Scientists for Global Responsibility

Irresponsible Science?

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Executive summary

This report reveals a previously unrecognised pattern of financial links between the fossil fuel and arms industries on the one hand, and some of the UK's leading professional engineering and science organisations on the other. The links revealed include funding and branding of school education programmes, sponsorship of prestige conferences and dinners, investments, major donations, and corporate membership. The professional organisations that received the most significant funding from these controversial industries were the Royal Academy of Engineering, EngineeringUK and the Energy Institute.

We found that some of the most influential professional engineering and science organisations prominently and, at times, preferentially promoted the fossil fuel and arms sectors. This is despite these industries having serious ethical shortcomings, such as failing to take the necessary scale of action to reduce carbon emissions or continuing to export weapons that fuel conflict and human rights abuses. Of most concern, some professional bodies promoted these industries to school children and other key audiences, but failed to discuss important ethical issues. Many invested large amounts in these companies, but did not acknowledge potential conflicts of interest. Most also failed to publish key financial data which would allow their members and others to hold them to account.

For ethical and reputational reasons, we argue that professional bodies should both be much more transparent about their income from corporations, and take major action to reduce and/or eliminate their financial links with the fossil fuel and arms industries.

This would allow the professional organisations to properly fulfil their goal of providing responsible leadership for the science and engineering community, and help accelerate urgently needed action to tackle the enormous environmental and security problems currently facing the world.

Scope of the study

Professional engineering and science organisations (PESOs) – which include professional institutions and learned societies – play a very important role in modern society, setting standards of conduct and providing leadership for scientists and engineers. As such, PESOs help the world gain a wide range of important social and environmental benefits. Yet society is also facing enormous threats created by the irresponsible use of science and technology. These threats include the global climate and air pollution crises, as well as the resurgent nuclear arms race, increasingly brutal conventional wars fuelled by the international arms trade, and growing risks from cyber and robotic weapons. At the centre of these problems lie very powerful fossil fuel and arms corporations. Yet the financial and institutional links between these industries and PESOs have rarely been investigated in depth.

This study seeks to fill this gap. We uncovered a wide range of financial relationships between PESOs and the fossil fuel and arms industries, and critically examined these links. To do this, we investigated a sample of 20 leading PESOs, all based in the UK, but many having international memberships. We focused on four main financial links – funding of school education programmes; investments; event sponsorship; and corporate membership schemes – as well as other areas in which we could find data. We also looked at relevant organisational policies, especially charters, mission statements, investment policies, and environmental statements. We used publicly available sources, such as annual reports, financial statements, and organisational websites. We found in many key areas that transparency was very poor, which was especially

disappointing given that openness is a cornerstone of scientific work.

Key findings

In more depth, the key findings of our study are as follows (with the numbering referring to sections in the main report).

School education programmes (section 4.2)

- Nine PESOs in this study published teaching resources or ran school education activities that were sponsored or otherwise directly involved fossil fuel or arms corporations. In most cases, details of the relationships were not transparent and we could only find very limited information on the specific financial links between those education programmes and the corporations concerned.
- We concluded that three PESOs ran school education programmes which had 'high' or 'very high' levels of involvement with the fossil fuel industry – the Royal Academy of Engineering, EngineeringUK, and the Energy Institute. For example, the available data showed that over 70% of the external funding received by the Royal Academy of Engineering for its recent school education programmes was from fossil fuel corporations. Meanwhile, EngineeringUK had received funding of at least £1m from Shell for its programme, 'Tomorrow's Engineers'.
- We concluded that two PESOs ran school education programmes which had 'very high' levels of involvement with the arms industry – the Royal Academy of Engineering and EngineeringUK. For example, almost all of the downloadable teaching resources provided by the Royal Academy of Engineering on its website involved arms corporations – mainly BAE Systems – and/or the armed forces and/or promoted military technologies. Meanwhile, the sole 'lead sponsor' of the high-profile 'Big Bang' science fair – the lead organiser of which is EngineeringUK – has been BAE Systems for many years.

Investments (section 4.1)

- We concluded that four PESOs held 'very high' levels of investments in the *fossil fuel industry* – the Energy Institute; EngineeringUK; the Institute of Physics; and the Royal Statistical Society.
- The *transparency* of investments was generally very poor. For the 15 PESOs in our study that held investments, we were able to identify only where approximately 5% of their total assets were held (although there was a large variation in openness between individual PESOs). Indeed, the disclosure was generally so poor that we were unable to determine whether any PESOs held high levels of investments in the *arms industry*. The two PESOs with the highest investments – The Royal Society and the Institution of Engineering and Technology – had some of the lowest levels of disclosure.
- Of 20 PESOs studied, only one – the British Psychological Society – had an *ethical investment policy* which restricted investment in the fossil fuel or arms industries. Five other PESOs held no investments in these industries due to their practice of not holding investments listed on stock exchanges or similar. These five were: the Association for Science Education; BCS - The Chartered Institute for IT; the Institution of Environmental Sciences; the Institution of Structural Engineers; and the Science Council.

Events sponsorship (section 4.3)

We concluded that:

- three PESOs received a 'very high' level of events sponsorship from the *fossil fuel industry* – the Energy Institute; the Geological Society; and the Royal Academy of Engineering. For example, the Energy Institute runs International Petroleum Week, an annual event which involves a prestigious international conference, sponsorship dominated by the oil industry and related sectors, and income measured in millions of pounds.

Recent sponsors included Rosneft, Russia's state-controlled oil company. Meanwhile, BP has been a sponsor of the Royal Academy of Engineering's prestigious annual dinner for at least three years in a row, and nearly 90% of the external sponsors of the Geological Society's events were from the fossil fuel sector.

- five PESOs received a 'high' or 'very high' level of events sponsorship from the *arms industry* – the Institution of Engineering and Technology, the Royal Academy of Engineering, the Institute of Physics, the Institution of Mechanical Engineers, and EngineeringUK. Industrial sponsors of these organisations' most prestigious events included some of the largest and most controversial corporations including BAE Systems, the Atomic Weapons Establishment, and Lockheed Martin.

Corporate membership and other relevant links (section 4.4)

We concluded that:

- three PESOs had 'high' or 'very high' levels of other financial or institutional links with the *fossil fuel industry* – the Energy Institute; the Geological Society; and the Royal Academy of Engineering. For example, 70% of the Geological Society's corporate members were from the fossil fuel sector, while the Engineering Teaching Fellowships run by the Royal Academy of Engineering were funded by ExxonMobil. The Energy Institute's president was, until 2019, a former managing director of Shell.
- three PESOs had 'high' or 'very high' levels of other financial or institutional links with the *arms industry* – the Institution of Engineering and Technology; the Royal Academy of Engineering; and EngineeringUK. For example, among the Institution of Engineering and Technology's major donors were BAE Systems, Thales and Airbus.

Other relevant issues (section 4.5)

- Seven PESOs in our study stood out due to the positive extent of their *environmental policies and practices*: the Chartered Institute of Environmental Health; the Engineering Council; the Institute of Physics; the Institution of Civil Engineers; the Institution of Environmental Sciences; the Institution of Mechanical Engineers; and the Royal Meteorological Society.
- Virtually none of the PESOs in our study regarded the *ethical issues related to arms industry* and peace issues more broadly as worthy of policy or activity – not even in relation to school education programmes.

Further detail is provided in the main report, with in-depth material given in a set of 20 case studies – one for each PESO – available as appendices to this report on the SGR website, **https://www.sgr.org.uk/**

Recommendations

Our recommendations are as follows.

1. PESOs should be *much more transparent* about the extent of their financial links to controversial sectors, including the fossil fuel and arms industries, especially those related to school education programmes, investments and high prestige event sponsorship. This should include:
    a. Disclosing all payments from corporate sources worth over £1,000 for school education programmes and event sponsorship in annual accounts.
    b. Disclosing the specific investment funds in which *all* their assets are held.
    c. Proactively working with investment fund managers to increase the level of disclosure of individual companies in which their funds are invested.
    d. PESOs should *review all financial links* with fossil fuel and arms companies, especially those related to school education programmes, investments and high prestige event sponsorship.

2. PESOs should *end all branding of school education programmes* (including teaching resources and in-school activities) by fossil fuel and arms corporations.
3. PESOs should commission educational materials aimed at school-age children which *discuss the ethical issues* related to the exploitation of fossil fuels and the use of military technologies.
4. PESOs should enact policies which *restrict or eliminate financial links to fossil fuel corporations* based on ethical criteria such as:
    a. The extent of the company's involvement in high-carbon fuels such as coal, unconventional oil (e.g. oil sands) and unconventional gas (e.g. shale gas);
    b. The extent to which the company is reducing the share of fossil fuel exploitation within its activities;
    c. The extent to which the company is pursuing 'Paris-compliant' policies and practices.
    d. In defining and applying such policies, PESOs could make use of the sources provided in sections 2.2 and 3.3, and appendix 21.
5. PESOs should enact policies which *restrict or eliminate financial links to arms corporations* based on ethical criteria such as:
    a. The extent of its sales of military equipment to Human Rights Priority Countries;
    b. The extent of its involvement in nuclear weapons development, manufacture or deployment;
    c. The extent of its involvement in military artificial intelligence programmes which could accelerate the development of lethal autonomous weapons.
    d. In defining and applying such policies, PESOs could make use of the sources provided in sections 2.3 and 3.3, and appendix 21.
6. PESOs should enact policies which *eliminate financial links to all corporations which have received significant penalties* in the last five years related to law-breaking or major malpractice.
7. PESOs should commission *briefing materials and/or courses* for their professional members on the relevance of *climate change and peace-building* to their work, if they have not done so already.
8. PESOs should agree and *implement environmental policies and practices* which aim to minimise the impacts of both the organisation itself and its professional members, if they have not done so already.
    a. PESOs should make use of best practice environmental management systems, such as ISO 14001, net zero carbon targets, and independent monitoring and verification.

1. Introduction

This report investigates and critically examines the financial links between two of the most controversial economic sectors – the fossil fuel and arms industries – and some of the leading professional engineering and science organisations in the UK.

Engineering and science bodies play a very important role in modern society, setting standards of professional conduct and providing a source of leadership for scientists and engineers. As such, these bodies help the world gain a wide range of important social and environmental benefits. Yet society is also facing enormous threats created by the irresponsible use of science and technology. The two areas on which we focus in this report are environmental and security threats, both because the scale of them is so large, and because they are often intertwined. In the environmental realm, there are urgent global threats to, for example, the climate system, air quality and biodiversity. In the security realm, there is the resurgent nuclear arms race, increasingly brutal conventional wars fuelled by the international arms trade, and growing risks from cyber and robotic weapons. Central to these problems is the behaviour of very powerful fossil fuel and arms corporations.

Many professional engineering and science bodies have had a close working relationship with corporations – given that the latter are major employers of scientists and engineers. However, as corporations have become more powerful, concerns have grown about whether they have too much influence over the professions, and thus make it harder for engineering and science organisations to adequately warn of the consequences of, for example, inaction on major threats to society and the environment.

Such concerns have been brought into focus especially by the activities of the tobacco industry since the 1950s. Although aware of the damaging health impacts of their products, the industry has been able to exert considerable influence within political, medical and public arenas either to prevent legal restrictions being placed on its products or reduce their scope – and it continues to do so in many countries. There is already compelling evidence that some of this behaviour has spread to other powerful sectors such as fossil fuels, pharmaceuticals, chemicals and armaments.[1,2,3,4]

This report focuses on the extent of financial links between the fossil fuel and arms industries and professional engineering and science bodies in the UK. The financial links that we explore mainly include:

- investments;
- funding of education activities aimed at school children;
- event sponsorship; and
- corporate membership schemes.

The report is structured as follows. In chapter 2, we provide background information. This includes key aspects of the professional engineering and science organisations based in the UK, as well as discussion of the most important ethical issues related to the fossil fuel and arms industries, and their use – and misuse – of science and engineering. We also discuss divestment and boycott campaigns as ways to influence and reform corporate behaviour. In chapter 3, we outline the methods used in this study, including data collection and analytical processes. This is followed, in chapter 4, by the main findings of the study, including key financial data on the 20 professional organisations we selected, together with our analysis. (In-depth data on all our case study organisations are provided in appendices 1–20.) In chapter 5, we provide further discussion of the ethical implications of the findings, followed our conclusions and recommendations in chapters 6 and 7 respectively.

2. Background issues

2.1 Professional Engineering and Science Organisations (PESOs)

Organisations for professional engineers and scientists have a long history, some dating back a century or more, and they fulfil a variety of functions.

In general, professional bodies, associations or institutions are membership organisations which set minimum standards of competence for practitioners in a given area of work, including in science and technology.[5] These standards cover qualifications, training courses and in-work assessments. As such, these bodies provide important benefits for the professions themselves as well as for wider society. The bodies also set ethical standards, which generally include basic rules to support the competence standards – for example, in science, these deal with issues such as honesty, corruption, and plagiarism – but can also include broader issues of social and environmental responsibility. Science and engineering institutions also carry out activities which include the following:

- running events, including training courses, conferences and public meetings;
- providing education resources, including materials for schools and universities;
- producing technical publications and members' magazines;
- maintaining research libraries;
- promoting science and technology employers, including corporate membership schemes;
- providing careers advice to members;
- making awards to individuals and organisations for high achievement; and
- providing information and advice to, for example, policy-makers, business and civil society.

The current structure for UK professional institutions in science and engineering is that two over-arching bodies, the Science Council[6] and the Engineering Council,[7] set broad professional standards, and then issue licenses to the more specialist institutions in each area which uphold these standards, and create further ones as are deemed necessary in those areas.

In addition to the professional institutions, there are the 'learned societies' – which are membership organisations devoted to specific academic disciplines.[8] These have a range of structures. Some have membership open to all those with an interest in the discipline, including those without academic qualifications. Others have a membership that is 'invite-only', such as The Royal Society – for scientists – and The Royal Academy of Engineering, both of which target those who are considered to have reached especially high standards of achievement in their respective professions. Many learned societies are also professional institutions, fulfilling the range of roles of both types of organisation.

There are also a range of other organisations which operate within the science and technology sphere. For example, there is EngineeringUK, which has been set up in association with the Engineering Council as the main body for the public promotion of engineering in Britain. There are also smaller organisations orientated towards specific campaign and outreach work, such as Scientists for Global Responsibility (SGR), the Campaign for Science and Engineering, and Sense About Science.

