ARMS TO RENEWABLES

WORK FOR THE FUTURE

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FOREWORD

The damage caused by the UK arms trade and militarism

Spending vast amounts of money on military procurement and pushing arms sales doesn't enhance security: it fuels conflict, supports repression and makes the world a more dangerous place.

The UK sells arms to over 100 countries across the globe. Despite government protestations that it has "rigorous" export controls, the reality is that the UK routinely arms many of the world's most repressive regimes and supplies arms to countries in the midst of conflict. The business interests of international arms companies are prioritised at the expense of human rights. Arms exports continued to Israel during its devastating attack on Gaza in 2014. Saudi Arabia used BAE Systems armoured vehicles to help suppress pro-democracy protests in Bahrain in 2011, and vigorous arms promotion continues to both these authoritarian regimes. The missiles of a single company, MBDA, were sold to the Gaddafi regime in 2007, were extensively used by the UK and French military in the 2011 war in Libya, and were also supplied by Qatar to rebel forces in Libya. Regardless of the obvious lessons to be drawn from this, Libya was again categorised by the government as a priority market for UK arms sales the following year.

The UK's approach to international problems is similarly destructive. Security is perceived to relate almost exclusively to military matters. When problems arise, the UK is willing to launch military action regardless of the misery likely to ensue and its counterproductive consequences. The appalling disasters of Afghanistan and Iraq have seen no change of approach. In marked contrast to this misplaced vigour, underlying drivers of insecurity receive scant political attention or action. Global threats stemming from climate change, competition over resources and inequality require fully committed, preventative action, but the responses are centred on containing the outcomes.

Although there is little in this briefing about the effects of the arms trade and militarism, it is these impacts that motivate our desire for change. The briefing focuses on the economic aspects of arms industry employment, but we find that the most obvious alternative for arms industry employment is one that also addresses one of the greatest threats to security. A move from militarism and the arms trade towards tackling climate change would be economically beneficial. At the same time it would reduce the insecurity caused by UK military policy while increasing security by starting to address greenhouse gas emissions meaningfully.

It is intended that this briefing will inform discussions of alternatives to the arms industry and demonstrate that there is the potential for more jobs in expanding, useful sectors, compared to arms production. Campaign Against Arms Trade (CAAT) will continue to work with others to identify the detailed mechanisms that can help make this shift a reality.

SUMMARY

The purpose of this briefing is to show that there are realistic alternatives to large-scale arms industry employment. To do this we compare arms employment with employment in selected renewable energy sectors – those of offshore wind and marine. The priority given to these is based on the UK's large-scale natural resources, a leading position in deployment, and the potential for the UK to be at the leading edge of the technology for both domestic production and export.

We approach the subject by assessing the current number of arms industry jobs and the outlook for the sector. We then provide background information on offshore renewable energy so we are in a position to compare the job numbers, skills and locations of both sectors. In the final section we provide broad recommendations for government policy.

The shape of the arms industry

The number of arms industry workers is often stated to be around 300,000. This, however, is a misuse of government figures. We estimate that there are around 115,000 UK arms industry jobs resulting from Ministry of Defence expenditure and a further 55,000 in arms export production. These give a total of 170,000 UK arms industry jobs. All of this employment is in the private sector.

In considering the jobs for which alternatives have to be found, we consider an end to arms exports and a halving of UK arms procurement, meaning around 115,000 jobs. Halving UK military procurement would save around £7 billion per year over the next decade and arms export subsidies amount to hundreds of millions of pounds per year. These are enormous sums of money which could be invested elsewhere, and wherever money is spent it would create jobs.

The outlook for UK arms procurement is likely to be static over the coming years. However, procurement is reducing in the major arms markets of the US and EU, so for the UK arms industry to stay at its current level will require increased exports to the rest of the world, in particular the Middle East. This will be hard, as every major arms producer is trying to sell to these markets.

While it is feasible that the arms industry can stay at its current size, it seems more likely that the long-term decline in UK arms industry jobs will reassert itself.

At present the arms industry receives a vast amount of political support and public money. This is despite its malign effects and the fact that it is a stagnant sector. Meanwhile, the renewable energy sector, which is vital for UK prosperity, its environment and security, remains marginalised by the government.

Alternatives to arms jobs

There is a severe skills shortage in Science, Technology, Engineering and Maths in the UK. As a result, there are many sectors that would be grateful recipients of arms industry workers.

One group of sectors – renewable energy and low-carbon technologies – is a prime candidate for the reallocation of resources, for economic, environmental and security reasons. A comparison of all renewable energy and low-carbon technologies against arms industry employment is impractical for this report so we focus on the most relevant technologies:

Offshore wind energy – The UK has the largest wind resources in Europe and has started the process of utilising these with as much offshore wind capacity installed as the rest of the world combined. While it is already a meaningful sector, it is also expanding rapidly and the potential generation capacity is enormous. However, this depends on government policy and, in particular, predictable long term pricing.

Marine energy – Although marine energy will be smaller scale than offshore wind, it will be an important sector for the UK. Similar to offshore wind, the UK has enormous wave and tidal resources. The latter can be broken down into tidal stream and tidal range which can be by means of barrages or lagoons. Although the sector is in its infancy, the UK leads the development of these technologies. If it can stay at the forefront, build the supply chain, and deploy substantial marine energy resources, it could, as for offshore wind, lead to substantial jobs and exports.

Employment comparison

Job numbers

Presently, it is estimated that there are around 16,000 UK jobs in offshore wind. In the main scenario we adopt there would be around 150,000 jobs in offshore wind although others have proposed a far greater rolling-out of the technology. We estimate that wave and tidal power could provide around 60,000 jobs. So a move towards offshore wind and marine energy could produce nearly twice as many jobs as would be needed for an end to arms exports and a halving of arms procurement.

These are total jobs rather than necessarily UK ones. The government estimates that the UK content for an offshore wind farm was about 25% in 2012. Reaping the employment rewards of UK offshore wind development and potential exports will require concerted UK government effort to promote a UK supply chain.

Skills

Both the arms and renewable energy sectors are highly skilled. They have similar breakdowns across broad categories of skill levels and employ many of the same branches of engineering. Perhaps most tellingly, there is substantial overlap between the companies in each sector, from large-scale offshore construction down to the component level.

The arms industry itself believes that renewable energy could make good use of its skilled workers. Even in 2010, in the midst of the economic downturn and when renewable energy projects were smaller than they are now, its trade association warned that if workers left the arms industry, other sectors including “alternative energy” “would mop up those people almost immediately”.

Each of the technologies needs policy support, investment and skilled workers. Change needs to happen quickly – both to address emissions and to put UK industry at the forefront of these important sectors.

Locations

Arms industry jobs are widely distributed around the country. The South West, East Midlands and South East of England are the areas with most arms employment, followed by Scotland and the North West of England.

Offshore renewable energy projects are spread around the coast according to the technology. The largest wind sites are along the east coast of England but there are many substantial allocated sites or identified resources around Scotland, North West England, Northern Ireland, Wales, South West England and, to a lesser extent, southern England. Wave energy is dominated by North West Scotland, with substantial resources also off North Scotland and South West England and Wales. The largest tidal stream resources are off northern Scotland but there are substantial amounts along the west and south coasts of Scotland, Wales and England. Tidal range is highest in the Bristol Channel, North West England, in the Wash and off Kent.

A comparison indicates that there would be more jobs than needed in Scotland, Wales and down the west and east coasts of England. Central England, Northern Ireland and South East England are the areas where the fit between renewable energy and arms employment isn't so obvious. However, there would be tens of thousands of supply chain jobs that could be located anywhere.

