity factors are much lower than those for wind, but what also matters is the end use: e.g. PV is well matched to summer daytime air conditioning loads, which will grow globally as climate change takes hold. When available at other times of the year, PV can replace

power from other power plants on the grid, which can then be used when there is no PV input – you don't necessarily need to store energy. You can also delay some demands, via smart grid interactive load management techniques. But there are limits to this time-shifting, and storage, although expensive, would help lift them. (Some clever new storage ideas are emerging, e.g. molten metal hydride storage: www.safehydrogen.com). Exporting/importing locally excess PV (and wind, wave, tidal) power via a pan-EU High Voltage DC supergrid would also help to balance variable supply and demand. The best mix of sources will depend on local/national contexts, and economics. I have no special brief for PV (wind is currently the cheapest major new renewable), but prices are falling and the UK potential seems to be larger than has been previously suggested."

Prioritising low energy options

I am in wholehearted agreement with the letters of Dr Mandy Meikle and John Davies (*SGR Newsletters 38 & 39*). The energy availability crisis we face is the flip side of the climate crisis. Each makes the other more challenging.

Slowing the decline in fossil fuel supply, by encouraging the exploitation of coal, shale gas and tar sands, worsens the climate challenge, but speeding the decline worsens the challenges of rapid adaptation to a lower-energy way of life. Renewables help, but they are plainly in no position to fill the gap smoothly.

With no ready solutions on the supply side, we must look to reduce energy demand. This is the one solution that helps in all regards, and groups like the Transition Towns and policy suggestions like Tradable Energy Quotas (TEQs; a type of carbon/energy rationing) are already leading the way.

It would be a step forward to see SGR engaging with these initiatives to move the debate forward.

Shaun Chamberlin, Kingston, Surrey

Editors' note: Due to the level of interest shown by SGR members in low energy options, we have included two articles in this issue of the newsletter by Mandy Meikle (p.8) and Genevieve Jones (p.17).

Rebound effect and other problems with energy efficiency

Martin Quick's article in *SGR Newsletter 39* is informative, but including improved energy efficiency as a way of combating global warming (fundamentally important, he says, to the concept of the European Roadmap 2050) needs to be questioned. Although the Jevons Paradox dates from the 19th century, it has been justifiably resurrected and shown to be highly relevant to the today's burgeoning energy crisis (see e.g. J H Polimeni et al, Eds. *The Jevons Paradox and the Myth of Resource Efficiency Improvements*, London, Earthscan, 2008). Simply put, it maintains that efficiency gains lead to lower prices and increased demand and consumption, the opposite of what we need. Some economists have tried to play down the most direct effect of this paradox, called the 'rebound effect', but empirical evidence shows it is substantial. For example, much higher fuel efficiency has been achieved for motor vehicles, but their numbers and the miles driven have increased dramatically. When indirect effects are incorporated, in which scale effects come to bear, the overall economy and energy use are expanded significantly.

Let me emphasise, I am all in favour of increased energy efficiency, but to believe it will lead to reduced consumption in a developed world dominated by profit-driven corporations, which will use any savings to expand further, is unrealistic. Unfortunately, China and India are following the same development road and their increasing energy demands will certainly outweigh any efficiency gains.

Charles Pearson, Cambridge, UK

Martin Quick replies: "Certainly in the past, energy consumption in many sectors has increased despite efficiency improvements. However, I think in the future energy costs are likely to rise significantly: as cheap supplies of oil and gas become scarce; with increasing competition from China and India for resources; and with the additional costs of switching

to low carbon alternative energy sources. Thus, people may not have so much spare money to spend on energy intensive goods and services, despite efficiency improvements."

Should flagship medical research centre be relocated?

This letter follows on from questions raised at SGR's 2008 and 2009 AGMs and further discussion on sgrforum, SGR members' email list.