In this report, we use the term professional engineering and science organisation (PESO) to cover all of the categories discussed above.

The fossil fuel industry has failed to take its share of the transformation action necessary to tackle climate change. (Image: iStock)

2.2 Fossil fuel industry

Summary of the industry

Fossil fuels – coal, oil and gas – currently provide approximately 80% of the energy used by human society[9] with the proportion in the UK being at a similar level.[10] However, these levels have been falling and, as we will discuss below, the threats from global climate change and other major environmental problems means they will need to decrease much more rapidly.

In the UK, the fossil fuel industrial sector includes:

- oil and gas exploration, extraction and refining;
- electricity generation from fossil fuels;
- gas distribution for heating; and
- a small amount of coal production and processing.

It directly provides approximately 135,000 jobs (full-time equivalent).* In addition, many 'indirect jobs' are provided by businesses working with the fossil fuel sector. This work includes manufacturing specialist equipment, supplying other raw materials, and providing specialist technical or financial support. There are also other sectors which are major users of fossil fuels in their own right, such as the automotive industry.

The UK is home to some leading fossil fuel corporations, in particular, BP and Shell.† These two are among the top 10 oil and gas companies in the world, in terms of their reported fossil fuel reserves.‡ In appendix 21, a full list is given of the corporations we have classified as being in the fossil fuel industry, with details of how the classification was carried out in chapter 3.

We now turn to the main ethical reasons why we have chosen in this study to focus on the fossil fuel industry.

Global climate change

Global climate change – caused by a range of human activities – is now widely accepted as one of the largest threats to society. Humans are emitting vast quantities of greenhouse

* This is an SGR estimate based on figures from the Department of Business, Energy and Industry Strategy (BEIS)[111] and the Office of National Statistics (ONS).[109]

† Shell – more formally known as Royal Dutch Shell – is headquartered in the Netherlands but incorporated in the UK. Hence it is considered a joint Dutch/UK corporation.

‡ Calculated in terms of equivalent carbon emissions.[91]

gases (GHGs) – the main GHG being carbon dioxide (CO_2) and the chief source of CO_2 being fossil fuel combustion. GHGs naturally trap the Sun's heat in the atmosphere and the oceans, but excess levels cause more extreme weather events in different parts of the world, such as heat waves, droughts, major storms and flooding. This in turn jeopardises food and water supplies, damages homes and other infrastructure, and threatens human health, which can cause mass migration and conflict. The UN's main scientific advisory body in this area, the Intergovernmental Panel on Climate Change (IPCC), has warned that human actions are "increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems."[11] It also said we "will amplify existing risks and create new risks" whose impacts "are generally greater for already disadvantaged peoples and communities."[11] Mass extinction of wildlife is another key consequence. Some research estimates that the annual global death toll due to climate impacts already numbers in the hundreds of thousands[12] while other scientific studies suggest that these levels will rise markedly in the next few decades.[13,14]

The IPCC's latest report has assessed the benefits of trying to keep global temperature change below 1.5°C – a target included in the 2015 Paris Climate Agreement (PCA) – and what action would be needed to do this.[15] It concluded that meeting this target would lead to considerable benefits across the world, especially for vulnerable groups. Furthermore, it would markedly reduce the risk of 'large scale singular events' – such as catastrophic melting of the Greenland ice sheet or die-back of the Amazon rainforest – which would rapidly accelerate climate change even further. To reach the 1.5°C target, the IPCC estimated that global CO_2 emissions would need to reduce by about 45% from 2010 levels by 2030, and reduce to net zero by 2050.[15] Such reductions would require a major economic, technological and social shift across the world. Given that wealthier, industrialised nations – including their businesses – are responsible for a disproportionately high level of current and historic emissions, there is a strong ethical argument for them to pursue transitions that are both much deeper and much faster.

What are the implications for the fossil fuel industry? The global temperature change is approximately proportional to the cumulative CO_2 emissions of human society.[11] This means that scientists can estimate the total amount of CO_2 which could be emitted before the 1.5°C target is breached.* This figure is thought to be around 2,800 billion tonnes of carbon dioxide (or $GtCO_2$), although uncertainty in this figure is high. About 2,200 $GtCO_2$ had been emitted by the end of 2017, leaving between 400 and 800 $GtCO_2$ left.[15] At the current rate of emissions – about 40 $GtCO_2$ per year – this budget will have been used up by around 2030.† Compare this with the 'proven reserves' of fossil fuels yet to be extracted, but held by the coal, oil and gas industries. These reserves are estimated‡ to hold the equivalent of emissions of 2,500 $GtCO_2$ – *over four times* the remaining budget for 1.5°C, and potentially a lot more allowing for uncertainties. Thus, one implication for the fossil fuel sector is that, not only should exploration for new reserves immediately cease, but extraction of 75% of their existing reserves should also not be carried out.

A key response of fossil fuel corporations to this finding has been to argue that carbon capture and storage (CCS) technologies should be used on a global scale to enable the use of these fuels to continue. However, the progress on developing and deploying such technologies has to date been very poor, with only a small number of projects

* For simplicity, we focus on the CO_2 budget, not the total budget for all GHGs. The implication is that similar action would be needed in relation to non-CO_2 GHGs as well.

† Although note that some academic research indicates that global society has already used up this budget.[110]

‡ Calculated based on data from Carbon Tracker Initiative.[80]

in operation around the world. Significantly, the Committee on Climate Change, which advises the UK government on climate policy, has been very critical of the lack of progress in this area.[16] But the Committee itself has been criticised by some academics for giving too much priority to CCS when other technologies – such as renewable energy – and other policy measures hold more promise.[17] In any case, it is the fossil fuel industry that – despite huge annual subsidies, which globally amount to between $370 billion[18] and $5,300 billion[19] – has consistently failed to invest adequately in either CCS or other measures to reduce the GHG emissions that it is ultimately responsible for.

In the last couple of years, some of the leading fossil fuel corporations have begun to implement more ambitious plans[20] – on occasion even claiming these are 'Paris-compliant', i.e. consistent with the PCA. However, a report published in September 2019 by the think-tank, Carbon Tracker Initiative, argues that no major oil company is investing in a Paris-compliant way, and indeed more than 50% of 2018 investments in major projects made by ExxonMobil, Shell, Total, Chevron, BP and Eni are not consistent with the PCA.[21]

Undermining climate science and policy

The lack of investment by fossil fuel corporations in measures to tackle climate change is only one of the problems of the industry. Disturbingly, it also has a long history of obstructionist behaviour on the issue. There is clear evidence, for example, that senior officials from companies such as Exxon knew about the dangers of climate change as early as the 1970s.[22] However, despite this knowledge, the industry has continued to undermine action taken to mitigate climate change, and it has done this by using tactics learnt from other industries.[23]

In the 1950s, the tobacco industry was confronted by compelling scientific evidence of the health damage due to smoking.[24] The response was to use a multitude of approaches to undermine and engineer doubt in the emerging science. The goal of campaigns run by the tobacco industry was to "disrupt the normative processes of knowledge production in medicine, science, and public health."[24] This was carried out by exploiting the important value of scepticism in science. By identifying, supporting, and amplifying the views of scientists who were sceptical of the relationship between smoking and illness they were able to convey to the public and legislators that the issue of detrimental health impacts of smoking was still an open debate with much uncertainty.[24,3] Exposure of these actions eventually led to the widespread practice by academics and universities of refusing research funding from the tobacco industry.[2]

Academics have shown that the fossil fuel industry has been using similar tactics in relation to climate science – indeed, it is clear that in many cases these were learnt from the tobacco industry itself.[3] Fossil fuel corporations have spent large sums of money on research to promote and amplify scepticism in order to cast unreasonable doubt on climate science – thus misusing the critical evaluation processes that are a cornerstone of scientific inquiry itself.[3] They have then gone on to use this doubt to argue that the science was too uncertain to warrant major legislative action.[25] Part of this action was to fund a range of lobby groups such as the Global Climate Coalition, the Competitive Enterprise Institute and the Scientific Alliance to further spread doubt about rigour of the scientific evidence.[23,2] Indeed, a recent report shows that in the three years following the agreement of the PCA in 2015, the leading oil and gas companies such as ExxonMobil, BP and Shell spent over $1 billion on climate-related branding and lobbying which were "overwhelmingly in conflict with the goals" of the PCA.[26] In particular, official records show that Chevron, ExxonMobil and BP were major donors to Donald Trump's presidential inaugural committee,[27] and so arguably share responsibility for his concerted efforts to reverse US action to tackle climate change. There is a strong case therefore that scientific and engineering organisations should follow

the example set in relation to the tobacco industry, that the fossil fuel industry has not given sufficient respect to the robustness of scientific evidence on the magnitude of the threat of climate change, and therefore funding ties should be severed.

Other major environmental and human rights problems

In addition to global climate change, the extraction and use of fossil fuels have played a central role in a wide range of other major environmental problems, including marine oil spills, poor air quality, acid rain, plastic pollution, ocean acidification, and contaminated land and fresh water. These have caused huge impacts to human health and natural ecosystems over the past decades. In addition, there have been numerous cases of human rights violations related to projects which extract fossil fuels, especially in countries which already have human rights problems. Perhaps most importantly, there are also major links between the political and economic control of (especially) international oil and gas resources and the use of military force, sometimes leading to war.[28] As such, there are important overlaps with the ethical issues related to the arms industry, which we discuss below. Limited space doesn't permit a detailed examination of these issues in this report, but they need to be borne in mind in any consideration of the ethical behaviour of the industry.

Law-breaking and malpractice

One further consideration is the extent to which fossil fuel corporations have been prosecuted or investigated for law-breaking and malpractice across the world.

Perhaps the largest case in recent history was the Deepwater Horizon disaster in 2010. An explosion at a BP-operated oil rig in the Gulf of Mexico led to 11 deaths and an oil spill of an estimated 4.9 million barrels of oil, causing enormous damage to marine life.[29] In 2015, BP agreed to pay US authorities $18.7 billion in fines,[30] with the total bill including compensation claims reaching a staggering $65 billion by 2018.[31]

Other recent cases have involved major coal and mining companies such as Rio Tinto[32] and Peabody Energy[33] as well as oil and gas companies such as ExxonMobil[34] and Shell.[35]

Indeed, the risks of prosecution for malpractice related to GHG emissions, air pollution or other environmental damage are growing.

2.3 Arms industry

Summary of the industry

Global military spending passed $1,800 billion in 2018, the highest level since the Cold War.[36] Recent increases have been driven by rising tensions between, for example, NATO countries and Russia, wars especially in the Middle East, and economic growth particularly in China. The international arms industry* has, unsurprisingly, benefitted from this increased spending. There is an ongoing debate about the extent to which increases in military spending lead to arms races and increased risks of armed conflict rather than, as the industry claims, improved security.[37]

Within the UK, military equipment spending is focused on the following main areas,[38] with UK-based corporations being involved in all of them:

- combat planes, military helicopters and support aircraft;
- nuclear-powered submarines, both nuclear-armed and conventional-armed;
- warships, from aircraft carriers to small support ships;

* The industry is variously referred to as the arms industry, defence industry or military industry. We use the term 'arms industry', as the industry produces armaments and related military equipment. This follows industrial convention, for example, the coal industry produces coal and the cosmetics industry produces cosmetics.

Air-strikes by Typhoons sold to Saudi Arabia by the UK have been responsible for major civilians casualties. (Photo: Ministry of Defence)

- land equipment, including tanks and other armoured vehicles;
- weapons, including missiles, bombs and ammunition;
- military information systems and services; and
- naval bases and logistics.

In addition, the UK is one of the world's largest arms exporting countries.[39]

According to data from the industry's trade association, the sector directly provides approximately 135,000 jobs (full-time equivalent).[40] In addition, many 'indirect' jobs are provided by companies working further down the manufacturing supply chain, or supplying support services. The industry also works closely with what is now often called the 'security industry', which covers sometimes overlapping civilian areas of work, including surveillance, policing, border control and cyber-security for civilian information systems. There are also, of course, many engineering- and science-related jobs in the armed forces,* and we discuss the relationship with this sector later in the report.

The UK is home to some of the leading corporations in this industry, most notably BAE Systems, the world's largest arms company outside of the USA in terms of military sales.[41] In appendix 21, a full list is given of the corporations we have classified as being in the arms industry, with details of how the classification was carried out in chapter 3.

Unique ethical issues

We now turn to the main ethical reasons why we have chosen in this study to focus on the arms industry. At the outset it is important to emphasise that organisations involved in the development and production of armaments and other military technologies are situated in a unique and controversial position in science and engineering. They are part of the only industry whose work is used to intentionally injure or kill humans. Because of this, the related ethical issues deserve special attention in relation to decisions on whether PESOs should develop financial and public relations links with such organisations.

Facilitating human rights violations

There is a great deal of evidence that the international arms trade has facilitated human rights violations across the world, and that UK industry has been a key component of this trade. For example, over the decade to 2017, the UK government licensed exports

* We estimate that there are about 40,000 engineering and science jobs in the UK armed forces – see appendix 21.

of arms and other military equipment worth £12 billion to 29 of the 30 nations classed as 'Human Rights Priority Countries' by the British Foreign Office.[42] These are nations where "the worst, or greatest number of, human rights violations take place."[43] These licences represented 31% of UK military exports over the period, and the figures show that the value of such exports has been growing. Indeed, the total does not include the 2018 deal to supply 48 Typhoon combat planes to Saudi Arabia reported to be worth £5 billion alone.[44]

The UK government maintains that it operates robust controls on the issuing of export licenses, but evidence indicates otherwise. For example, considerable concern has been voiced about exports to Saudi Arabia of equipment, including combat aircraft and bombs, made in the UK by companies such as BAE Systems and Raytheon, as well as the technical support required to keep them in operation.[45] This is especially due to Saudi's leading involvement in the ongoing war in Yemen, during which its air strikes and other military operations have been condemned for violating international humanitarian law by the United Nations, Amnesty International and numerous other organisations.[46,47] Many civilian facilities and activities have been hit by bombs dropped by aircraft operated by Saudi Arabia or its allies. These include hospitals, schools, weddings, funerals and refugee camps.[45] Indeed, due to the war, Yemen is now home to the world's largest humanitarian crisis, with 24 million people in need of humanitarian assistance,[48] and the number of deaths – both in combat and indirectly due lack of food and basic services – is projected to pass 230,000 by the end of 2019. Children account for more than half the deaths.[49] The conduct of the war has led numerous countries to revoke or suspend arms sales to Saudi Arabia, including Germany, Austria, Sweden and the Netherlands.[45] Congress has tried to suspend US arms exports, but has so far been vetoed by the President.[50] In the UK, leading defence commentators have stated that the Saudi-led air campaign would quickly grind to a halt if British contractors were withdrawn,[45] hence decisions in this country will determine whether the related human rights violations continue. Against this background, it was highly significant that, in June 2019, the Court of Appeal ruled that UK exports were indeed "unlawful" due to the clear risk that the arms might be used in a serious violation of international humanitarian law.[51] At the time of writing, the UK government was appealing the decision to the Supreme Court, but in the meantime, the issuing of arms export licenses to Saudi Arabia was suspended.