Conclusion

The renewable energy sector is a viable alternative to the arms industry. The suggested expansion of offshore wind and marine energy would lead to many more jobs than displaced arms workers would need, the skills required would be similar, and there would also be appropriate work available in most areas where arms workers are located.

Each of the technologies needs policy support, investment and skilled workers. Change needs to happen quickly – both to address emissions and to put UK industry at the forefront of these important sectors.

At present the arms industry receives a vast amount of political support and public money. This is despite its malign effects and the fact that it is a stagnant sector. Meanwhile, the renewable energy sector, which is vital for UK prosperity, its environment and security, remains marginalised by the government. The contrast between the waste and destruction of the arms industry and the potential and benefits of the renewable energy sector is stark.

We propose that:

- the UK government starts a fundamental review of its security policy and role in the world. These are presently focused on military approaches, sidelining wider security threats and the underlying drivers of national and international insecurity such as climate change. We consider that an objective review along these lines should stop the business of exporting arms and radically cut military procurement.
- the government promotes renewable energy and low-carbon technologies. This should be through its policies and legislation, with the top priority being a binding renewable energy target for 2030 to provide the stability required for investment, and increased public funding, in particular for Research & Development and investment in infrastructure such as ports.
- the government should commit to building the domestic supply chain for renewable energy
- as the government radically reduces arms procurement and exports, it should prioritise early identification of areas that are less equipped to provide new jobs for arms industry workers and put effective measures in place to encourage alternative sources of work to locate there.

1 INTRODUCTION

The most pervasive justification for arms sales and large-scale arms procurement is that of 'jobs', and this argument is routinely used to defend the indefensible.

The purpose of this research briefing is to show that there are realistic alternatives to large-scale arms industry employment. To do this we compare arms employment with that of selected renewable energy sectors – those of offshore wind and marine.

We make this comparison in broad terms, by considering numbers of potential employees, the skills of employees, and the location of work. This briefing is indicative and not envisaged as a proposal for a tightly-focused shift from arms to offshore wind and marine energy. First, further research would be required to consider specific policies and mechanisms for a shift. Second, we recognise that there are a host of other renewable energy and low-carbon technologies that will require substantial and swift expansion over the coming decade, and that the skills of arms workers would be a benefit to many of these as well as to other useful sectors of the economy.

A steady reduction in arms industry employment may not be a significant problem at the national level as there is presently, and will be for the foreseeable future, a severe science and engineering skills shortage. Arms industry workers appear to have been relatively able to find alternative work within the normal employment market even during the economic downturn. However, as we are considering a large number of workers it is practical as well as responsible to consider how well arms workers might fit with alternative sectors.

In order to compare our chosen sectors, we first, in section 2, assess the current number of arms industry jobs and the outlook for that sector. In section 3 we consider renewable and low-carbon alternatives and provide background information on offshore wind and marine energy resources. This allows us to compare, in section 4, the job numbers, skills and locations of arms and offshore wind and marine energy. In section 5 we conclude and provide broad recommendations for government policy.

2 THE SHAPE OF THE ARMS INDUSTRY

The number of workers in the arms industry

The number of arms industry workers is usually stated to be around 300,000. This, however, is a misuse of government figures. In this section we will separately consider the number of arms industry jobs arising from Ministry of Defence (MoD) expenditure and exports, and then look at the outlook for the UK arms industry. All of the employment being considered is in the private sector.

Arms industry jobs resulting from MoD expenditure

The usual way of calculating the arms industry employment numbers comes from MoD statistics. These stopped being published in 2009 and the most recent statistics are from the 2007/08 fiscal year. These cover two categories of jobs. One is direct jobs in companies which receive contracts from the MoD. The other is indirect jobs that occur through the supply chain.

The MoD estimates for UK industry employment resulting from its spending in 2007/8 are in table 2.1.

Table 2.1 » MoD estimates of employment from MoD expenditure[1]

	2007/08
Employment from MoD expenditure	235,000
Direct	125,000
Indirect	110,000
Split by:	
Equipment expenditure	
Direct	75,000
Indirect	75,000
Non-equipment expenditure	
Direct	50,000
Indirect	40,000

1 MoD, UK Defence Statistics 2009, table 1.10, bit.ly/1hFwS6c. The detailed methodology used to produce the figures is given in the Defence Statistics Bulletin No.5 (MoD, March 2003, bit.ly/1rnf367). All figures are to the nearest 5,000 so may not sum exactly because of rounding. In the notes accompanying the figures, the MoD states that: "direct" employment is that generated in those companies providing the product or service directly to MoD, or that within the exporter. "Indirect" employment is that provided through "the supply chain" by sub-contractors or suppliers to the "direct" contractor. The figures exclude MoD service and civilian personnel, The MoD statistics do not include "induced" employment, that which results from the personal spending of direct and indirect employees.

However, the figure of 235,000 covers all jobs created by MoD spending. This includes spending on food, water, stationery, computers, train fares, hotels, security companies, cleaning and building management, health, and all the other goods and services the military have to buy.

We are concerned here about the number of jobs in the arms industry. By this we mean jobs making and servicing arms. To find this number, we use a technique the consultancy Oxford Economics developed in a report for the arms industry.[2]

Oxford Economics used MoD statistics for 2006/07, reporting total MoD spending with UK suppliers of £16.49 billion. From this, Oxford Economics isolated the expenditure which was classified under the Standard Industrial Classification (SIC07) codes which specifically related to arms and weapons, listed in table 2.2. It found that total spending in these categories was £6.34 billion. MoD spending in all other industrial categories, including £1.64 billion of other equipment, was treated as not directly arms-related.

Table 2.2 » SIC07 codes relating specifically to UK arms production

29.6	Weapons & Ammunition
30	Data Processing Equipment
31	Other Electrical Engineering
32	Electronics
33	Precision Instruments
34, 35.2, 35.4, 35.5	Motor Vehicles & Parts
35.1	Shipbuilding & Repairing
35.3	Aircraft & Spacecraft

If we apply this working to 2007/08, total equipment spending was £8.11 billion and arms spending (i.e. the above categories) was £6.20 billion. There will have been some arms industry spending in other equipment categories (MoD statistics note that payments to AWE (the Atomic Weapons Establishment) Management Ltd would be outside the equipment categories, and Oxford Economics suggests that "parts of QinetiQ" would be similarly excluded), so we add £400 million to both the arms and overall equipment totals to cover such omissions.[3]

The MoD estimated that there were 75,000 direct jobs in equipment in 2007/08 and the same number of indirect jobs, giving a total of 150,000 jobs.[4] If we assume that the ratio of arms spending to total equipment spending was the same as the ratio of arms jobs to total equipment jobs, then there would have been around 115,000 direct and indirect jobs in domestic arms production in 2007/08.

While the MoD employment data ceased at this date, figures for arms spending with UK industry continued, and this spending increased markedly from 2007/08 to 2009/10. It then began to decrease; however, the extent to which it decreased is masked by a change in methodology.[5] Other figures presented by the arms industry's trade association, ADS, show that arms industry employment increased from 2008 to 2010 and then, by 2012, had fallen-back almost to the 2008 level.[6] Following this, we would expect arms industry employment numbers to be a little above those in 2007/08.

2 Oxford Economics, The Economic Case for Investing in the UK Defence Industry, 2009, p.7, bit.ly/1oR5Cvn

3 AWE has a contract for £8.4 billion over 25 years (MoD, response to Freedom of Information Act request, 13.12.2013, bit.ly/1oZv6k9). An average gives £336 million per year. QinetiQ receives £250-£500 million a year from the MoD (MoD, Finance Bulletin 1.01: Trade Industry & Contracts 2014, August 2014, table 1.01.03, bit.ly/1kDhgbC) but only a portion is relevant here.