Abandoning the Category 4 provision for 'deadly' pathogen work at The Francis Crick Institute (formerly the UK Centre for Medical Research and Innovation) in Somers Town in central London (House of Commons Select Committee, February 2011) excludes it from "being one of the leading medical research centres in the world". Therefore, there is no longer a need for the separate entities of London University, Medical Research Council, Wellcome Trust and Cancer Research UK to carry on with building at the Brill Place site. As a consequence of this, could they not now seek an alternative way forward?

Cancer Research UK, in particular, should welcome this opportunity to get out of this mistaken marriage of convenience, whereby its dowry of voluntary funds, accumulated and accumulating, would dry up as its identity and known work became lost through assimilation into a management with a CEO directing the Institute as a single workplace.

The new building, covering the entire three-acre site, is incapable of expansion. Therefore, if Cancer Research UK – overcoming the previous named barrier – became wealthier and wanted to expand it could do so only by displacing someone else. Or leave to set up again as a separate institution.

The Medical Research Council can, as a result of this situation, use its present site of 47 acres to carry out its programme for improvements, and this could be done at a fraction of the £650 million cost of Brill Place.

Pathogen research, of course, must go ahead whilst bearing in mind comments made at a previous Select Committee hearing on this subject, when the USA and Germany facing the same problem of biosecurity, each had considered off-shore islands as being the most secure.

Lacking such, the MRC could examine the practicality of building a science park for pathogen research and possibly combining this with a hospital for undiagnosed patients. This could be done in conjunction with World Health Organisation. At present, there is no international dedicated hospital for this purpose.

A site for this village could possibly be at Berners Roding, near Chelmsford. This, an emptied village with only its church – which has to be maintained in good order to remind us of its former habitation – is farmed as a single, 5,000 acre unit by the Co-operative.

If this option were to be followed, this would allow Camden to build on land granted to it during British Library negotiations in the 1970s – including a swimming pool, houses and open spaces – and contribute to lessening the ten year gap in life-expectancy between Somers Town and residents of Hampstead, less than two miles away.

It says something extremely significant about our local health-network when the Wellcome Trust, University College Hospital and London University, all within 15 minutes walking distance of Somers Town, can have facilities and many hundred people engaged on research and yet totally ignore a report prepared in 2006 by Professor Kessel for Camden's Primary Care Trust, which fully detailed Somers Town's deficiencies.

Alan Spence, Bury Place, London WC1A

Energy saving thoughts

Because reducing CO_2 emissions from power stations is so important, I feel John Davies' letter *(SGR Newsletter 39)* is wise to emphasise the need to reduce energy consumption in the industrialised countries. I would like to suggest that reducing the use of heating in buildings must surely be one of the easiest ways to start.

But this needs to be made easy for people! I would like to see systems developed and routinely installed where, in addition to its thermostatic valve, each radiator also carries an electrically worked on/off valve, operated whenever the light switch is used. Thus that radiator would only use heat when the light is on. Heat is invisible and thus wasted, but an unneeded burning light (using perhaps one twentieth of the room heater's energy) is always switched off! True, rooms would not be warm when first entered, but thermostatic valves provide a rapid temperature rise before they automatically ease down as room temperature rises. And the light would not be wasted even in daytime – it would contribute its own few watts to the heat in the room.

And if I may, a further energy saving proposal: I would love it if governments promoted electric city cars small enough to be quickly loaded in the side of special electric main-line trains, where they would be recharged from the overhead line whenever the motive power was not taking full current (i.e. downhill and when coasting into stations). Just think – a network of such trains would make the range of electric vehicles unlimited, while saving oodles of city CO_2 and other pollution!

Finally, an appeal for good science! I was appalled to see in a colleague's house a kettle specially made to only boil one cup at a time, despite being fillable with the usual litre or two. This is a ridiculous waste of manufacturing resources as, except in a heatwave (a rare event in GB!), any excess heat from boiling a full kettle will not be wasted as it will also contribute to the heating of the house; whereupon, if necessary, a room thermostat will duly reduce the amount of heating fuel used.

Bob Rainbow AMIMechE, Penmorfa, Gwynedd

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- Stuart Parkinson
- Vanessa Spedding
- Kate Maloney
- Gill Aitken

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