Nuclear weapons

Another key area of controversy is nuclear weapons. The UK is one of only nine states in the world to deploy these weapons of mass destruction, with an arsenal currently estimated to consist of 215 warheads.[52] In common with the other nuclear weapons states, the UK is engaged in a 'modernisation' programme. This involves the manufacture of four new nuclear-powered Dreadnought class submarines to carry the existing Trident missiles that are armed with nuclear warheads. The submarines are being manufactured by a consortium which mainly includes BAE Systems, Rolls-Royce and Babcock. It is planned that they will replace the current Vanguard class vessels in the early 2030s, and are intended to have a lifespan of about 30 years. The missiles are manufactured in the USA by Lockheed Martin and the stock is 'shared' between US and UK submarines under a long-standing agreement which is also controversial. The warheads are manufactured by the Atomic Weapons Establishment (AWE), a 'government-owned, contractor-run' facility in Berkshire. The industrial consortium behind AWE consists of Lockheed Martin,* Serco and Jacob Engineering Group. At the time of writing, the modernisation programme was experiencing serious technical and financial problems.[53]

* The UK subsidiary of the US company.

The 40 nuclear warheads carried by one UK Trident submarine are capable of causing huge devastation
(Image: iStock)

The explosive power or 'yield' of a typical British nuclear warhead is estimated to be 100 kilotonnes of TNT equivalent, about seven times the yield of the bomb dropped on Hiroshima at the end of World War II.[54] The Trident submarines* are typically armed with 40 such warheads when on patrol.[53] Using academic research on the impacts of nuclear weapons, SGR has estimated that this number of warheads, if launched at major cities which are routinely included as targets in nuclear war plans, would directly cause about 10 million casualties.[55,56] Furthermore, the smoke arising from the intense fires caused by the nuclear attack would be injected into the stratosphere leading to climatic cooling around the world, thus causing widespread crop failures and other environmental impacts, threatening 1–2 billion people with famine.[55,56]

The aim of Britain's nuclear weapons, as argued by the government and other advocates, is that they are deployed as a deterrent and would only be used as a 'last resort'. However, it is an open question as to whether their use would actually be worse than any scenario they are deployed to prevent, and therefore the weapons are arguably not credible as a deterrent. Numerous other flaws in the theory and practice of nuclear deterrence have been identified.[54]

An especially important problem is the potential for nuclear launch by accident or miscalculation. While numerous safeguards are in place to prevent such circumstances, assessments of historical records have shown that unforeseen human and technical errors have resulted in an alarming number of 'near nuclear incidents' and accidents in both the UK and other nuclear weapons states.[57,58] The rise of cyber-security threats is believed to be increasing the risks, including to UK nuclear-armed submarines.[59]

The deployment of nuclear weapons is widely opposed. 115 countries – 60% of the world's total – are part of Nuclear Weapons-Free Zones.[54] Nearly 7,800 cities are affiliated to the Mayors for Peace network which seeks rapid nuclear abolition.[60] More than 500 civil society organisations in over 100 nations are part of the International Campaign for the Abolition of Nuclear Weapons (ICAN), which was awarded the 2017 Nobel Peace Prize.[61] Interestingly, the US-based Global Zero campaign involves "political leaders, senior military commanders and national security experts from across the political spectrum and in every nuclear-armed region of the world".[62] It has proposed a plan for phasing out all nuclear weapons across the world by 2030.

* Both Vanguard class and Dreadnought class submarines are commonly referred to as 'Trident submarines' after the missiles they carry.

Perhaps most importantly – given the failure of nuclear weapon states to disarm, as encouraged by the 1968 Nuclear Non-Proliferation Treaty – 135 nations took part in negotiations which led to the agreement of the Treaty on the Prohibition of Nuclear Weapons (TPNW) in 2017.[63] This treaty is proceeding towards 'entry into legal force' which is expected in 2020. Significantly, it prohibits ratifying nations from providing 'assistance' – including financial – for corporations involved in the development, manufacture or deployment of nuclear weapons. This will restrict investment by international banks and other financial institutions in such corporations. We discuss the issue of divestment later in section 2.4.

Greenhouse gas emissions

One little discussed issue in relation to the arms industry and the use of military equipment is the emission of greenhouse gases. Given that our study also considers the ethics of the fossil fuel industry, it is useful to briefly highlight this aspect here.

Some military vehicles – especially warships, combat planes, transport planes and tanks – are very heavy consumers of fossil fuels and thus emitters of GHGs. For example, a US B-2 bomber emits over 250 tonnes of CO_2 on a single mission.[64] Indeed, the US Department of Defense is the world's largest institutional consumer of petroleum, with annual GHG emissions greater than that of whole European nations such as Sweden.[64] Estimation of world military GHG emissions is beset by incomplete reporting, but SGR has argued that these could be as high as 5% of the global GHG total.[65]

Law-breaking and malpractice

A large number of companies involved in the international arms trade have been linked to major corruption, fraud and other malpractice scandals. Research by organisations including the Stockholm International Peace Research Institute (SIPRI), a leading security think-tank, indicates that corruption is widespread in the arms trade and that there are systemic features of the industry that actually encourage this malpractice. SIPRI's review stated that "Studies suggest that corruption in the arms trade contributes roughly 40 per cent to all corruption in global transactions."[66]

Some of the world's largest arms corporations have incurred huge financial penalties* due to their malpractice, including: BAE Systems ($450m);[67] Boeing ($615m);[68] Lockheed Martin ($28m);[69] and Rolls-Royce ($820m).[70] In addition, Airbus are, at the time of writing, under investigation in France, the UK and USA over allegations of corruption so serious that fines could run into billions of euros.[71]

The codes of conducts of professional engineering and science organisations include very strong wording on corrupt behaviour, and this applies to both the organisations themselves and their members. For example, the Engineering Council's code – which applies to all engineering bodies registered with it – states that registrants should "Reject bribery and all forms of corrupt behaviour, and make positive efforts to ensure others do likewise".[72] Meanwhile, the Science Council explicitly states in its code that the science bodies registered with it should "Never engage in corrupt practice".[73] A logical extension of these codes is that PESOs should be extremely careful concerning links of a financial or promotional nature with corporations found guilty of such behaviour. Our study has investigated financial links including investment, sponsorship and donation between PESOs and arms corporations – as well as the associated public relations activity. PESOs with such associations risk both their reputation and the reputation of the wider science and engineering community.

* The figures here are given in US dollars, using exchange rates at the time the penalty was incurred.

Detrimental impacts on science and engineering

Some research has highlighted detrimental impacts that military sector involvement can have on science and engineering, especially within universities.[74] For example, evidence from the UK indicates that military involvement can undermine openness and accountability. Detailed data on arms industry and military involvement in universities can often be difficult to obtain, and university officials, corporations and researchers themselves are often unwilling to publicly discuss details of their academic research despite the institutions receiving significant public funding. In addition, university staff critical of the military involvement may be discouraged from speaking out publicly.[74] Another problem is that military involvement can steer research priorities towards "high-technology, weapons-based approaches to dealing with security threats" while marginalising other approaches which, for example, aim to tackle the root causes of conflict or use political, diplomatic or other non-technological approaches to tackle the problems.[74,75]

There is a risk that similar problems will arise when there are significant financial and other institutional ties between PESOs and the arms industry/ military sectors. The potential result of this could be that professional organisations would be less willing to be critical of the arms sector or publish views of those who are critical of the sector.

2.4 Divestment and boycott campaigns

The major ethical problems created by the fossil fuel and arms industries have led to a range of political and social campaigns against some or all of their activities. Two of the most prominent types of campaigns in recent years have been those focused on divestment from and/or boycotting of the corporations concerned. The broad argument used to justify these campaigns is that companies have proven so resistant to taking adequate action to address social and/or environmental problems in which they play a significant role that these tactics are necessary to motivate them – and their supporters in government and elsewhere. If they fail to change, they will lose key business.[76] In some cases, the aim is to drive certain industrial practices out of existence.

Currently, divestment campaigns are especially prominent, with the most successful being focused on the fossil fuel industry. With an estimated one-fifth of the global total of industrial greenhouse gas emissions originating from investor-owned companies, investors are in a powerful position – and indeed have a particular responsibility – to influence the emissions of these pollutants.[77] The same argument also applies to investment in the military industrial sector, as the majority of the world's largest arms companies are also investor-owned.[41] Re-investing in competing, but more ethically beneficial areas, such as some renewable energy companies, can be even more effective. Such a change in investment strategy is especially supported by younger generations.[78]

There is also a financial case for divestment, especially from fossil fuels. Many, such as Mark Carney, Governor of the Bank of England,[79] Carbon Tracker Initiative[80] and risk analysts from major financial institutions[81] argue that investors in fossil fuel companies are risking huge losses. They argue that there are high risks of 'stranded assets' or a 'carbon bubble' due to valuation of fossil fuel companies based on the assumption that they will be able to extract and burn their proven fossil fuel reserves. This, as we discussed in section 2.2, is in serious doubt if the world is to keep below the 1.5°C or even 2°C climate targets. John Fullerton, former managing director at JP Morgan, calculated in 2011 that the market value of the 80 percent of proven reserves that would have to be written off to meet the 2°C target would create an eye-watering $20 trillion in stranded assets.[82]

Divestment campaigns can be focused directly on financial institutions, such as banks, investment companies, or pension providers, or they can be focused on

Commitments to divest from fossil fuels currently amount to over $9 trillion
(Image: iStock)

organisations with large reserves, such as universities and PESOs, which then make investments using the financial institutions.

It is worth giving some examples of the recent successes of fossil fuel divestment campaigns. At the time of writing, the Fossil Free campaign website – run by the US-based organisation 350.org – listed over 1,050 institutions which have made a total or partial commitment to divest from fossil fuels.[83] The total value of these commitments was estimated to be an impressive $9.2 trillion. Investing organisations making these commitments included the Norwegian Sovereign Wealth Fund, the parliament of Ireland, the World Council of Churches, New York City, and the British Medical Association. The UK campaign group, People and Planet, listed over 75 UK universities which had made similar commitments,[84] which has particular significance for this study given the high proportion of academic staff who are members of PESOs.

Arms industry divestment campaigns have been more modest in scale, but have also had some success. The 'Don't Bank on the Bomb' campaign run by PAX, based in The Netherlands, encourages financial organisations to divest from arms corporations involved in the manufacture of nuclear weapons – in line with the TPNW. In addition to the corporations involved in the UK nuclear programmes listed earlier (see section 2.3), this includes AECOM, Airbus, Bechtel, Boeing, General Dynamics, Honeywell International, Leonardo, Northrop Grumman, and Raytheon.[85] At the time of writing, over 20 major financial institutions had enacted comprehensive policies barring investment in such companies,[86] and 40 more had policies partially restricting such investments.[87] This campaign has been given extra impetus by the agreement of the TPNW – see section 2.3.

Another example is the 'Clean Investment' campaign run by Campaign Against Arms Trade.[88] This encourages UK universities to divest from arms corporations, mainly due to sales to governments with poor human rights records. Eight universities had made divestment commitment at the time of writing.

Boycott campaigns tend to be broader than divestment campaigns, arguing that *all* financial links between a given organisation and a given industry should end. Recent campaigns have focused on an especially polluting or controversial part of an industry, for example, oil sands, coal or hydraulic fracturing (fracking) or nuclear weapons, landmines, cluster bombs, or arms exports.

3. Methodological issues

In this study, we assessed the scale and importance of a range of financial links between a sample of PESOs and fossil fuel/arms corporations. This chapter outlines the methods and data sources used.

3.1 Selection of PESOs and types of financial data

We selected 20 UK-based PESOs to study, and these covered a range of disciplines – including natural and social sciences, engineering and technology – and a range of sizes, both in terms of membership and income. We included eight bodies in engineering and technology, five in the natural sciences, two in the social sciences, one in mathematics, and four that crossed multiple disciplines. In particular, we included the two 'umbrella' bodies (the Science Council and the Engineering Council), the two leading learned societies (The Royal Society and the Royal Academy of

Table 1 – Professional engineering and science organisations (PESOs) examined in this report

Organisation name	Membership	Investments (£m)	Sponsored school programmes?	Sponsored events?	Corporate membership?
Association for Science Education	7,000	0.0	Y	Y	Y
BCS - The Chartered Institute for IT	73,000	0.0	Y	Y	Y
British Psychological Society	50,000	12.9	N	Y	N
Chartered Institute of Environmental Health	9,000	9.5	N	Y	Y
Energy Institute	20,000	3.6	Y	Y	Y
Engineering Council	NA	1.6	N	N	N
EngineeringUK	NA	1.2	Y	Y	Y
Geological Society	12,000	5.4	Y	Y	Y
Institute of Materials, Minerals and Mining	18,000	8.8	Y	Y	Y
Institute of Mechanical Engineers	115,000	23.2	N	Y	Y
Institute of Physics	51,000	22.1	Y	Y	N
Institution of Civil Engineers	90,000	18.7	Y	Y	Y
Institution of Engineering and Technology	170,000	110.0	Y	Y	Y
Institution of Environmental Sciences	3,500	0.0	N	Y	N
Institution of Structural Engineers	28,000	0.0	Y	Y	N
Royal Academy of Engineering	1,500	41.0	Y	Y	Y
Royal Meteorological Society	3,500	0.7	Y	Y	Y
Royal Society	1,500	200.1	Y	Y	N
Royal Statistical Society	10,000	1.7	Y	Y	Y
Science Council	NA	0.0	N	Y	Y

Notes
Membership figures are approximate.