4 MoD, UK Defence Statistics 2009, table 1.10, bit.ly/1hFwS6c

5 The new methodology improves both the basis for determining UK content but also the categories that spending fits into. However, the change is so marked that the MoD stated that "no meaningful comparison can be made between the estimates based on the old methodology and those based on the new methodology." (MoD, Defence Statistics Bulletin No.13, August 2014, p.11 bit.ly/XAiGd2)

6 ADS, UK Defence Industry Outlook, July 2014, bit.ly/1vofv3U. We do not know the basis for the report's figures but assume the data would be consistent year-on-year so use the change over time.

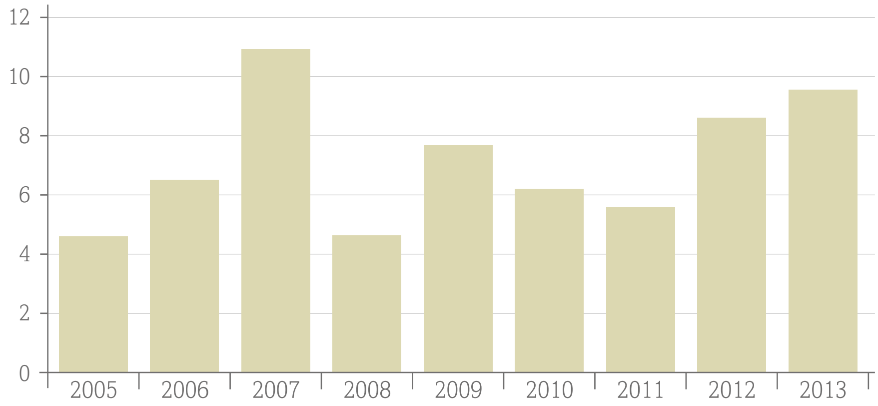
While this may point to an employment figure a little higher than the 115,000 we initially identified, the improved MoD methodology demonstrates that, prior to the change, the MoD was overestimating the amount of spending on the UK arms industry. As part of its explanation of the methodology the MoD compared spending in 2010/11 using both old and new methodologies. This showed that identified arms spending with UK industry was reduced by £1.15 billion, or 13%. This is only a single year's data, but if it was applied to the 115,000 jobs it would reduce the total to around 100,000 jobs.

Overall, as there are arguments for a higher number of jobs but also for a significantly lower number, it feels as if our initial estimate of 115,000 jobs is a fair basis for proceeding.

Arms industry jobs resulting from arms exports

In addition to the UK jobs in arms production for the MoD, we need to include UK employment resulting from arms exports. The MoD used to provide figures for this but, as above, the data stops after 2007/08. To get a sense of the way arms export employment might have changed we can look at figures for arms export orders over recent years:

Chart 2.1 » Estimates of Arms Export Orders, constant 2012 £bn[7]



The numbers are so variable because these are reported orders, not deliveries. One large order will have a major impact on the sales numbers, as happened in 2007 with the Saudi Arabia order for Eurofighter Typhoon aircraft. The orders are then filled over many years. Also, the actual deliveries may differ from the orders. As the MoD states, "it should be noted that export orders can subsequently be cancelled, prolonged or changed at any time in the future after the initial order has been placed."[8]

The data reflects total export orders but doesn't identify content that is from the UK and that which is imported from elsewhere, integrated into equipment in the UK, and then exported. The overall figure for this import content has been estimated to be around 40%.[9]

As the deliveries will take place over several years, it is necessary to consider long term averages and trends rather than specific dates. In this case there is no meaningful trend. The average of the employment figures for the most recent five years of available data (2003/4–2007/8) is 61,000 jobs.[10]

In 2010, ADS estimated total UK arms export jobs to be 55,000.[11] This is unlikely to number an underestimate[12] and, as it is broadly consistent with figure derived from the MoD, but more recent, we will use that figure.

7 See MoD, Finance Bulletin 1.01: Trade Industry & Contracts 2014, August 2014, table 1.01.09, bit.ly/1kDhgbC and the same bulletin for 2013, table 1.01.08, bit.ly/1qA4Nmm. The figures are converted to constant 2012 data using the UK Treasury's GDP deflator (bit.ly/MKIGfN). The figures are produced by the government's arms promotion unit, UKTI DSO, from a survey of companies. It is also worth noting that UKTI DSO figures are substantially higher than those of some other sources (for example, the Congressional Research Service, Conventional Arms Transfers to Developing Nations, 2004-2011, table 36, bit.ly/1mArIw6).

8 MoD, Finance Bulletin 1.01: Trade Industry & Contracts 2014, August 2014, table 1.01.09, bit.ly/1kDhgbC

9 M. Chalmers, N.V. Davies, K. Hartley and C. Wilkinson, The Economic Costs and Benefits of UK Defence Exports, University of York, November 2001, p.11, bit.ly/1orhqnx

10 UK Defence Statistics 2009, table 1.10, bit.ly/1hFwS6c

11 UKTI DSO, response to Freedom of Information Act request, 22.12.2010, bit.ly/1sIiV01

12 As ADS is the arm industry's trade association, it has an interest in highlighting the industry's economic importance

Total UK arms industry jobs

Adding MoD- and export-related arms industry jobs gives a total of 170,000.

Table 2.3 » Total UK arms industry jobs

Jobs in the UK arms industry	
Jobs relating to arms export	55,000
Jobs relating to arms sales to the MoD	115,000
Total jobs	170,000

That the total figure is essentially the same as that estimated for 2007/08 seems at odds with the public perception of cuts in arms industry jobs and statements from the arms industry. There seem to be two possible explanations:

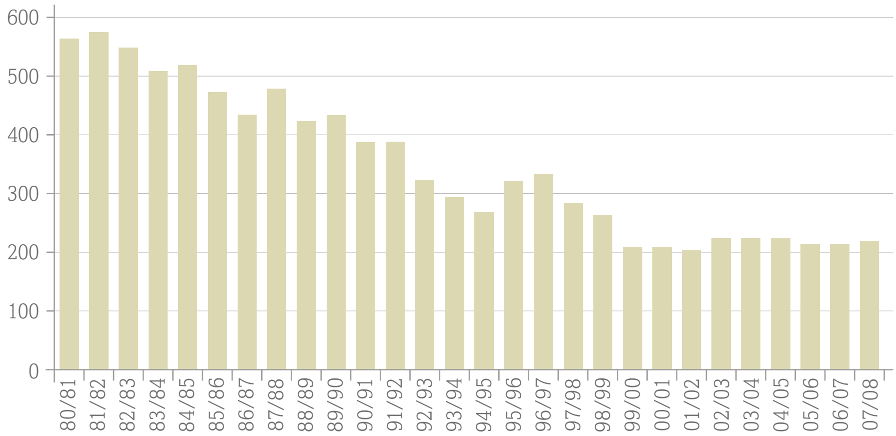
- The number of jobs is too high, i.e. there have been cuts in the arms industry but the data isn't accurate or recent enough to pick these up
- The public perception is wrong. The most likely explanation for this is that the job cuts that have been proposed or taken place have been highlighted &/or exaggerated by the arms industry, presumably in order to apply political pressure to keep arms spending higher than it might otherwise be.

It isn't possible to assess the relative merits of these possible explanations.

Outlook for the arms industry

There has been a long term decline in employment in the arms industry in the UK. The number of jobs halved during the 1980s and 1990s, levelling-out over the 2000s.

Chart 2.2 » UK jobs from MoD equipment spending and exports, thousands[13]



Note: the numbers for MoD spending are larger than the arms spending we have identified as the figures include both arms equipment spending and spending on other equipment.