BOX 1 – INVESTMENTS

The type of investments we focus on in this report are often called 'listed investments' and are traded on, for example, stock exchanges. These are documented in the annual/financial reports of the investing organisation. In general, five categories are included within investment funds:

1. Fixed interest securities – either from governments ('government bonds', 'gilt-edged securities' or 'gilts', the latter two being UK-specific) or companies ('corporate bonds');
2. Equities – either UK or overseas, also known as 'stocks', and are bought in the form of 'shares';
3. Property – which again can be UK or overseas;
4. Commodities – such as gold (although these is rarely included); and
5. Cash – which is often only held to facilitate more efficient trading in the other assets.

It should be noted that we have only considered investments categorised under the broader heading of 'fixed-assets' in financial reports, and not those listed under the categories of 'current assets' or 'cash in hand or at bank'.

In order to determine the companies in which the PESOs are invested, we examined the data sheets published by the investment fund managers used by the PESOs (with full references provided in appendices 1–20). However, it should be realised that these only provide a 'snapshot' of investment behaviour and vary over time according to the stock-market performance of the companies concerned. Nevertheless, these do provide the best guide available for this type of analysis.

More information on investments can be found in, for example, texts on standard accounting practice.[89]

Engineering), and the leading promotional organisation in the sector (EngineeringUK). Many of the PESOs included significant levels of overseas membership. The full list of the 20 PESOs – in alphabetical order – is given in table 1, together with summary information.

We explored four main financial links:

- investments – as defined in box 1;
- funding (including branding) of education activities aimed at school age children;
- sponsorship of events aimed at professional and public audiences; and
- corporate membership schemes.

We also looked at the organisations' relevant policies – including general organisational policies, as well as specific policies on ethical standards, ethical investment and the environment. All of this was supplemented with further information where available and where we deemed it to be relevant, such as corporate donations, sponsored fellowship/research schemes, corporate advertising in magazines or on websites (generally aimed at members), and board membership.

The material was gathered mainly from publicly available sources, including annual reports (including financial reports) and websites. We also wrote to all 20 PESOs asking for information on their investment

policies and practices, including: ethical investment policies; details of investment portfolios, and the reasoning behind the amount of data that has been published in annual reports; and their general views on ethical investment concerns and divestment campaigns. (A generic copy of the letter sent is provided as appendix 22). Some material – for example, copies of membership magazines – was also obtained via members of the PESOs concerned. For consistency, the data on investments was obtained from sources covering a financial year ending in 2015 or 2016. Later financial reports were inspected to check if there had been any significant changes in practice, and this noted if applicable. All other data used generally covered periods of activity between 2015 and 2019, with the most recent data used where available and applicable.

All the data and sources are provided in appendices 1 to 20, one for each PESO. These are available to download via the SGR website.* Summaries of the key data are provided in the following chapter.

3.2 Transparency and the use of proxy data

As will be discussed in more depth in the following chapter, the transparency of the PESOs' financial links to corporations was generally poor, with very limited specific data being available within publicly available sources. Hence, we used proxy data to judge the level of corporate involvement in many areas. For example, in the absence of detailed financial data on the funding of school education programmes, we used indicators such as the proportion of programme funders which were part of the arms or fossil fuel industry. In determining whether the level of involvement was high or low, we compared this proportion with the proportion of employees in the wider science and technology sectors that are employed in the arms or fossil fuel industries, as specified below.

Such comparisons are difficult because of varying definitions of the specific sectors and jobs that make up the science and engineering sectors. We have used the following rationale. Since fossil fuel and arms corporations are mainly based within the engineering sector, we have used data from that sector as a guide. Arguably, we could have used broader data – also including employers focused on scientific research – but using this narrower definition makes our approach more conservative. In addition, clearer employment data is available on the UK engineering sector. With disciplines where this rationale would not be meaningful, we have adapted it as discussed in individual case studies.

According to *The State of Engineering*, published annually, engineering enterprises employed over 5.6 million people in 2018.[90] As stated in sections 2.2 and 2.3 respectively, the fossil fuel industry directly employs approximately 135,000 people in the UK and the arms industry also directly employs about 135,000. We have used direct employment figures as this is most consistent with our definitions of fossil fuel and arms companies, as given in the next section. Hence each of the two industries employs about 2.5% of people working in the engineering sector. Based on this, we have defined the classifications in table 2 to indicate whether the financial involvement of either fossil fuel or arms companies is large or small. Again, we have set the scale to be conservative.

Table 2 – Generic classifications of different levels of financial involvement between PESOs and the fossil fuel or arms industry

Proportion	Classification
0%	None
1% to 4%	Low
5% to 9%	Medium
10% to 19%	High
20% and above	Very high

* https://www.sgr.org.uk/

3.3 Defining arms and fossil fuel companies

In determining the scale of the financial links between PESOs and the fossil fuel and arms industries, it is necessary to be clear about the criteria used to decide whether a particular corporation falls in either of those categories.

In this study, we defined a corporation as being part of the fossil fuel industry if it met one or more of the following criteria:

- It was listed in *The Carbon Underground 200*,[91] as compiled by Fossil Free Indexes, which lists the top 100 corporations in the world in terms of their holdings of coal reserves and the top 100 in terms of oil and gas reserves;* or
- A majority of its activities were focused on the exploration, extraction, processing, transport or sale of fossil fuels. As discussed in section 2.2, this included the sale of electricity generated using fossil fuels.

Similarly, we defined a corporation as being part of the arms industry if it met one or more of the following criteria:

- It was listed in the *SIPRI Arms Industry Database*,[41] as compiled by the Stockholm International Peace Research Institute (SIPRI), which lists the top 100 arms-producing companies in the world in terms of military sales;
- A majority of its activities were focused on design, development, manufacture, testing, sale or deployment of military technologies; or
- It had significant involvement in the design, development, manufacture, testing, sale or deployment of nuclear weapons, including warheads, delivery systems (e.g. missiles) or platforms (e.g. submarines).

In general, these criteria overlap well with the description of the industries given in chapter 2, allowing the comparisons proposed in section 3.2 to be meaningful. There were a few situations, however, which require further explanation. For example, a small number of large engineering corporations appeared in the 'top 100' lists even though a relatively small proportion of their total activity was in the fossil fuel or arms sectors. For example, we have classified Rolls-Royce as an arms corporation due to it being in the top 20 in the world in terms of military sales, and manufacturing the propulsion system for the UK's new nuclear-armed Dreadnought submarines. However, only 23% of the company's sales in 2017 were classified as military.[41] Our view is that this potential bias is offset by the fact that some corporations (especially in the information and communications technology sector) that we have not classified as part of the arms sector have large military contracts. For example, BT had numerous military contracts which represented only a small proportion of its revenue. As an example, in 2015/16, the company had contracts with the Ministry of Defence worth over £350m[92] which amounted to only 2% of its total revenue.[93]

In a small number of cases, PESOs had financial and/ or promotional links with the UK's armed forces. Due to the obvious links with the arms industry – especially in design, testing, sale or deployment of military technologies, including nuclear weapons – we have simply included them under the arms industry 'umbrella' in our assessment of the scale of financial links. However, we recognise that this throws up a number of issues, which are discussed in chapters 4 and 5 and appendix 21.

A full list of the corporations/ organisations classified in this study as being part of the arms and/or fossil fuel industries is given in appendix 21.

* As measured in tonnes of potential carbon dioxide emissions.

4. Main findings: the financial links

This chapter summarises the main findings of our analysis of key financial links between 20 UK-based professional engineering and science organisations (PESOs) and the fossil fuel and arms industries. Overall, we consider that the links in many cases are significant and disturbing. Also, of great concern is the widespread lack of transparency over these links. The detailed data can be found in appendices 1–20, with further analysis in the following chapters.

4.1 Investments

The PESOs we examined held a range of investments – as documented in their annual/financial reports – and these are summarised in table 3. The investments of concern to this study (as defined in section 3) often include funds held in fossil fuel and arms corporations.

Table 3 – Investments: a summary of key data for the PESOs

Organisation name	Investments (£m)	Ethical investment policy?	Percentage of total investment funds disclosed	Percentage of total investment known	Estimated % of known investments in fossil fuels industry	Estimated % of known investments in arms industry
Association for Science Education	0.0	None	100%	100%	0%	0%
BCS - The Chartered Institute for IT	0.0	None	100%	100%	0%	0%
British Psychological Society	12.9	Extensive	7%	7%	-	-
Chartered Institute of Environmental Health	8.4	None	7%	7%	-	-
Energy Institute	3.6	None	100%	16%	29%	-
Engineering Council	1.6	Limited	100%	24%	1%	0%
EngineeringUK	1.2	None	100%	16%	29%	-
Geological Society	5.5	Limited	80%	*50%	7%	0%
Institute of Materials, Minerals and Mining	8.9	None	71%	44%	9%	0%
Institute of Mechanical Engineers	23.2	None	3%	3%	-	-
Institute of Physics	22.1	Limited	100%	10%	22%	-
Institution of Civil Engineers	18.7	Limited	54%	15%	10%	-
Institution of Engineering and Technology	110.0	None	0%	0%	-	-
Institution of Environmental Sciences	0.0	None	100%	100%	0%	0%
Institution of Structural Engineers	0.0	None	100%	100%	0%	0%
Royal Academy of Engineering	41.0	Limited	6%	6%	-	-
Royal Meteorological Society	0.7	Limited	0%	0%	-	-
Royal Society	200.1	Limited	4%	-	-	-
Royal Statistical Society	1.7	Limited	60%	21%	31%	0%
Science Council	0.0	None	100%	100%	0%	0%

Notes

All investments rounded to the nearest £0.1m, with investments of less than £0.1m indicated by a dash. Percentages are rounded to nearest whole percent, with dashes indicating insufficient data to make an estimate (see appendices 1–20 for more details).

* For the Geological Society, a higher percentage of 'known' investments was recorded for the arms sector – see appendix 8 for details.

Five PESOs held no relevant investments: the Association for Science Education; BCS - The Chartered Institute for IT; the Institution of Environmental Sciences; the Institution of Structural Engineers; and the Science Council. The other 15 did hold investments, which varied from £670,000 (the Royal Meteorological Society) up to £200 million (The Royal Society). The combined value of these investments was approximately £485m.

As discussed below, the PESOs held their investments in existing managed funds or the funds were managed for them by external investment management companies. This is standard practice for organisations in general. However, this did not mean that the PESOs had no control over where their money was invested. There now exist a range of funds which use ethical criteria to select investments – for example, by restricting or blacklisting investments in industries such as fossil fuels or arms, or by applying certain positive screening criteria. Indeed, as discussed in section 2.4, a growing number of organisations specifically instruct their investment managers to blacklist investments in the fossil fuel and arms industries.

Transparency

We found that transparency around investments was generally very poor, as shown in table 3. Out of the 15 PESOs which held financial investments, only four disclosed all the funds in which their investments were held. Nine disclosed where a portion of their investments were held, but in some cases the proportion was very low. Two disclosed such limited information that we were unable to determine any companies in which their funds were invested. These two were the Institution of Engineering and Technology and the Royal Meteorological Society. We were especially concerned about the low level of disclosure by the two organisations with the largest investment sums of those considered in this study – The Royal Society, which held £200m, and the Institution of Engineering and Technology, which held £110m (67% of the total held by the 20 organisations). The Royal Society only disclosed a few percent (see appendix 18), while the Institution of Engineering and Technology, as mentioned, disclosed zero (see appendix 13).

To complicate matters further, there were often multiple layers of data obscuring the information on investments in specific corporations because most organisations invest through managed funds. These are 'pooled' funds from a number of investors which are managed by a professional investment management company. The investment funds normally only disclose their largest five or ten holdings.* This means that, despite an organisation stating where a certain percentage of its funds may be invested, the actual amount of funds which we are able to identify may be much lower. For example, EngineeringUK stated in its annual accounts where it had placed 100% of its investments, but a large proportion of these were invested in managed funds, so we were only able to identify specific information about where 16% of its investments were held (see appendix 7).

Due to the general lack of transparency on investments, we wrote to each of the 20 PESOs asking for further information (as discussed in section 3). Unfortunately, the response to these letters was very limited. Only five organisations responded.† Some further information was provided but, in general, even this was not very revealing.

Hence, for the 15 PESOs that held investments, we were able to identify where only approximately £22m was held. This was about 5% of the total amount invested, a shockingly low figure. If we exclude the

* For an example, see appendix 5, the case study on the Energy Institute, whose funds are invested in the Alpha Common Investment Fund.

† The five were the Energy Institute, the Institution of Structural Engineers, the Royal Academy of Engineering, The Royal Society and the Royal Statistical Society.

two PESOs with the largest investments – The Royal Society and the Institution of Engineering and Technology, which as discussed had very low levels of disclosure – then the percentage of 'known' investments for the other 13 PESOs rises to nearly 12%. This is a marked improvement, but still worryingly low.

Only for one organisation – the Geological Society – were we able to identify where at least 50% of their investments were held. We complement them on their comparative openness, but there is clearly a need for a major increase in transparency across the sector.

Investments in the fossil fuel industry

The levels of investment held by the 20 PESOs in the fossil fuel industry – as far as we were able to ascertain based on the limited data – are shown in table 3. Our interpretation of the importance of these levels is shown in table 4, using the scale defined in section 3.2.

Table 4 – PESO involvement with fossil fuel corporations

Organisation name	Investments	School education programmes	Sponsored events	Other
Association for Science Education	None	Medium	None	Low
BCS - The Chartered Institute for IT	None	None	None	None
British Psychological Society	None	-	None	-
Chartered Institute of Environmental Health	Medium	-	None	-
Energy Institute	Very high	High	Very high	Very high
Engineering Council	Low	-	-	-
EngineeringUK	Very high	High	High*	Medium
Geological Society	Medium	Medium	Very high	Very high
Institute of Materials, Minerals and Mining	Medium	Low	None	Low
Institute of Mechanical Engineers	Medium	-	Medium	Low
Institute of Physics	Very high	None	None	None
Institution of Civil Engineers	Medium	None	None	None
Institution of Engineering and Technology	Medium	None	None	Low
Institution of Environmental Sciences	None	-	None	-
Institution of Structural Engineers	None	None	None	-
Royal Academy of Engineering	Medium	Very high	Very high	Very high
Royal Meteorological Society	Medium	None	None	None
Royal Society	Medium	None	None	Low
Royal Statistical Society	Very high	None	None	-
Science Council	None	-	None	None

Notes
* For EngineeringUK, the sponsored events overlapped with the school education programmes.

The available data was sufficient for us to conclude that four PESOs held 'very high' levels of investments in the fossil fuel industry. These were: the Energy Institute (where 29% of its known investments were in the fossil fuel sector); EngineeringUK (29%); the Institute of Physics (22%); and the Royal Statistical Society (31%). It is very concerning to discover such high levels. The Royal Statistical Society has since implemented a policy to increase the proportion of its investments in environmentally-conscious businesses (see appendix 19). While this is commendable, it remains to be seen whether this leads to a reduction in its high level of investments in fossil fuels.

At the other end of the spectrum, five PESOs held no investments in the fossil fuel industry due to their decision not to hold investments at all. As mentioned above, these were: the Association for Science Education; BCS - The Chartered Institute for IT; the Institution of Environmental Sciences; the Institution of Structural Engineers; and the Science Council.

One PESO has, since we carried out the analysis, adopted an ethical investment policy which excludes most fossil fuel corporations. This is the British Psychological Society. The relevant part of the policy wording states, "Investment shall be precluded where the primary part of their business clearly demonstrates the following characteristics: … Engagement in fossil fuel extraction" (see appendix 3). It is very encouraging to see this development. While the criteria are not quite as strict as the definition used in this report (see section 3.3), it would still exclude the overwhelming majority of corporations that were of concern. However, given the current lack of openness around its investments (see table 3), the society still needs to take further steps to ensure external audiences can see that it is sticking to its ethical criteria.

Regarding the other 10 PESOs, we concluded that they all had investments in the fossil fuel industry, even when data was sparse, due to their lack of ethical investment policies which specifically excluded this (see later), together with the prevalence of fossil fuel companies within investment funds. In three cases, the available data pointed towards a 'medium' level of fossil fuel investment, and in six further cases we concluded that the lack of contradictory data meant it was reasonable to assume a 'medium' level. In one case (the Engineering Council), the available data indicted a 'low' level of fossil fuel investment.

The most common fossil fuel corporations in which investments funds were held by the PESOs in this study were Shell, BP and Rio Tinto – among the world largest (see section 2.2). Also notable were holdings in particularly controversial companies like Pembina Pipeline,[94] which is involved in the highly energy intensive and polluting extraction of 'tar sands'.[95]

Investments in the arms industry

The levels of investment held by the 20 PESOs in the arms industry are shown in table 3. The data is obviously even more limited than in the case of the fossil fuel industry. Our interpretation of the importance of these levels is shown in table 5, guided by the scale defined in section 3.2.

Five PESOs held no investments in the arms industry due to their decision not to hold investments at all. As mentioned earlier, these were: the Association for Science Education; BCS – The Chartered Institute for IT; the Institution of Environmental Sciences; the Institution of Structural Engineers; and the Science Council.

Also, as mentioned earlier, the British Psychological Society has recently adopted an ethical investment policy. The relevant part of the policy wording states, "Investment shall be precluded where the primary part of their business clearly demonstrates the following characteristics: … Manufacture and sale of armaments to oppressive regimes" (see appendix 3). Hence, this policy ends investment in most arms corporations, and we very much welcome this step. However, the policy makes no mention of weapons of mass destruction – particularly

Table 5 – PESO involvement with arms corporations

Organisation name	Investments	School education programmes	Sponsored events	Other
Association for Science Education	None	Low	None	None
BCS - The Chartered Institute for IT	None	None	None	None
British Psychological Society	Low	-	None	-
Chartered Institute of Environmental Health	Medium	-	None	-
Energy Institute	Medium	None	Low	None
Engineering Council	Low	-	-	-
EngineeringUK	Medium	Very high	Very high*	High
Geological Society	Low	None	None	None
Institute of Materials, Minerals and Mining	Low	None	Low	Low
Institute of Mechanical Engineers	Medium	-	High	Medium
Institute of Physics	Medium	Low	High	Medium
Institution of Civil Engineers	Medium	Low	Low	Medium
Institution of Engineering and Technology	Medium	Medium	Very high	Very high
Institution of Environmental Sciences	None	-	None	-
Institution of Structural Engineers	None	None	None	-
Royal Academy of Engineering	Medium	Very high	Very high	High
Royal Meteorological Society	Medium	None	None	None
Royal Society	Medium	None	None	Low
Royal Statistical Society	Low	None	None	-
Science Council	None	-	None	Low

Notes
* For EngineeringUK, the sponsored events overlapped with the school education programmes.

nuclear weapons – nor involvement in the development of lethal autonomous weapons. Hence, we encourage the society to take further steps. Furthermore, as mentioned above, the society's lack of openness over its investments will make it hard for members and external audiences to judge how effectively it is applying its policy.

Regarding the cases for the other 14 PESOs, the sparse data was more difficult to interpret. On the face of it, the PESOs seemed to have very few investments in arms corporations. However, very few of the investment funds or the investment policies of these PESOs specifically excluded any activity in the arms sector. The more likely explanation of this situation is that, as fund managers only reveal the largest investments they hold, smaller corporations such as those in the arms industry are effectively hidden. Whereas some fossil fuel corporations feature among the largest of any type of corporation in the world, arms corporations are in comparison much smaller. For example, in the 2019 edition[96] of the Fortune Global 500 (a list of corporations ordered by global revenue), seven fossil fuel companies were listed in the top ten, while the world's largest arms company (in terms of military sales), Lockheed Martin,[41] was only 197th. A similar picture was also seen when comparing the two industries by market value.

Hence, in table 3, we only estimated the percentages of arms industry investment if the percentage of known investments was above 20%. This led to four PESOs being given an estimate of 0%. However, in recognition of the uncertainties, in table 5, these PESOs were given a rating of 'low' involvement with the industry in this category rather than 'none'. The other ten PESOs were given a rating of 'medium'.

Ethical investment policies and practices

Of the 20 PESOs surveyed, we found that nine – as shown in table 3 – either had some form of ethical investment policy or indicated that social, environmental or other ethical considerations were involved in the decision-making processes for investments. A further five held no listed investments and hence did not consider that they needed an ethical investment policy. Only one of the 20 PESOs had an ethical investment policy which dealt in a significant way with the ethical issues raised by investment in the fossil fuel or arms industries, as discussed in section 2.2 and 2.3. In this section, we briefly review the ethical investment policies and practices of the nine PESOs that implement them.

In 2018, following calls from its membership and other health professionals,[97,98] the British Psychological Society published an extensive ethical investment policy covering, as discussed earlier, investments in fossil fuels and armaments (see appendix 3). While the policy does not exclude all investments in these areas as defined in this study, it does focus on two of the most problematic areas – extraction of fossil fuels and export of weapons to oppressive regimes. We have suggested above potential improvements to tackle some of the other related ethical issues but, nevertheless, the society's policy sets an important example that other professional bodies could follow.

Another PESO to specifically exclude certain sectors from all its investments was The Royal Society. In its response to our request for more information on its policies and practices, it stated that it did not invest "in companies or funds that derive a significant portion of their income from the sale or manufacturing of tobacco products" (see appendix 18). Considering the enormous detrimental effects that the tobacco industry has had on both public health and the integrity of scientific research,[24,3] this is very positive and we commend The Royal Society for taking this stand. However, the society has not chosen to take any similar steps in regard of the fossil fuel or arms industries.

In 2018, The Geological Society adopted an ethical investment policy (see appendix 8). The aim is "to ensure that investments are consistent with the Society's values and ethos and do not conflict with the Society's aims. Individual investments can be excluded if they are perceived to be in conflict with these requirements."[99] We were not able to find out whether this meant that any fossil fuel or arms corporations were excluded.

The Engineering Council did not have a specific ethical investment policy, but the fund in which it chose to place all its investments excluded the tobacco industry. Furthermore, some of the other funds in which the main fund was invested specifically excluded prostitution, pornography or the arms industry (see appendix 6).

In 2018, the council of the Royal Statistical Society took the decision to invest between 5% and 15% of its investments in environmentally-conscious companies. So, while the society does not have a general policy to exclude any corporations on ethical grounds, it is now acting to increase the proportions of those which meet positive environmental criteria.

The Royal Academy of Engineering stated that one of the criteria used in the selection of its investment managers was their ethical investment policies (see appendix 16). Although it gave no information in its financial documents concerning specific ethical criteria, one of the main investment funds it used excluded investments in tobacco, gambling or arms corporations.

As part of its financial policy, the Royal Meteorological Society stated that investments should not be held in companies "whose activities are contrary to the aims of the Society or its social, environmental and ethical responsibilities."[100] While we were able to find the society's aims clearly defined on its website, we were unable to find any information on how the society interprets its 'social, environmental and ethical responsibilities' in terms of investment practice. The society did not respond to our

letter seeking further information. Further discussion can be found in appendix 17.

The Institute of Physics was in a similar position. Its financial policy stated that investments should not compromise the objectives of the institute, which was defined as the promotion of the "...advancement and dissemination of a knowledge of and education in the science of physics [...] for the benefit of the public and the members of the Institute."[101] Again, it was not clear how this was interpreted in investment practice, and we received no reply to our letter seeking further information. Further discussion can be found in appendix 11.

As part of its financial documents, the Institution of Civil Engineers stated that its money should only be invested in funds whose managers are signatories of, or their approach is compatible with, the UN's Principles for Responsible Investment (UNPRI)* – see appendix 12. While the UNPRI's intentions may be progressive on paper, the organisation has acknowledged that, beyond raising awareness, it has failed to have a tangible impact around responsible investment.[102] Again, this demonstrates the limited nature of the ethical standards applied to investment practice by even the more socially aware PESOs in this study.

Some of the other PESOs examined in this study did place a proportion of their investments in funds that used ethical screening criteria, but there were no indications in the documentation we found that these choices were related to those criteria.

4.2 School education programmes

One area of special concern to this study is the involvement of the fossil fuel and arms industries in school education programmes run by PESOs. These programmes may also involve the armed forces, sometimes in collaboration with the arms industry. While these organisations often claim that their engagement with school-age children is motivated by the desire to increase the numbers studying STEM subjects (Science, Technology, Engineering and Mathematics), it is also apparent that there are major public relations benefits to be gained for employers whose activities are considered controversial.

Indeed, investigations of the engagement by armed forces with schools has revealed some important information in this regard. For many years, the British armed forces have had difficulties meeting recruitment targets. As part of the effort to tackle this, they have developed a range of programmes to target young people. Justifying these, the head of the armed forces' recruitment strategy stated, "These days, our youngsters are incredibly discerning. They make decisions based on a much broader tapestry of information than was offered to any of us. We have to cut through branding clutter with real efficiency. Our new model is about raising awareness, and that takes a ten-year span. It starts with a seven-year-old boy seeing a parachutist at an air show and thinking, 'That looks great.' From then the army is trying to build interest by drip, drip, drip."[103]

The evidence indicates that some other employers, crucially in the fossil fuel and arms industries, are suffering similar problems to the armed forces. These include greater ethical awareness among young people and a negative image with some sections of the public more generally, and hence recruitment has become more difficult. In response, these sectors are adopting similar targeting methods to the armed forces. In particular, they emphasise STEM skills shortages to justify well-funded and prominent STEM 'enrichment activities'. This gives them wide access to school children from a young age to create positive sentiment towards the companies and their activities.[104] Indeed, current guidance for STEM education activities aimed at children encourages

* The UNPRI is a list of six investment principles that cover environmental, social, and corporate governance issues.[112]

Nine professional engineering and science organisations in our study ran school education programmes involving the fossil fuel and/or arms industries.
(Image: iStock)

"meaningful encounters" with employers from age 11,[105] which large corporations, such as those in the fossil fuel and arms sectors, are well placed to exploit.

Transparency

Of the organisations surveyed, we found that 14 PESOs ran programmes or provided resources aimed at schools, teachers and/ or children. These organisations are shown in table 1, with fuller details given in the appendices. Of these, we found evidence that at least nine PESOs published education materials or ran activities that were sponsored or otherwise directly involved companies that were part of either the arms or fossil fuel industries. The branding of the corporations involved was often prominently featured on the educational resources.

Again, there were serious problems of transparency. We found very limited information on the extent of the financial links between the programmes run by the PESOs and the corporations concerned. Indeed, often the total funding for the education programmes themselves was unclear in publicly available documents. Two PESOs published more extensive relevant financial data than others. The Association for Science Education (see appendix 1) provided funding data for each education programme by year, but it did not provide a clear indication of the funding provided by individual industry partners. The Royal Academy of Engineering (see appendix 16) published a significant amount of data on the finance provided by individual external funders, including corporations, of many of its education programmes. However, at times there was a clarity or detail in relation to the funding.

While organisations may sometimes claim commercial confidentiality as a reason for not publishing such information, when the organisations involved are as controversial as fossil fuel and arms corporations, and the material is being provided for children, such arguments seem very thin. Given the discussion in chapter 2, especially over the role of the fossil fuel industry in deliberately trying to undermine public confidence in the science of climate change, and the aim of some of these education programmes being to change public perceptions of the professions,[106] the case for greater openness about financial links is strong.

Given the lack of transparency over the financial links, we used proxy data – as discussed in section 3.2 – to judge the level of involvement of fossil fuel and arms corporations in school education programmes run by PESOs. In this specific case, we examined the proportion of corporate partners/ sponsors which were from the relevant industries.

Involvement with the fossil fuel industry

As shown in table 4, we found six PESOs that ran school education programmes where there was some involvement of fossil fuel corporations: the Association of Science Education; the Energy Institute; EngineeringUK; the Geological Society; the Institute of Materials, Minerals and Mining; and the Royal Academy of Engineering. The most prominent involvement of the fossil fuel industry was in those schemes run by the Royal Academy of Engineering, EngineeringUK and the Energy Institute.

The Royal Academy of Engineering publicised 13 education programmes on its website and about one quarter of the external funders were fossil fuel corporations (see appendix 16). Data revealed in the academy's annual accounts indicated that, of the external funding received for the period 2016–18 for education programmes, over 70% was from fossil fuel corporations. The main funders from this sector were BG Group* and Petrofac. There was also prominent involvement in the education programmes from BP, Shell and Anglo American, some of the world's top fossil fuel corporations.[91]

EngineeringUK is the lead organiser of some of the UK's most high-profile education events for school children, including the annual Big Bang Fair (see appendix 7). According to publicly available information, about 6% of the organisation's sponsors and partners for its school education programmes were fossil fuel corporations. However, we think it highly likely that the proportion of funding from these companies is greater than this percentage. Especially prominent among the education sponsors and partners was Shell, which alone provided £1 million of funding for the Tomorrow's Engineers programme.