From what we have seen, the number of arms industry jobs seems to have continued to be stable, but there are a number of indications that point towards possible further decline.

13 MoD, Defence Statistics, multiple years from 1992 to 2009, available at bit.ly/1pIimyR

MoD arms spending

The UK government is planning for arms procurement to increase by 1% per year in real terms from 2014/15 to 2020/21.[14] If this is followed, UK arms industry employment from MoD expenditure is likely to be stable. However, there are questions as to the certainty of this. The parliamentary Public Accounts Committee pointed out that it depends on there being no further MoD cuts and also savings in non-equipment expenditure being achieved.[15]

Even though cuts in UK military spending have been lighter than those for most departments, the military budget has been reduced over recent years. In real terms, it was cut by 13% between 2009/10 and 2012/13 and is planned to fall by 21% by 2015/2016.[16] Although the MoD expects to return to real term budget increases after this point, it seems at least as likely that there will be further real terms cuts over the next few years.[17] If there are further MoD cuts, or if personnel or operational costs can't be cut fast enough, it will increase the pressure on the arms procurement budget.

Some analysts have considered that the UK's overall strategic/military ambition has been reduced following the cuts,[18] and this, if real, may be reinforced by the public's unwillingness for the UK to be involved in military interventions (as was the case regarding Syria in 2013). With fewer personnel and deployments it would be hard for arms procurement to buck that trend indefinitely. However, it is very open to question as to whether there is a deliberate strategic shift taking place or merely a temporary adjustment due to the policy of austerity.

Exports

If UK procurement spending falls then arms exports will need to increase for arms industry employment to stay at current levels.

Exports to the US and EU

A number of reports – such as those from the RAND corporation, Brookings and Deloitte[19] – have assumed substantial cuts in the arms procurement of the US and European countries. The Deloitte 2014 industry outlook report is even subtitled "Expect another record year for commercial aerospace and continued declines in defense". It considers that the end of prolonged period of armed conflict in Iraq and Afghanistan (meaning large-scale military involvement by NATO countries) was leading to lower budgets.

The US is the UK's second largest arms market, after Saudi Arabia. Its military spending increased massively during the 2000s but then declined substantially from its 2010 peak.[20] Several other major UK markets are within the EU, in particular France, Italy, the Netherlands, Germany and Spain. The European Defence Agency reports a 10% decrease in military spending in the EU between 2008 and 2012, with equipment spending decreasing by approximately the same amount.[21]

Other markets

Not all arms budgets are being cut. There are increasing military budgets in other regions including South Asia, South East and East Asia and the Middle East.[22] But the presence of demand doesn't necessarily mean contracts for UK arms exporters.

14 MoD, Defence Equipment Plan 2012, January 2013, bit.ly/VdKdyX

15 Public Accounts Committee, news release, May 2013, bit.ly/Q8AjfD

16 Treasury, Public Expenditure Statistical Analyses 2014, July 2014, table 1.10, converted to constant 2012/13 figures, bit.ly/1kYMeLW

17 See RUSI, 10.12.2013, bit.ly/1sLRGkd

18 Such as Andrew Dorman in Brookings Institute, The Implications of Military Spending for NATO's Largest Members, July 2012, bit.ly/XeveH5

19 RAND, NATO and the Challenges of Austerity, 2012, bit.ly/1qeQyV9; Brookings Institute, The Implications of Military Spending for NATO's Largest Members, 2012, bit.ly/XeveH5; Deloitte, 2014 Global Aerospace and Defense Industry Outlook, 2013, bit.ly/1sxksZd

20 US military spending has, since 2010, reduced by about a third of the amount it increased during the 2000s. (SIPRI, Military Expenditure Database, bit.ly/1hjX3Ww)

21 European Defence Agency (EDA), Defence Data 2012, December 2013, bit.ly/XewbPm. Denmark is not included as it is not part of the EDA. Croatia joined after the period covered in the report. Over the same period personnel saw greater reductions (around 14.6%) and operation and maintenance saw a decrease of less than 1%.

22 SIPRI, Military Expenditure Database, bit.ly/1hjX3Ww

The UK government's arms sales unit, UKTI DSO,[23] assesses prospects for UK arms exports. It suggests that while UK companies have a "footing in selected markets" in the Asia-Pacific region, "it remains a very competitive part of the world, with US, Russian and French companies active". In Latin America and Africa, it says UK companies haven't achieved significant business.[24]

Thus, the main focus of UK arms exports remains the Middle East, which, according to UKTI DSO, has been the source of 55% of UK arms export orders over the past decade. Deloitte[25] suggests that "regional tensions" here will lead to increased purchases of equipment, and it is clear that military spending is increasing in a number of Middle East countries, not least Saudi Arabia, UAE and Oman.[26] However, the extent to which arms spending is due to a military threat is debatable. A prime objective for Saudi Arabia appears to be maintaining the status quo of Gulf authoritarianism, as evidenced by its military intervention to help suppress democracy protests in Bahrain in 2011. It seems that the UK's best prospect for increased arms exports is to some of the world's most repressive regimes.

Overall prospects

With reductions in US and EU arms spending but possible increases in other areas (particularly, in terms of UK arms export potential, the Middle East), the question is whether the latter will be able to balance out the former. There appears to be little evidence or industry optimism that this will happen.

In 2012, the President of industry trade association ADS said that the UK arms industry was "flatlining at best."[27] The arms sales of the largest arms companies (the top 100 as identified by the Stockholm International Peace Research Institute, SIPRI) fell in both 2011 and 2012 after a prolonged period of increases,[28] a trend that Deloitte suggests would continue in 2013.[29] An international survey of arms industry executives carried out by McKinsey reported, in April 2013, that there was "near-universal expectation" of a decline in the global market.[30]

In 2014, the prospects were similarly downbeat with the arms market being assessed as "challenging" by many of the major UK-headquartered arms companies (such as BAE, Rolls-Royce, Chemring and Cobham[31]).

This lack of optimism may be because domestic and NATO markets are still most important to most arms companies, but also because all the major arms producers are trying to export and are targeting the same buyers. In response to the government's exhortation to export, the president of ADS said "The trouble is, everybody is exporting."[32]

In summary, MoD arms procurement seems likely to be static at best over the coming years. With procurement reducing in the major UK markets of the US and EU, the prospects for exports there are poor. So for the arms industry to stay at its current level will require increased exports to the rest of the world, in particular the Middle East. This will be hard as every major arms producer is trying to sell to these markets. While it is feasible that with a lot of government support the arms industry could stay at its current size, it seems more likely that the long term decline in UK arms industry jobs will reassert itself.

23 UKTI DSO is the UK Trade & Investment's Defence & Security Organisation. Its role is to promote arms and "security" sales.

24 UKTI DSO, Export Figures 2013, July 2014, bit.ly/VDUhSP

25 Deloitte, 2014 Global Aerospace and Defense Industry Outlook, 2013, bit.ly/1sxksZd

26 SIPRI, Military Expenditure Database, bit.ly/1hjX3Ww

27 Observer, 15.4. 2012, bit.ly/1BaM6hc

28 SIPRI, Recent Trends in the Arms Industry, bit.ly/1nKQut7

29 Deloitte, 2014 Global Aerospace and Defense Industry Outlook, 2013, p.6, bit.ly/1sxksZd

30 McKinsey, Defense Outlook 2015, April 2013, bit.ly/1h7OVs3

31 BAE Systems, Annual Report 2013, 17.3.2014 bit.ly/1orku2V "In a challenging climate for defence spending..."; Rolls-Royce, Annual Report 2013, 28.2.2014, bit.ly/VhKnoQ "... to ensure we can effectively compete and win in today's challenging market."; Chemring, Chairman's Statement, 23.1.2014, bit.ly/1pM2hvo "Defence markets have remained challenging"; Cobham, Preliminary Results, 6.3.2014, bit.ly/1umd0ke "... in what remains a challenging US defence/security market" also "Strong growth in commercial markets offset by continued weakness in defence/security markets"

32 Observer, 15.4. 2012, bit.ly/1BaM6hc

How many workers would be affected?