In 2017, the school education programmes run and promoted by the Energy Institute were almost entirely sponsored by fossil fuel corporations, including ExxonMobil, BP, Shell and ChevronTexaco (see appendix 5).

However, after a website redesign in 2018, links to these materials were removed from the main site. At least one remained online complete with corporate branding but, at the time of writing, no new educational materials were being promoted on the site. The changes seemed to coincide with the organisation's adoption of a new strategic theme on a 'lower carbon world'.

The other three PESOs had lower levels of fossil fuel industry involvement. We estimated the proportion of involvement in school education programmes run by the Association for Science Education to be about 5% (see appendix 1). Most of the Geological Society's education resources did not involve external partners, although a couple were directly sponsored by fossil fuel corporations and some programmes did receive funding from the corporate membership scheme (see appendix 8). Meanwhile, only one company which we classified in the fossil fuel sector was involved in the education programmes run by the Institute of Materials, Minerals and Mining (see appendix 9).

In summary, the extent of the financial links between both the Royal Academy of Engineering and EngineeringUK and the fossil fuel industry in relation to their school education programmes is quite considerable. The ethical issues raised will be discussed further in chapter 5.

Involvement with the arms industry

As shown in table 5, we found six PESOs which ran school education programmes involving arms corporations: the Association of Science Education; EngineeringUK; the Institute of Physics; the Institution of Civil Engineers; the Institution of Engineering and Technology; and the Royal Academy of Engineering. Some of these collaborations also involved the UK armed forces. The most prominent involvement of the arms sector was in those schemes run by the Royal Academy of Engineering and EngineeringUK.

* The BG Group has since been taken over by Shell (see appendix 21).

Most of the school education programmes run by the Royal Academy of Engineering either involved arms corporations, the armed forces or promoted military technologies (see appendix 16). Of the total number of external organisations funding these programmes, we estimated about a quarter were from the arms/ military sectors. Financial data published by the academy indicated that over 20% of the external funding either came from these sources or were provided for the promotion of military technologies. The most common sponsor/ partner was BAE Systems, the largest arms company outside the USA, and involved in many of the most controversial elements of the arms industry (see section 2.3). Other partners included the Royal Air Force (RAF), the Royal Navy, Boeing, and Rolls-Royce. Boeing is the world's second largest arms corporation in terms of military sales, and Rolls-Royce is the second largest UK arms corporation (see appendix 21). One education programme was specifically focused on military technologies – to mark the 100th anniversary of the founding of the RAF. Called 'Aiming for Awesome' and notably funded by non-military sources, the programme provided teaching resources on different engineering aspects of the RAF's aircraft over the century. Another programme provided 'After School Club Resources'. 94% of these featured branding from BAE Systems. Despite the very high level of involvement from the arms/ military sectors, we found no discussion in any of the academy's programmes of the related ethical issues.

The school education programmes run by EngineeringUK also had a large amount of involvement from arms corporations, as well as the UK armed forces (see appendix 7). Of the external organisations involved, we estimated that 20% were from the arms/ military sectors. From the available financial information, we concluded that the proportion of funding coming from these sectors was likely to be markedly higher. Again, BAE Systems was a prominent partner being, for example, the sole 'lead sponsor' of the high-profile Big Bang Fair for many years. Other organisations involved in EngineeringUK's programmes were Airbus, Thales, Leonardo and Rolls-Royce – all among the world's top 20 arms corporations[41] – as well as all three branches of the UK armed forces.

The other PESOs which ran school education programmes involving arms corporations had rather more limited links. For example, the Institution of Engineering and Technology ran a competition which had as its 'national sponsor' Bechtel, the US engineering giant, which has a large military division including work on nuclear weapons (see appendix 13). The Institute of Physics published a teaching resource involving Babcock, part of the consortium building the UK's new nuclear-armed submarines (see appendix 11). Meanwhile, the Institution of Civil Engineers ran an exhibition for school children, with one of the partners being AECOM, the large engineering corporation which helps to manage some US nuclear weapons sites (see appendix 12). Finally, the Association of Science Education included some arms companies among the sponsors for its 'Optoelectronics college' (see appendix 1).

In summary, it is again astonishing to see the extent of the financial links between both the Royal Academy of Engineering and EngineeringUK and another controversial sector, the arms industry, in relation to their school education programmes. Also disturbing was the lack of discussion of the related ethical issues within the education materials. These issues will be covered further in chapter 5.

4.3 Events sponsorship

Organising events is an important part of the work of PESOs, whether they are aimed at educating their members or as a public outreach exercise. The size and prestige of the events ranges from small technical seminars and specialist courses up to large conferences and formal annual dinners. The larger events each generate income of tens to hundreds of thousands of pounds, while many provide opportunities for business and government to access

senior figures in the science and technology professions. Sponsorship of events is a key way of financing them, so there are often opportunities for industry, including for fossil fuel and arms corporations, to undertake this sort of public relations work. Of the PESOs that we surveyed, virtually all seemed to organise events of some description, but more limited numbers took funding from the sectors of concern to this study.

Again, transparency was generally poor in this area, with few relevant financial figures being publicly published by the organisations concerned. Even the labelling of the relationship used – such as sponsors, partners or supporters – was unclear and inconsistent. So, as before, we had to supplement what was available with proxy data in order to carry out our analysis (see section 3.2).

Sponsorship by the fossil fuel industry

As shown in table 4, we found evidence that five PESOs in this study accepted event sponsorship from the fossil fuel industry. These were: the Energy Institute; EngineeringUK; the Geological Society; the Institution of Mechanical Engineers; and the Royal Academy of Engineering. Of these, we considered the Energy Institute, the Geological Society, and the Royal Academy of Engineering to have especially high levels of these financial links.

Many of the events organised by the Energy Institute had a strong focus on fossil fuels, especially the oil sector (see appendix 5). From the evidence we could uncover, the income received from events sponsored by or aimed at those in the oil industry was considerably more than those focused on, for example, energy efficiency or renewable energy. The most prominent example was International Petroleum Week, an annual event which involved a prestigious international conference, sponsorship dominated by the oil industry and related sectors, and expensive ticketing. Income from the event was measured in millions of pounds, and recent major sponsors included Rosneft, the controversial state-controlled Russian oil corporation, and ENI, the Italian oil and gas giant. The prestigious Energy Institute Awards also featured high levels of sponsorship from the fossil fuel sector, including from Shell.

The Geological Society also received significant event sponsorship income from fossil fuel corporations (see appendix 8). Although most of its events were not sponsored, where it did receive income from external organisations, oil and gas companies were dominant. We estimated that nearly 90% of the sponsors of the society's events were part of the fossil fuel industry. This included prestigious events. For example, BP was a recent sponsor of one of the society's annual dinners. Indeed, the majority of the society's income for 'science and education' activities came from its Petroleum Group, an internal section set up to facilitate activities in the field.

From the available data, the Royal Academy of Engineering also received high levels of sponsorship income from the fossil fuel industry (see appendix 16). Regarding its recent high prestige events, we found that nearly 20% of the event sponsors were from the fossil fuel industry. For example, BP had been a leading sponsor of its annual dinner for at least three years in a row, while Shell had been a recent sponsor of its Global Grand Challenges Summit.

The other PESOs which ran sponsored events involving fossil fuel corporations had more limited links. The events run by EngineeringUK – such as the Big Bang Fair – were covered in section 4.2, as they were aimed at school-age audiences. A particular concern here was the prominent sponsorship by corporations such as Shell. The Institution of Mechanical Engineers runs prestigious events such as its annual dinner and Formula Student – a combined competition and event where groups of university student compete to build and test a racing car (see appendix 10). Recent sponsors included ExxonMobil, one of the world's largest fossil fuel corporations. Prominent sponsors also included leading automotive corporations

Nine professional engineering and science organisations in our study received events sponsorship from the fossil fuel and/or arms industries. (Image: iStock)

which, while not directly part of the fossil fuel industry, are nevertheless closely related.

Sponsorship by the arms industry

As shown in table 5, we found evidence that seven PESOs in this study accepted event sponsorship from the arms industry. These were: EngineeringUK; the Institute of Materials, Minerals and Mining; the Institution of Mechanical Engineers; the Institute of Physics; the Institution of Civil Engineers; the Institution of Engineering and Technology; and the Royal Academy of Engineering. Of these, we considered the Royal Academy of Engineering, the Institution of Engineering and Technology, the Institute of Physics, the Institution of Mechanical Engineers, and EngineeringUK to have high levels of these financial links.

Again, the Royal Academy of Engineering was found to have numerous prominent financial links to the arms industry in this category (see appendix 16). Nearly 60% of the sponsors of its recent high prestige events were from the industry. For example, Lockheed Martin, BAE Systems and Rolls-Royce were all leading sponsors of the academy's recent Annual Dinners. Meanwhile, Lockheed Martin was also a founding sponsor of its Global Grand Challenges Summits.

The Institution of Engineering and Technology drew a large proportion of its event sponsorship from the arms industry (see appendix 13). Our short survey of its main events revealed that 23% of sponsors were from that sector in the last few years. For example, among the recent 'Platinum Sponsors' of its annual dinner were Babcock, part of the consortium building the UK's new nuclear-armed submarines. BAE Systems were also frequent sponsors, including of the prestigious Churchill Medal.

The Institute of Physics was notable especially due to its financial links to the Atomic Weapons Establishment (AWE), where the UK's nuclear warheads are developed, manufactured and refurbished (see appendix 11). Over several years, the AWE has been a leading sponsor of the institute's awards dinner. Another notable example was where the 'platinum sponsor' of a recent international conference on women in physics was Northrop Grumman, a leading US-based arms corporation.

We found that the Institution of Mechanical Engineers also had a high proportion of arms corporations among the sponsors of its most prestigious events (see appendix 10). Dassault Systemes, the leading French arms company, was a recent sponsor of its annual dinner, while GKN was a frequent partner of Formula Student.

As discussed above, the events run by EngineeringUK – such as the Big Bang Fair

– were covered in section 4.2, as they were aimed at school-age audiences. The most prominent concern here was the high-profile role of BAE Systems.

4.4 Other financial and institutional links

Corporate/ organisational membership

Of the PESOs surveyed in this study, we found that 14 had some form of corporate or organisational membership scheme. The form of these schemes varied significantly, and often limited details were publicly available. In general, they involved member organisations paying fees to the particular PESO for benefits which included one or more of the following: promotional opportunities to the PESO's membership; assistance with professional membership for individual engineers and/or scientists; and general public relations. Schemes were variously called: corporate membership; organisational membership; company-based registration; partnership; or something similar.

Of the 14 PESOs which ran such schemes, four did not publicly disclose a list of any of their corporate members. The four were: BCS – The Chartered Institute for IT; the Chartered Institute of Environmental Health; the Institute of Materials, Minerals and Mining; and the Royal Statistical Society.

Six PESOs listed members/ partners which were part of the fossil fuel industry. These were: the Association of Science Education; the Energy Institute; EngineeringUK; the Geological Society; the Institution of Mechanical Engineers; the Institution of Engineering and Technology; and the Royal Academy of Engineering. The organisations with the highest proportion of fossil fuel corporate members were:

- the Geological Society (70%);
- the Energy Institute (40%);*
- the Royal Academy of Engineering (20%); and
- EngineeringUK (8%).

The Institution of Mechanical Engineers did not publicly provide sufficient information to enable us to make an estimate. The proportions of the other two PESOs were less than 5%. We estimate that the Geological Society receives nearly £80,000 per year in corporate affiliations fees from the fossil fuel industry (see appendix 8).

Six PESOs listed members/ partners which were part of the arms industry. These were: EngineeringUK; the Institution of Mechanical Engineers; the Institution of Civil Engineers; the Institution of Engineering and Technology; the Royal Academy of Engineering; and the Science Council. The organisations with the highest proportion of fossil fuel corporate members were:

- the Institution of Engineering and Technology (21%);
- EngineeringUK (18%);
- the Royal Academy of Engineering (15%); and
- the Institution of Civil Engineers (14%).

The Institution of Mechanical Engineers did not publicly provide sufficient information to enable us to make an estimate. The proportion of the Science Council was 5%.

It is notable that, again, EngineeringUK and the Royal Academy of Engineering both feature prominently among the PESOs with high levels of financial links to both the fossil fuel and arms industries.

Advertising

We found that most PESOs published magazines for their members which ran advertisements, and in some cases this involved advertising from the corporate

* Not including academic departments specialising in fossil fuel-related research.

sector. We analysed the advertising carried by magazines of seven of the PESOs in this study, and found that most of the adverts seemed to be for services for the relevant profession rather than for the promotion of a particular sector. As such, we saw little advertising for the arms and fossil fuel sectors. The main exceptions were the Geological Society and the Energy Institute whose magazines carried a comparatively high proportion of adverts for the oil and gas industries. Advertising for arms companies was also carried by the Institute of Physics, although the proportion was much smaller.

Corporate donations and other financial links

Some of the PESOs in our study reported a number of other significant sources of income from the corporate sectors, including donations and grants for activities not covered so far. We note key examples here.

In its annual reports, the Institution of Engineering and Technology reported the receipt of sizeable donations and legacies from a number of sources (see appendix 13). In recent years, these totalled over £1 million per year. Our brief survey of recent major donors revealed that 10% were arms corporations, including Airbus, BAE Systems and Thales, although the amounts donated by individual organisations were not revealed.

The Royal Society listed in its annual reports 'outstanding donors', which again included some major corporations (see appendix 18). Our brief survey found that 4% were part of the arms sector, with a similar proportion being part of the fossil fuel sector. Furthermore, the society's Industry Fellowships scheme was funded by Rolls-Royce.

One other programme run by the Royal Academy of Engineering also received significant income of relevance to this report (see appendix 16). The Engineering Teaching Fellowships were funded by ExxonMobil, with the society's recent annual spending on the programme being £75,000.

We also noted that the Energy Institute sells a health and safety toolkit on behalf of Shell Exploration and Production Ltd (see appendix 5). According to a recent annual report, this yielded income of £100,000 per year.

Finally, we noted that EngineeringUK lists a range of contributors to its annual *State of Engineering* report (see appendix 7). Our brief survey of recent contributors found 13% were arms corporations and 7% were fossil fuel companies. The financial relationship of the contributors to the report was not specified.

Board members

We looked at the board members/ trustees of two PESOs as examples where the influence of the fossil fuel and arms industries might be present.

Of the members of the governing council of the Energy Institute, at the time of writing, about half had strong links or a background in the fossil fuel sector, especially the oil and gas industry (see appendix 5). Indeed, the president of the council up until mid-2019 was Malcolm Brinded, former Managing Director of Royal Dutch Shell.

Of the members of the board of trustees of the Institute of Physics, about one in six had noteworthy links to the arms or military sectors (see appendix 11).

4.5 Other relevant policies

In this final section of the main findings, we give an overview of policies of the PESOs with particular relevance for links to the fossil fuel and arms industries. We have covered ethical investment policies in section 4.1, so this section focuses on broader environmental policies and those related to ethical issues in the arms sector. In addition to the recurring problem of lack of transparency, we found an added problem in that many of the PESOs we assessed published a wide variety of documents that were relevant to environmental issues, but were not necessarily labelled or indeed used as

environmental policies. Regarding ethical issues related to the arms industry, policies were virtually non-existent. Hence, what follows is only intended to give a 'flavour' of the range of material we discovered.

Regarding environmental policies, we particularly looked for documents which aimed to reduce the environmental impacts of the PESO itself or its professional membership. If there were particular references to action on climate change, these were noted in the case studies. We also noted documents intended to inform environmental action by industry, government or the wider public.

Among our case study PESOs, seven organisations which stood out due to the extent of their environmental policies and practices were:

- the Chartered Institute of Environmental Health – especially for its in-depth coverage of the multiple dimensions of environmental issues, including support for local government professionals;
- the Engineering Council – especially for incorporating sustainable development into the UK Standard for Professional Engineering Competence;
- the Institute of Physics – especially for operating an environmental management system compliant with the international standard, ISO 14001;
- the Institution of Civil Engineers – especially for its Charter for Sustainable Development;
- the Institution of Environmental Sciences – especially for its environmental audit process;
- the Institution of Mechanical Engineers – especially for including environmental issues as one of its six 'critical engineering themes'; and
- the Royal Meteorological Society – especially for having set and met demanding targets for reducing its own environmental impacts.

In addition, some PESOs, notably the Chartered Institute of Environmental Health and the Energy Institute, run multiple training courses for their members on certain environmental issues.

However, three organisations stood out as having no clear environmental policies and limited materials on environmental issues were:

- the British Psychological Society;*
- the Institute of Materials, Minerals and Mining; and
- the Science Council.

Other PESOs are notable for certain environmentally-related activities. For example, The Royal Society and the Royal Academy of Engineering have both published numerous reports on how science and/or engineering can help tackle environmental problems, including climate change. These reports are often aimed at senior policy-makers. Finally, the BCS – The Chartered Institute for IT had an environmental policy and programmes to encourage its members to reduce their environmental impacts but, strangely, its policy seemed to doubt the strength of climate change science (see appendix 2).

Three things are especially notable about the policies discussed in this section. Firstly, several organisations demonstrated a level of interest and concern in environmental issues that at times seems at odds with their associations with the fossil fuel industry. Secondly, it was striking how little commonality there was between the PESOs' different approaches to tackling environmental issues. Thirdly, it was also striking that virtually none of the PESOs regarded the ethical issues related to arms industry and peace issues more broadly as worthy of policy or activity.

* Except in regard of its ethical investment policy as discussed earlier.

5. Discussing the ethical issues

There are a number of ethical issues raised by the main findings which deserve further discussion – especially in relation to a number of counter-arguments which are sometimes used to challenge the views put forward in this report.

One important issue is the size of the financial links between the professional engineering and science organisations (PESOs) and the fossil fuel and arms industries. In general, the dominant sources of income for the professional institutions tend to be individual membership fees and sales of technical publications and other services. For the top learned societies – The Royal Society and Royal Academy of Engineering – the main income is grants from government. Hence, it can be argued that the influence of the financial links with controversial companies is small. However, in some key areas – such as school education programmes and public events, as discussed in this report – income from such sources can be very significant for an individual PESO, and then the pressure not to question, challenge or even publicly discuss controversial corporate behaviour is thus increased. Within the evidence we gathered, it was striking how often opportunities were not taken to publicly discuss ethical issues related to, especially, arms corporations and the military. Given the high profile of these organisations within the school education materials of some PESOs, this we found especially troubling. The issue is related to the now well-recognised problem of 'sponsorship bias' within science where the presence of a corporate sponsor can influence the outcome of the research.[2,4]

Transparency over corporate links therefore becomes very important. If income from the fossil fuel or arms industry – with all the ethical issues this raises – is not clearly revealed in accounts, and hence open to challenge, then trust in PESOs is eroded. Indeed, openness is a cornerstone of high-quality scientific research, so it is particularly disturbing that we found it so difficult to uncover clear data on these corporate links. Standard practices among investment fund managers or commercial confidentiality agreements are often obstacles to openness in this area, but we argue that PESOs need to use their influence to encourage reform.

It is also striking that, despite numerous recent examples of arms and fossil fuel corporations facing major financial penalties for law-breaking related to, for example, corruption or major pollution incidents, this did not seem to affect their involvement as public relations partners for PESOs. Occasionally, we discovered within PESO documents theoretical concerns about the reputational consequences of associations with controversial organisations, but little that was specific to the sectors or companies examined in this study. There is a strong case that guidelines for PESOs on suitable collaborators for public relations activities should exclude any organisation which has such a poor record. It is notable that, for example, after Rolls-Royce agreed to pay huge penalties to the UK Serious Fraud Office and other official bodies in 2017 in relation to bribery claims (see section 2.3), the Royal Academy of Engineering still considered the company a suitable sponsor for its prestigious annual dinner, and EngineeringUK still considered it suitable as a leading sponsor of the Big Bang Fair aimed at tens of thousands of children.

A common defence for collaboration with the fossil fuel or arms industries is that, despite the serious ethical concerns, they still provide valuable, if not essential, services for society and are important parts of the engineering and science professions. With about 80% of the energy used by human civilisation still being derived from fossil fuels (see section 2.2), and armed forces still being a critical part of national security (see section 2.3), this argument cannot be lightly dismissed. However, refusing funding for public relations work or divesting from these industries does not imply a desire to eliminate them altogether – or indeed a desire to end engagement with the industries – but it does

send a clear message that ethical standards need to markedly improve. PESOs claim a leadership position in the engineering and scientific professions, and what better way to show that leadership than to champion transformative action on the major threats to human civilisation and the natural world such as climate change and nuclear weapons?

It is also striking that, when school education programmes are funded by fossil fuel or arms corporations, we do not see a discussion of the related ethical issues within those programmes. For example, the Royal Academy of Engineering decided to brand virtually all of its downloadable teaching resources with the logo of BAE Systems, yet it did not include any exercises within those resources on the ethics of the international arms trade, the use of armed drones in warfare, or the deployment of nuclear weapons. Similarly, the educational resources the academy produced to mark the centenary of the RAF were published under the title 'Aiming for Awesome', which showed little sensitivity to, for example, the tens of thousands of civilian victims of RAF bombing raids which took place over Hamburg and Dresden during World War II. Indeed, having BAE Systems as the lead sponsor of the 'Big Bang' science fair almost seemed to be an in-joke – one in rather poor taste considering how the company's technologies are currently being used to kill civilians in Yemen (see section 2.3). We contend that the enthusiasm shown by PESOs to promote engineering and science as desirable and exciting career options to young people should not be blind to important ethical issues.

Likewise, when deciding on prominent sponsors for prestigious annual dinners or awards ceremonies, PESOs need to be much more sensitive to the message that is sent out to the public when leading fossil fuel or arms corporations are chosen. When the Institute of Physics chooses the Atomic Weapons Establishment to sponsor the laser show at its awards dinner or the Royal Academy of Engineering chooses BP as a sponsor of its annual dinner for three years in a row, they should not be surprised if their reputation suffers as a result.

Some may argue that it is unhelpful to classify fossil fuel or arms companies in the way that we have, because some of them have, for example, significant divisions within the company that are not part of those sectors, or some companies have more progressive policies to reduce their greenhouse gas emissions. Again, this argument is not without some merit, but the scale of the ethical problems we have identified and the degree to which all the companies we have included in these categories are complicit is also a highly important factor. For example, natural (fossil) gas may produce less GHG emissions per unit of energy than coal or oil, but it is still considerably more polluting than most renewables, and the oil and gas industry as a whole has failed and continues to fail to invest the resources necessary to reduce GHG emissions on a scale and in a time frame commensurate with the climate problem (see section 2.2).

Similarly, some may argue that grouping the armed forces together with the arms industry is not justified. The UK armed forces, after all, do more than just use armed force. They provide assistance in disaster relief both in the UK and around the world. They also take part in essential peacekeeping missions. Again, there is some justification for this argument. But the UK government is committed to maintaining armed forces which can "project our power globally" to defend ill-defined "vital interests" – and for this power to include the threat to use weapons of mass destruction.[107] This military capability is well beyond a level that most other nations have, or agree it is necessary to have. Uncritical promotion of the use of science and engineering in such a military stance – which is what PESOs working with the UK armed forces do – is something that at least ought to be publicly debated. Indeed, this is especially important when promoting materials to school-age children, which is what PESOs like the Royal Academy of Engineering and EngineeringUK do. Such a view is lent further support by a report published in August 2019 by the Child Rights International Network. This points out that the UK is the only country

in Europe to recruit for its armed forces from age 16 and more soldiers are recruited at 16 than any other age (although they are not placed in combat situations until they reach 18).[108] The report includes analysis of official data which concludes that the British Army is intentionally targeting young people from deprived backgrounds, and outlines evidence that enlistment at such a young age is detrimental to mental health and social mobility. PESOs need to take account of such evidence when deciding education partners and planning their materials for schools.

Some PESOs may also defend their high level of collaboration with specific industries on the basis that the professional discipline or sector they cover has a high level of involvement of those industries. For example, within this study, we repeatedly found that among the PESOs with the highest levels of financial links to fossil fuel industry were the Energy Institute and the Geological Society. With fossil fuels being such a dominant energy source and the industry being a major user of geological sciences, this is no surprise. But are these disproportionate collaborations therefore justified?

In the case of the Energy Institute, it is worth considering the employment levels in different parts of the UK energy sector. Latest figures from the UK's Office of National Statistics show that the number of direct jobs in energy efficient products is approximately 125,000, nearly 35,000 work in renewable energy and nearly 15,000 are employed in nuclear power.[109] Comparing these figures to the 135,000 directly employed by the UK fossil fuel industry (see section 2.2) reveals that the latter sector is not even responsible for a majority of the direct jobs in the broader energy sector and from which the Energy Institute could draw its membership. Taking account of the need to prioritise those employers which are leading the struggle to reduce emissions of GHGs and other pollutants, it is hard to see why the Energy Institute still gives such prominence to the oil and gas sector when choosing, for example, sponsors for prestigious events. The is also a major question mark over why it continues to run its annual International Petroleum Week at all. Surely an International Energy Week would be far more appropriate?

Likewise, only 20% of the members of the Geological Society are members of its specialist 'Petroleum Group' (see appendix 8). So why is this group allowed to play such a large role in the society's science and education activities and why are leading fossil fuel corporations so prominent among the sponsors of its events?

A further counter-argument is that, by providing higher levels of funding for PESOs, the fossil fuel and arms industries are doing 'more than their fair share' when it comes to funding STEM education activities. However, such funding must be seen in light of the growing difficulty that these controversial sectors have in recruiting high quality staff. Corporate funding of PESOs' education activities is in reality a reflection of simple commercial decisions about the efficient use of marketing and public relations budgets. To consider it 'generous' is arguably naïve.

In general, one of our key concerns is the tension that exists within PESOs between maintaining a high level of objectivity in the information it provides to the public, and promoting its profession, especially to young people, as being the basis of an interesting, exciting and rewarding career. Our view is that too much enthusiasm in doing the latter can put a strain on the former especially when it involves working with controversial organisations such as fossil fuel and arms corporations.

In summary, by continuing to foster financial links with fossil fuel and arms corporations, we argue that PESOs are facing a similar dilemma to that faced by medical research organisations in earlier decades when offered lucrative funding opportunities by the tobacco industry. The medical research organisations slowly woke up to the huge damage to public health and the environment in which they were complicit, and ended these contracts. How long will it take PESOs to follow a similar path?

6. Conclusions

Professional Engineering and Science Organisations (PESOs) set professional standards and provide leadership on ethical issues in these sectors. However, the findings of this study raise numerous doubts about whether that leadership is sufficient.

We have chosen to focus on the financial links between PESOs and fossil fuel and arms corporations. Robust and extensive scientific evidence has for some time pointed to global climate change being one of the greatest threats to human civilisation, while the fossil fuel industry has repeatedly failed to deliver action on the scale needed – indeed, it has often lobbied against such action. Meanwhile, weapons of mass destruction – in the shape of nuclear weapons – also continue to threaten the future of human civilisation, while the world's arms industries prop up precarious deterrence strategies. Further, global military expenditure is reaching record levels as international arms races are fuelled by militaristic policies and powerful lobbying by arms companies. Human rights violations, including war crimes, are facilitated by arms sales from democratically elected governments including the UK. Numerous corporations in these sectors have also faced huge financial penalties for corrupt practices or environmental damage. Some have even acted to undermine the science of climate change to fuel political and public opposition to necessary action. PESOs can show leadership by reducing and eliminating financial links with these sectors. Yet, our evidence shows that this not happening to any great extent – indeed, in many cases the reverse is true.

In more detail, the key findings of our study are as follows.