Our best estimate is that there are currently around 170,000 arms industry workers and that this number is more likely to decrease than increase.

That outlook assumes the status quo in terms of government policy, but we are proposing a fundamental review of the UK government's approach to security, focused on the security and well-being of the population rather than on military and arms company interests. This would include a far greater emphasis on non-military "priority risks" in the government's National Security Strategy[33] as well as on the underlying drivers of insecurity such as climate change and competition over resources.[34] It would mean the end of overseas military interventions, which damage both national and international stability and security. Billions of pounds would be saved each year by stopping the procurement and support of offensive military capabilities such as the nuclear arsenal, aircraft carriers and their F-35 fighter-bombers, and the air-to-air refuelling capacity.[35]

Alongside and complementary to these changes, there would be a radical reduction in arms exports to safeguard international stability and security and also, vitally, basic human rights.

This fundamental review of government policy would have substantial implications for arms industry employment. For the purposes of comparison with the renewable energy sectors being considered, we will include a scenario of an end to arms exports and halving of UK arms procurement. This would mean that alternative employment would be needed for 115,000 arms industry workers.

While there would be substantial job cuts in the arms industry, there would be enormous financial savings. Halving UK arms procurement would save around £7 billion per year over the next decade.[36] In addition to this, arms export subsidies amounting to hundreds of millions of pounds per year would be saved.[37] These resources could be invested far more usefully.

33 HM Government, The National Security Strategy, October 2010, bit.ly/1eJJDMh. While the NSS covered a wide range of threats, the allocation of funding continues to be completely dominated by the military.

34 For more on "sustainable security", see Oxford Research Group, bit.ly/1doQJVs

35 For more on UK spending on offensive weaponry, in particular Research & Development spending, see Scientists for Global Responsibility, Offensive Insecurity, September 2013, bit.ly/1vBkKAp

36 MoD, Defence Equipment Plan 2012, January 2013, bit.ly/VdKdyX

37 SIPRI, Assessment of UK Arms Export Subsidies, 25.5.2011, bit.ly/1sBi04W

> "The defense market worldwide is worth a trillion dollars annually. The energy and environmental market is worth at least eight times this amount. The former is set to contract...; the latter is set to expand exponentially, especially in the renewables arena."
>
> Jane's online

3 ALTERNATIVES TO ARMS JOBS

"Climate change *will* amplify existing social, political and resource stresses.... The effects of climate change are *likely* to dominate the global political agenda, especially in the developed world where it *will* represent an increasingly important single issue."

MoD, Global Strategic Trends – Out to 2040, February 2010

The case for renewable energy & low-carbon technologies

There are a number of sectors that would be grateful recipients of arms industry workers and, of course, in reality any major change in public spending and the substantial reduction of a manufacturing sector would lead to workers finding work across numerous sectors.

However, one group of sectors – renewable energy and low-carbon technologies – appears to be a prime candidate for the reallocation of resources. There are several reasons for this:

1. the environmental imperative is overwhelming, including humanitarian and security impacts
2. energy security would be greatly improved by local production
3. there would be substantial economic benefits for the UK
4. renewable energy is identified as a feasible match in terms of job numbers, skills and locations.

The first three of these are discussed briefly below. The fourth is considered in section 4.

1 The environmental imperative

In September 2013, the Intergovernmental Panel on Climate Change (IPCC) released its Fifth Assessment Report. It stated:

> *"Warming of the climate system is unequivocal... The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased… Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions."*[38]

This environmental change is already affecting human well-being and this impact is set to worsen dramatically as temperatures increase. The World

38 Intergovernmental Panel on Climate Change, Climate Change 2013: The Physical Science Basis, September 2013, www.ipcc.ch/report/ar5/wg1/

Health Organisation has recently stated that climate change affects "clean air, safe drinking water, sufficient food and secure shelter", and that between 2030 and 2050 "climate change is expected to cause approximately 250,000 additional deaths per year from malnutrition, malaria, diarrhoea and heat stress".[39] Overall, the marginalised and those living in poverty are, and will be, particularly vulnerable to climate change.[40]

Security too will be dramatically affected by climate change. The Oxford Research Group, which has a Sustainable Security programme, states that the loss of infrastructure, resource scarcity, and mass displacement of peoples will lead to "civil unrest, intercommunal violence and international instability".[41] This analysis also exists within the world's militaries. The UK MoD has assessed climate change to be one of four "key drivers of change".[42] It says "Out to 2040, there are few convincing reasons to suggest that the world *will* become more peaceful. Pressure on resources, climate change, population increases and the changing distribution of power are *likely* to result in increased instability and likelihood of armed conflict." It goes on to state, "Climate change *will* amplify existing social, political and resource stresses.... The effects of climate change are *likely* to dominate the global political agenda, especially in the developed world where it *will* represent an increasingly important single issue."

However, attempts to contain the outcomes through military control will not only be ineffective, but are likely to exacerbate conflict. What is needed is a preventative strategy; that of urgently curbing emissions.

Progress towards addressing climate change

In 2009, the intergovernmental Copenhagen Accord set a goal of holding the maximum global average temperature increase to below two degrees Celsius compared to pre-industrial levels.[43] The IPCC has said that this likely means reducing greenhouse gas emissions "by 40-70% compared with 2010 by mid-century, and to near-zero by the end of this century."[44] However, emission targets are far from where they need to be. Following a 2014 IPCC report, Greenpeace commented that greenhouse gas emissions had continued to increase and continuing as we are would, according to IPCC figures, "result in 3.7 to 4.8 degrees of warming by the end of the century."[45]

The UK

The UK Government has made commitments on emissions. The UK Climate Change Act 2008 sets legally-binding targets for the UK to reduce greenhouse gas emissions by at least 34% by 2020 and at least 80% by 2050 (from 1990 levels). The UK's implementation of the EU's Renewables Directive sets a target of 15% of UK energy to come from renewable sources by 2020, meaning around 30% of UK electricity demand.[46] In 2013 renewable sources contributed 5.2% of total energy and 14.9% of electricity generation.[47]

However, there is no binding renewable energy target for 2030, for either the EU or UK, and this is widely seen as necessary to provide the certainty required for further investment and reduced emissions.

2 Energy security

While there are many definitions of energy security, the fundamentals boil down to an uninterrupted supply of energy at prices that are reasonable and avoid excessive volatility, now and into the future.