School education programmes (section 4.2)

- Nine PESOs in this study published teaching resources or ran school education activities that were sponsored or otherwise directly involved fossil fuel or arms corporations. In most cases, details of the relationships were not transparent and we could only find very limited information on the specific financial links between those education programmes and the corporations concerned.
- We concluded that three PESOs ran school education programmes which had 'high' or 'very high' levels of involvement with the fossil fuel industry – the Royal Academy of Engineering, EngineeringUK, and the Energy Institute. For example, the available data showed that over 70% of the external funding received by the Royal Academy of Engineering for its recent school education programmes was from fossil fuel corporations. Meanwhile, EngineeringUK had received funding of at least £1m from Shell for its programme, 'Tomorrow's Engineers'.
- We concluded that two PESOs ran school education programmes which had 'very high' levels of involvement with the arms industry – the Royal Academy of Engineering and EngineeringUK. For example, almost all of the downloadable teaching resources provided by the Royal Academy of Engineering on its website involved arms corporations – mainly BAE Systems – and/or the armed forces and/or promoted military technologies. Meanwhile, the sole 'lead sponsor' of the high-profile 'Big Bang' science fair – the lead organiser of which is EngineeringUK – has been BAE Systems for many years.

Investments (section 4.1)

- We concluded that four PESOs held 'very high' levels of investments in the *fossil fuel industry* – the Energy Institute; EngineeringUK; the Institute of Physics; and the Royal Statistical Society.
- The *transparency* of investments was generally very poor. For the 15 PESOs in our study that held investments, we were

Only one organisation in our study intentionally restricted investment in the fossil fuel and arms industries. (Image: iStock)

able to identify only where approximately 5% of their total assets were held (although there was a large variation in openness between individual PESOs). Indeed, the disclosure was generally so poor that we were unable to determine whether any PESOs held high levels of investments in the *arms industry*. The two PESOs with the highest investments – The Royal Society and the Institution of Engineering and Technology – had some of the lowest levels of disclosure.

- Of 20 PESOs studied, only one – the British Psychological Society – had an *ethical investment policy* which restricted investment in the fossil fuel or arms industries. Five other PESOs held no investments in these industries due to their practice of not holding investments listed on stock exchanges or similar. These five were: the Association for Science Education; BCS - The Chartered Institute for IT; the Institution of Environmental Sciences; the Institution of Structural Engineers; and the Science Council.

Events sponsorship (section 4.3)

We concluded that:

- three PESOs received a 'very high' level of events sponsorship from the *fossil fuel industry* – the Energy Institute; the Geological Society; and the Royal Academy of Engineering. For example, the Energy Institute runs International Petroleum Week, an annual event which involves a prestigious international conference, sponsorship dominated by the oil industry and related sectors, and income measured in millions of pounds. Recent sponsors included Rosneft, Russia's state-controlled oil company. Meanwhile, BP has been a sponsor of the Royal Academy of Engineering's prestigious annual dinner for at least three years in a row, and nearly 90% of the external sponsors of the Geological Society's events were from the fossil fuel sector.
- five PESOs received a 'high' or 'very high' level of events sponsorship from the *arms industry* – the Institution of Engineering and Technology, the Royal Academy of Engineering, the Institute of Physics, the Institution of Mechanical Engineers, and EngineeringUK. Industrial sponsors of these organisations' most prestigious events included some of the largest and most controversial corporations including BAE Systems, the Atomic Weapons Establishment, and Lockheed Martin.

Corporate membership and other relevant links (section 4.4)

We concluded that:

- three PESOs had 'high' or 'very high' levels of other financial or institutional links with the *fossil fuel industry* – the Energy

Institute; the Geological Society; and the Royal Academy of Engineering. For example, nearly 80% of the Geological Society's corporate members were from the fossil fuel sector, while the Engineering Teaching Fellowships run by the Royal Academy of Engineering were funded by ExxonMobil. The Energy Institute's president was, until 2019, a former managing director of Shell.

- three PESOs had 'high' or 'very high' levels of other financial or institutional links with the *arms industry* – the Institution of Engineering and Technology; the Royal Academy of Engineering; and EngineeringUK. For example, among the Institution of Engineering and Technology's major donors were BAE Systems, Thales and Airbus.

Other relevant issues (section 4.5)

- Seven PESOs in our study stood out due to the positive extent of their *environmental policies and practices*: the Chartered Institute of Environmental Health; the Engineering Council; the Institute of Physics; the Institution of Civil Engineers; the Institution of Environmental Sciences; the Institution of Mechanical Engineers; and the Royal Meteorological Society.
- Virtually none of the PESOs in our study regarded the *ethical issues related to arms industry* and peace issues more broadly as worthy of policy or activity – not even in relation to school education programmes.

In summary, we found that some of the most influential professional engineering and science organisations prominently and, at times, preferentially promoted the fossil fuel and arms sectors. This is despite these industries having serious ethical shortcomings. Of most concern, some professional bodies promoted these industries to school children and other key audiences, but failed to discuss important ethical issues. Many invested large amounts in these companies, but did not acknowledge potential conflicts of interest. Most also failed to publish key financial data which would allow their members and others to hold them to account.

For ethical and reputational reasons, we argue that it is in the interest of both the public and the professional organisations themselves to take major action to reduce and/or eliminate the financial links between themselves and the fossil fuel and arms industries. This would allow the professional organisations to properly fulfil their goal of providing ethical leadership for the science and engineering community and help accelerate wider action to tackle the enormous environmental and security problems that currently face the world.

7. Recommendations

Our study has documented extensive financial links between some of the most prestigious professional engineering and scientific organisations (PESOs) and the fossil fuel and arms industries. It has highlighted numerous ethical problems raised by these links. In this final chapter, we list proposals for reducing and/or ending these links, as well as addressing some of the broader ethical issues raised.

General recommendations are as follows.

1. PESOs should be *much more transparent* about the extent of their financial links to controversial sectors, including the fossil fuel and arms industries, especially those related to school education programmes, investments and high prestige event sponsorship. This should include:

    a. Disclosing all payments from corporate sources worth over £1,000 for school education programmes and event sponsorship in annual accounts.

    b. Disclosing the specific investment funds in which *all* their assets are held.

    c. Proactively working with investment fund managers to increase the level of disclosure of individual companies in which their funds are invested.

    d. PESOs should *review all financial links* with fossil fuel and arms companies, especially those related to school education programmes, investments and high prestige event sponsorship.

2. PESOs should *end all branding of school education programmes* (including teaching resources and in-school activities) by fossil fuel and arms corporations.

3. PESOs should commission educational materials aimed at school-age children which *discuss the ethical issues* related to the exploitation of fossil fuels and the use of military technologies.

4. PESOs should enact policies which *restrict or eliminate financial links to fossil fuel corporations* based on ethical criteria such as:

    a. The extent of the company's involvement in high-carbon fuels such as coal, unconventional oil (e.g. oil sands) and unconventional gas (e.g. shale gas);

    b. The extent to which the company is reducing the share of fossil fuel exploitation within its activities;

    c. The extent to which the company is pursuing 'Paris-compliant' policies and practices.

    d. In defining and applying such policies, PESOs could make use of the sources provided in sections 2.2 and 3.3, and appendix 21.

5. PESOs should enact policies which *restrict or eliminate financial links to arms corporations* based on ethical criteria such as:

    a. The extent of its sales of military equipment to Human Rights Priority Countries;

    b. The extent of its involvement in nuclear weapons development, manufacture or deployment;

    c. The extent of its involvement in military artificial intelligence programmes which could accelerate the development of lethal autonomous weapons.

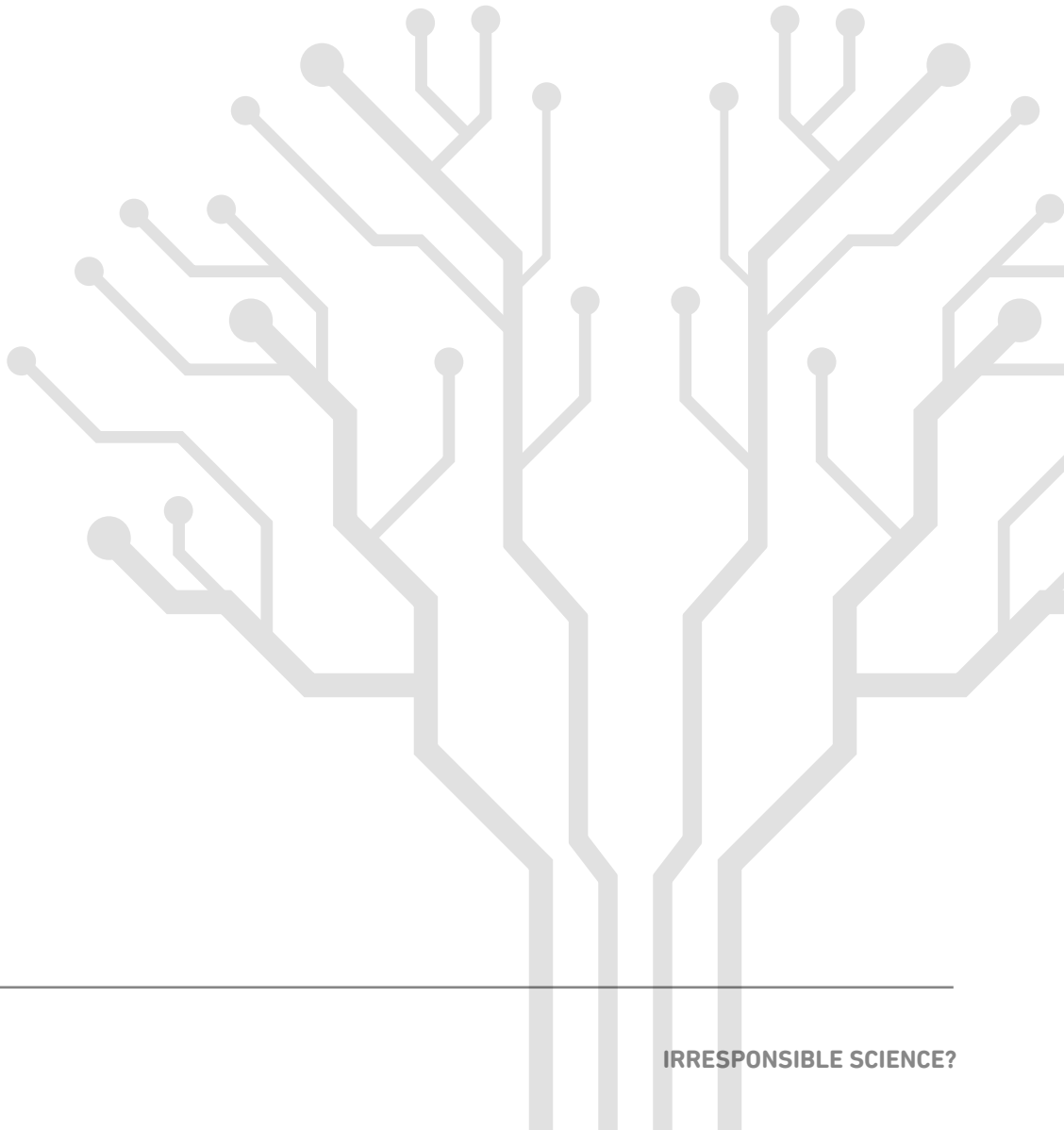
    d. In defining and applying such policies, PESOs could make use of the sources provided in sections 2.3 and 3.3, and appendix 21.

6. PESOs should enact policies which *eliminate financial links to all corporations which have received significant penalties* in the last five years related to law-breaking or major malpractice.

7. PESOs should commission *briefing materials and/or courses* for their professional members on the relevance of *climate change and peace-building* to their work, if they have not done so already.

8. PESOs should agree and *implement environmental policies and practices* which aim to minimise the impacts of both the organisation itself and its professional members, if they have not done so already.

    a. PESOs should make use of best practice environmental management systems, such as ISO 14001, net zero carbon targets, and independent monitoring and verification.



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While every effort has been made to ensure the accuracy of information in this report, any errors are, of course, the responsibility of the authors.

List of appendices

1. Association for Science Education (ASE)
2. BCS - The Chartered Institute for IT
3. British Psychological Society (BPS)
4. Chartered Institute of Environmental Health (CIEH)
5. Energy Institute (EI)
6. Engineering Council
7. EngineeringUK (EUK)
8. Geological Society
9. Institute of Materials, Minerals and Mining (IOM3)
10. Institute of Mechanical Engineers (IMechE)
11. Institute of Physics (IOP)
12. Institution of Civil Engineers (ICE)
13. Institution of Engineering and Technology (IET)
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16. Royal Academy of Engineering (RAEng)
17. Royal Meteorological Society (RMetS)
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20. Science Council
21. List of fossil fuel and arms corporations
22. Generic letter sent to PESOs

These appendices can be downloaded from:
https://www.sgr.org.uk/publications/irresponsible-science

Acronyms and abbreviations

CCS	carbon capture and storage (or sequestration)
CO_2	carbon dioxide
GHG	greenhouse gas
$GtCO_2$	giga (billion) tonnes of carbon dioxide
ICAN	International Campaign for the Abolition of Nuclear Weapons
IPCC	Intergovernmental Panel on Climate Change
ISO	International Standards Organisation
IT	information technology
NATO	North Atlantic Treaty Organisation
PCA	Paris Climate Agreement
PESO	professional engineering and science organisation
SGR	Scientists for Global Responsibility
SIPRI	Stockholm International Peace Research Institute
STEM	science, technology, engineering and mathematics
TNT	trinitrotoluene
TPNW	Treaty on the Prohibition of Nuclear Weapons
UN	United Nations
UNPRI	United Nations Principles for Responsible Investment
VAT	value-added tax

NB: The names of individual PESOs are spelt out in full in the main report, but acronyms are defined in the 'List of appendices' and used throughout appendices 1-20. Company names/ acronyms are listed in appendix 21.

SGR
responsible science

Irresponsible science?

How the fossil fuel and arms industries finance professional engineering and science organisations

This report reveals a previously unrecognised pattern of financial links between the fossil fuel and arms industries on the one hand, and some of the UK's leading professional engineering and science organisations on the other. The links revealed include funding and branding of school education programmes, sponsorship of prestige conferences and dinners, investments, major donations, and corporate membership. The professional organisations that received the most significant funding from these controversial industries were the Royal Academy of Engineering, EngineeringUK and the Energy Institute.

Scientists for Global Responsibility (SGR) is a UK-based membership organisation which promotes responsible science and technology. Its membership includes hundreds of natural scientists, social scientists, engineers and professionals in related areas. It carries out research, education, and advocacy work centred around science and technology for peace, social justice and environmental sustainability. It is an active partner of ICAN, which was awarded the Nobel Peace Prize in 2017.

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