39 World Health Organisation, Climate change and health, August 2014, bit.ly/1dqdx8I

40 Intergovernmental Panel on Climate Change, Climate Change 2014: Impacts, Adaptation, and Vulnerability, Summary for Policymakers, March 2014, 1.usa.gov/1yb5DyY

41 Oxford Research Group, Sustainable Security, bit.ly/1doQJVs

42 MoD, Global Strategic Trends – Out to 2040, February 2010, bit.ly/1gRZIQS

43 UN Framework Convention on Climate Change, 30.3.2010, bit.ly/1kItvyE

44 Intergovernmental Panel on Climate Change, Climate Change 2014: Mitigation of Climate Change, April 2014, press release, bit.ly/1sVK28C

45 Greenpeace, 15 key findings from the IPCC mitigation report, 13.4.2014, bit.ly/1kKY8bH

46 UK Government, Offshore Wind Industrial Strategy, August 2013, p.61, bit.ly/1qvQ3EP

47 DECC, Digest of UK Energy Statistics 2014, July 2014, bit.ly/YM2JBe

Presently, the UK is a large net importer of energy, with imports accounting for 47% of UK energy use in 2013. It is a substantial net importer of each of coal, oil and gas: coal imports are dominated by Russia, US and Colombia; natural gas imports are mainly from Norway, with Qatar, the Netherlands and Belgium behind it; and the main sources of oil, primarily transport fuels, are via the Netherlands (which is a major trading hub so the fuel is likely to have originated elsewhere), Russia, Sweden, Kuwait and the US.[48]

With such a high reliance on imports, reasons for concern regarding several key suppliers,[49] and the volatility in international gas prices, there is good reason to maximise domestic production. Doing this in concert with reduced energy use would both improve the security of supply and give more control over prices.

The importance of renewable energy in the UK's future energy security appears to be well recognised by the UK public. A poll commissioned by RenewableUK in June 2014 asked respondents which of several choices should be the top priority for the UK to ensure future energy security. 48% selected "Investing more in renewable energy". Second, with 15%, was "Building more nuclear reactors".[50]

In addition to energy supply, shifting from imports to domestic production would provide wider security benefits: it would help ensure that the UK retains independence by avoiding reliance on individual suppliers, and also avoids the perceived need to intervene militarily to secure energy supplies.

3 Economic benefits

Military publisher Jane's said in 2011,

> *"The defense market worldwide is worth a trillion dollars annually. The energy and environmental market is worth at least eight times this amount. The former is set to contract...; the latter is set to expand exponentially, especially in the renewables arena."*[51]

And William Hague offered in 2012:

> *"I believe we should reframe our response to climate change as an imperative for growth rather than merely being a way of being green or meeting environmental commitments... The low carbon economy is at the leading edge of a structural shift now taking place globally."*[52]

The energy sector is enormous and needs to move away from fossil fuels over the coming years. As many technologies are at an early stage of development, there is the potential for the UK to take a lead in these, building expertise and a substantial domestic supply chain. This will put the UK in a position to not only reap the rewards of its own energy spending, but also realise export potential (whilst also helping other countries cut their own carbon emissions).

A report by the Centre for Economics and Business Research in 2012 estimated that, under both its medium (Gone Green) and high (Accelerated Growth) scenarios, offshore wind alone could increase net exports of energy and equipment by around £20 billion a year by 2030.[53] This would radically improve the UK's balance of trade, being equivalent to around 75% of the current annual trade deficit.

48 DECC, Digest of UK Energy Statistics 2014, July 2014, bit.ly/YM2JBe

49 For example, liquified natural gas from Qatar could be interrupted by closing the "choke point" of the Straits of Hormuz (Chatham House, Maritime Choke Points, January 2012, bit.ly/1r0gZRB), and there is substantial concern in the EU over supplies from Russia (eg. Reuters, 1.9.2014, reut.rs/1pkRQeo)

50 RenewableUK, press release, 24.7.2014, bit.ly/WF4leQ

51 Jane's online, home.janes.com/events/conferences/e2ds2011/ (no longer available online)

52 Guardian, 15.5.2012, bit.ly/1qTwGcR

53 Centre for Economics and Business Research, The Macroeconomic Benefits of Investment in Offshore Wind, June 2012, p.41, bit.ly/1nZU0Ba. This includes reductions in fossil fuel imports. Also, a recent report by Cambridge Econometrics estimates that imports of oil and gas would be reduced by £8.5 billion a year even if the UK only meets its current carbon budgets (Cambridge Econometrics, The Economics of Climate Change Policy in the UK, 10.9.2014, bit.ly/1rVADQJ). The four carbon budgets presently extend to 2027.

"There is no resource constraint on the proportion of UK electricity demand that can be generated from offshore wind – with the constraint imposed instead by social, economic, regulatory and technical factors."

Crown Estate, UK Offshore Wind Market Study, October 2012

Which renewable energy & low-carbon technologies?

A renewable energy and low-carbon transition would require many different technologies: the direct electricity production of wind, wave, tidal, hydro and solar PV, but also substantial energy contributions from heat exchangers and sustainable biomass, geothermal and solar heating.

Alongside increasing renewable energy generation, the electrification of much of heating and transport would be required in order to be able to move away from gas and petrol. This will require advances in power storage. The final elements for a transition are energy efficiency improvements and innovations (from insulation to Combined Heat and Power projects) to bring energy use down to a level that is feasible for supply.

A comparison of all renewable energy and low-carbon technologies against arms industry employment is impractical for this briefing so we will focus on the most relevant technologies. In assessing these, the main factors are the skills fit and the number of potential jobs. For both of these the offshore wind and marine energy sectors stand out and are considered in detail below. Many other sectors would bring benefits but probably not to the same scale or with the same skills level/relevance, or the potential is less certain at this point:

Onshore wind is a significant energy source in the UK, but it is a relatively mature technology to which the UK came too late. Electric vehicles could lead to new jobs, particularly in advanced batteries and infrastructure, but the sector is already highly competitive. Combined Heat and Power projects require a range of relevant skills, including electrical and mechanical engineering, although the number of jobs would be lower than for wind and marine energy. Solar PV production is dominated by China. While third generation Solar PV is a potentially important technology where, given investment, the UK could have a substantial role, it is too soon to discuss employment outcomes. Similar potential and employment uncertainty applies to the energy storage technologies which will become an important sector as renewable energy develops, in order to balance supply and demand. Several other sectors could make useful contributions to employment, but don't have a large skills overlap with arms, e.g. deep geothermal heating involves a greater emphasis on construction and geological skills and sustainable biomass would require more construction and forestry management skills.

However, all of these would contribute to the opportunities available for the workforce as a whole, including arms workers.

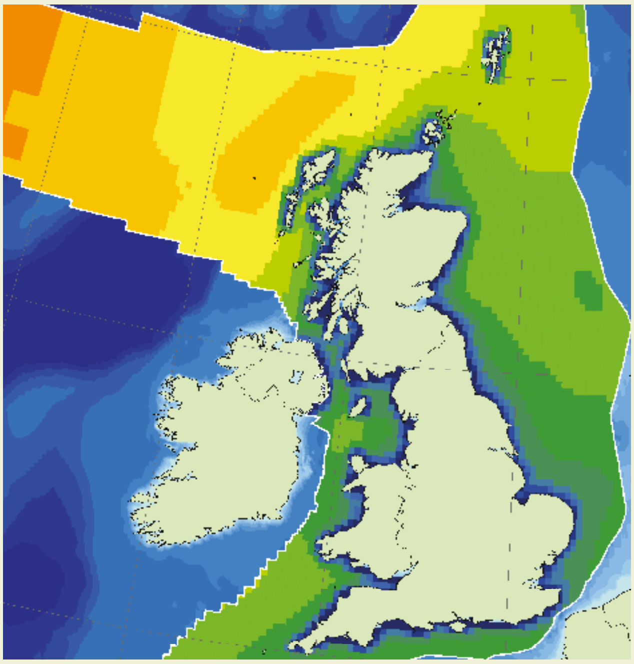
Offshore wind and marine energy

The priority we are giving to offshore wind and marine energy is based on the UK's large-scale natural resources, a leading position in deployment, and the potential for the UK to be at the leading edge of the technology for both domestic production and export. Each of the technologies needs policy support, investment and skilled workers. Change needs to happen quickly – both to address emissions and to put UK industry at the forefront of these important sectors.

Charts 3a to 3d indicate the distribution and scale of offshore energy resources in UK waters: wind, wave and tidal.

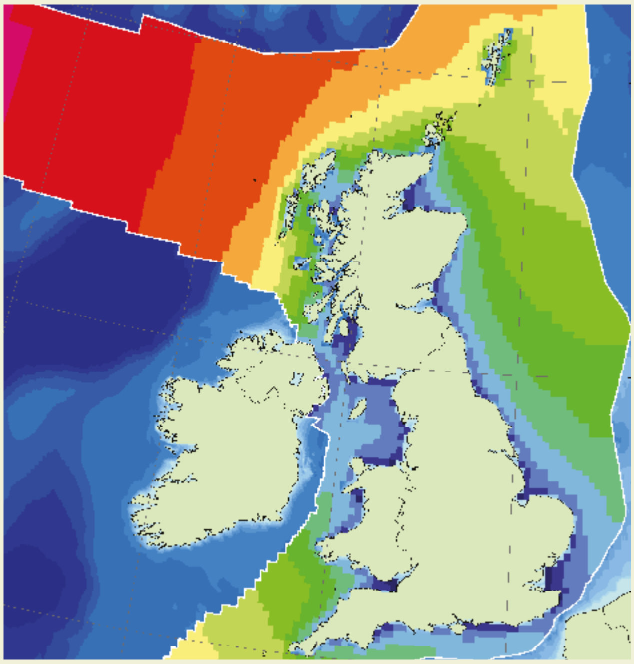
Charts of energy resources in UK waters[54]

Chart 3a » Annual Mean Wind Speed (m/s)



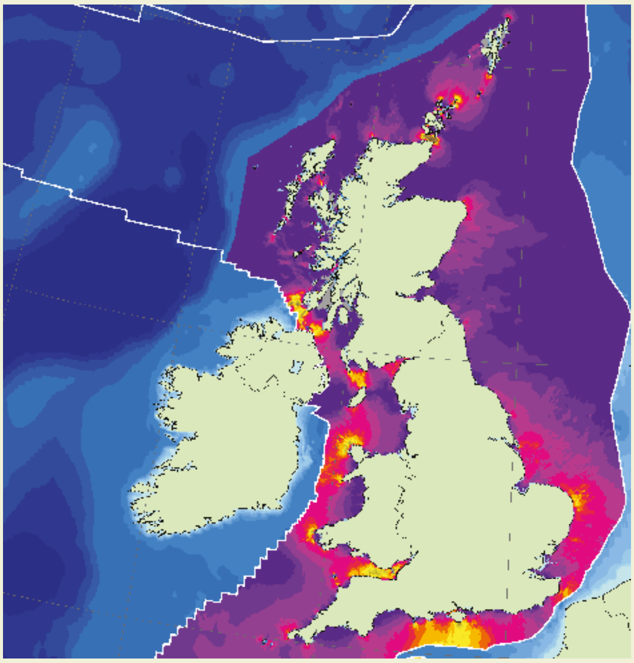
12.1–12.5	10.1–10.5	8.1–8.5
11.6–12.0	9.6–10.0	7.6–8.0
11.1–11.5	9.1–9.5	7.1–7.5
10.6–11.0	8.5–9.0	<7.1

Chart 3b » Annual Mean Significant Wave Height (m)



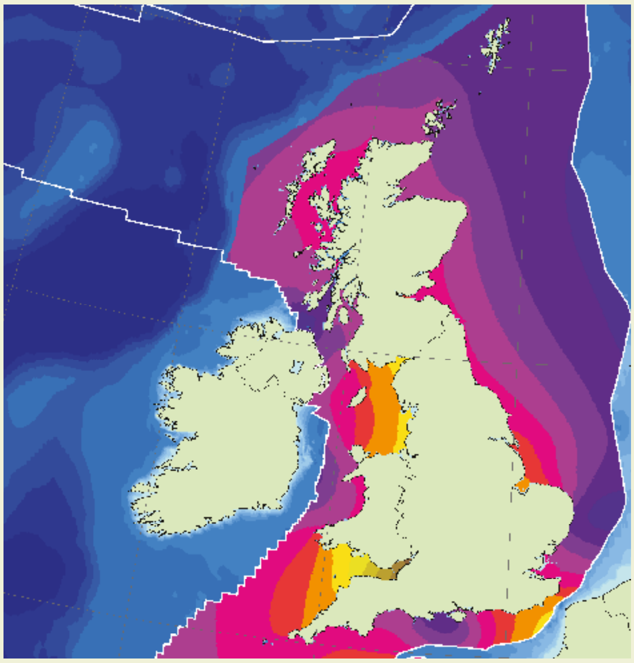
3.26–3.50	2.26–2.50	1.26–1.50
3.01–3.25	2.01–2.25	1.01–1.25
2.76–3.00	1.76–2.00	0.76–1.00
2.51–2.75	1.51–1.75	<0.25

Chart 3c » Mean Spring Tidal[55] Power (kW/m²)



6.01–8.00	2.01–3.00	0.26–0.50
5.01–6.00	1.51–2.00	0.11–0.25
4.01–5.00	1.01–1.50	0.06–0.10
3.01–4.00	0.51–1.00	0.01–0.05

Chart 3d » Mean Spring Tidal Range (m)



11.01–12.00	7.01–8.00	3.01–4.00
10.01–11.00	6.01–7.00	2.01–3.00
9.01–10.00	5.01–6.00	1.01–2.00
8.01–9.00	4.01–5.00	< 1.01

Reproduced from http://www.renewables-atlas.info/ © Crown Copyright

54 Atlas of UK Marine Renewable Energy Resources, 2008, ABPmer. Date of access (04 August 2014) http://www.renewables-atlas.info/

55 Spring tides are those of increased range occurring near full moon and new moon. The term is not related to the season of the year.

Offshore wind energy

The UK has the largest wind resources in Europe and has started the process of utilising these with as much capacity installed as the rest of the world combined.[56] This scale of resource is because the wind speed is high[57] and because there is a great deal of relatively shallow water on the continental shelf, stretching a long way out to sea. Because of these ideal building conditions, the UK has been referred to as the "Saudi Arabia of offshore wind".[58]

The depth is important because offshore wind turbines are presently 'fixed', i.e. mounted on the sea bed at depths up to 60m. The next generation of wind turbines will be 'floating'. These will need to be anchored to the sea bed so will be suitable for deeper water, but still less than 700m.[59] Floating turbines are being developed. Japan's original plan for a 2016 demonstration project was accelerated by the Fukushima nuclear disaster, with the first turbine being switched on in November 2013. Fittingly, it was installed off the coast of Fukushima.[60] Other designs have been installed off Norway and Portugal[61] and two separate plans have been put forward for arrays of floating turbines off Aberdeenshire.[62]

Offshore wind will probably need to be the dominant source of UK electricity if carbon emissions are to be reduced to the extent required. While it is already a meaningful energy source (producing around 3% of the UK's electricity[63]), it is also expanding rapidly. The largest wind farms are being constructed off the east coast of England, but there are wind farms in operation, under construction or being planned at many sites around the UK coastline.

The Offshore Valuation Group – a collaboration of government and industry organisations – assessed the value of the UK's offshore renewable energy resource in 2010. It estimated that the "practical resource" of offshore wind, i.e. the available resource if developed to its maximum potential, to be 1,939TWh. This was split between 406TWh for fixed wind and 1,533TWh for floating wind, see table 3.1.

Table 3.1 » Offshore Valuation Group estimate of practical resource for offshore wind[64]

	Currently allocated capacity,[65] TWh	Additional practical resource, TWh	Total practical resource, TWh	Installed capacity, GW
Fixed wind	165	241	406	116
Floating wind	–	1,533	1,533	350

A MW (megawatt) is one million watts and a GW (gigawatt) is one billion watts. These units are used to state the maximum power that a turbine or wind farm can supply. This is referred to as the installed capacity. TWh (terawatt hours, or a billion kilowatt hours) refer to the amount of energy actually provided, usually over a year. This takes into account that power isn't generated when wind speeds are low or turbines need repair.[66]

56 RenewableUK website, bit.ly/1hDlNTd

57 Crown Estate, UK Offshore Wind Market Study, October 2012, p.17, bit.ly/1mbVVqO

58 Institute for Public Policy Research, Pump up the volume, 2013, p.5, bit.ly/1uJAxck

59 Offshore Valuation Group, The Offshore Valuation, May 2010, pp.34&39 bit.ly/1vBb8FZ

60 Scientific American, 8.11.2013, bit.ly/1u3Rld8

61 Deutsche Welle, 23.1.2013, bit.ly/1ARubJp

62 Guardian, 24.11.2013, bit.ly/1dU4fqI; BBC, 16.5.2014, bbc.in/1uRPEA2

63 About 3.2% of electricity generation was provided by offshore wind from 2012 to 2013 via installed capacity of 3.5GW (DECC, UK Renewable Energy Roadmap Update 2013, November 2013, bit.ly/1i4edFU).

64 Offshore Valuation Group, The Offshore Valuation, May 2010, p.13 & p.30 bit.ly/1vBb8FZ

65 This capacity has been allocated by the Crown Estate and is in the development pipeline. However, only a small proportion of it is operational yet.

66 Load factors (the electricity actually produced relative to the maximum that could be produced at full power operation) are between 35% & 45% for fixed offshore wind (Offshore Valuation Group, The Offshore Valuation, May 2010, p.89, bit.ly/1vBb8FZ)

As total electricity generation (and use) in the UK is presently less than 400TWh,[67] The Crown Estate suggests that "there is no resource constraint on the proportion of UK electricity demand that can be generated from offshore wind – with the constraint imposed instead by social, economic, regulatory and technical factors."[68]

A number of studies have proposed levels of offshore wind installed capacity over the coming decades and some of these estimates are in table 3.2. We have included high scenarios because we consider that, for environment, security and economic reasons, the UK needs to be ambitious for offshore wind.

Table 3.2 » Selected estimates of offshore wind installed capacity

Source	GW of capacity installed
Centre for Alternative Technology [69]	140 by 2030
Pöyry report to Committee on Climate Change, "max scenario" [70]	156 by 2050
Campaign against Climate Change [71]	195 in 20 years
British Pugwash, "high renewables pathway" [72]	76 by 2050
World Wildlife Fund, "stretch scenario" [73]	52 by 2030
Offshore Valuation Group, "scenario 2" [74]	149 by 2050 / 96 by 2030
Offshore Valuation Group, "scenario 3" [75]	361 by 2050 / 96 by 2030

Given that, as of the middle of 2013, there was only 3.3GW of installed capacity, with another 1.3GW under construction,[76] these might seem overly aspirational. However, The Crown Estate's leasing rounds already enable a capacity of over 49GW[77] and this barely dents estimates for possible power generation. As stated above, the Offshore Valuation Group estimates that the total "practical resource" for offshore wind is 116GW for fixed and 350GW for floating.

Marine energy

Although marine – wave and tidal – energy will be smaller-scale than offshore wind, it will be an important sector for the UK. As for wind, the UK has substantial wave and tidal resources. According to the Renewable Energy Association, the UK has "a third of Europe's wave resource and half of Europe's tidal resource".[78]

By 2011 there were 12 wave and tidal technologies that had progressed to the stage of large scale testing at sea. Six were by UK teams in UK waters, four were by foreign teams in UK waters and two were elsewhere.[79] This progress has continued. Most recently, in July 2014, the Crown Estate agreed seabed rights for five new marine energy sites as well as six more marine energy demonstration zones.[80]

If the UK can stay at the forefront of wave and tidal power, build the supply chain and deploy substantial marine energy resources, they could, as for offshore wind, lead to substantial jobs and exports.

Wave power can be harnessed out at sea or near, or on, the shoreline, although the best resources occur where strong winds have travelled over a long distance and before friction with the seabed occurs nearer the coastline.

67 DECC, Digest of UK Energy Statistics 2014, July 2014, bit.ly/YM2JBe

68 Crown Estate, UK Offshore Wind Market Study, October 2012, p.16, bit.ly/1mbVVqO

69 Centre for Alternative Technology, Zero Carbon Britain, 2013, p.61, www.zerocarbonbritain.org

70 Pöyry, Analysing Technical Constraints on Renewable Generation to 2050, March 2011, p.64, bit.ly/1yg1KJ9

71 Campaign against Climate Change, One Million Climate Jobs, October 2010, bit.ly/1o2yhsp; One Million Climate Jobs Technical Note: Jobs and Capacity in Renewable Energy, October 2010, bit.ly/1macgfU

72 British Pugwash, Pathways to 2050, 2013, p.75, bit.ly/1u6Jxaj

73 WWF, Positive Energy, October 2011, bit.ly/1yg3v9g

74 Offshore Valuation Group, The Offshore Valuation, May 2010, pp.42&56, bit.ly/1vBb8FZ

75 Offshore Valuation Group, The Offshore Valuation, May 2010, pp.42&58, bit.ly/1vBb8FZ

76 RenewableUK, State of the Industry 2013, 6.11.2013, p.14, bit.ly/1u1BifJ

77 DECC, Digest of UK Energy Statistics 2014, July 2014, bit.ly/YM2JBe

78 Renewable Energy Association, Made in Britain, April 2012, p.30, bit.ly/1gOiV5K, only the summary is available online

79 Carbon Trust, Accelerating Marine Energy, July 2011, p.6, bit.ly/1qJ4tqt

80 Crown Estate, news release, 8.7.2014, bit.ly/1nwMPP2

A wide range of technologies are in development[81] including the snake-like Pelamis which is around 180m long and 4m in diameter, currently deployed at the European Marine Energy Centre in Orkney.[82]

About half of the UK's practical wave energy resource stretches out from the west of the Hebrides, about a quarter is found off North Scotland, around Orkney and Shetland, and about a quarter is off South East England and Wales.[83]

Tidal power resources are divided into tidal stream, barrage and lagoons. All have the advantage of the tides, and hence the energy generation, being entirely predictable. The UK has a high tidal range, with the Bristol Channel having the highest in the world outside Canada.[84]

Tidal stream is where devices sit in the normal tidal flow. Their potential is greatest where there is a large tidal range and the shape of the coastline funnels the currents, amplifying them. There are many types of tidal energy converters being developed (the main types are set out on the website of the European Marine Energy Centre[85]).

The largest tidal stream resources are in northern Scotland, concentrated in the Pentland Firth between the Scottish mainland and Orkney Islands. However, there are also substantial resources down the west cost of Scotland and Wales, in the Bristol Channel, around the Isle of Wight and off Kent.

Tidal barrage and lagoon power generation is similar to that of normal river dams except the flow is two-way. For barrages, a dam is placed across an estuary and is filled when the tide rises (generating electricity) and empties when the tide falls (generating electricity). Lagoons are similar to barrages but are not across waterways. Instead, a barrier/causeway is built to fully enclose an artificial lagoon. The environment impact is widely considered to be far lower for lagoons than barrages because of their much reduced effect on the tidal flow of an estuary.

While a few tidal barrages already exist outside the UK,[86] a proposal for a barrage across the Severn estuary was rejected by the government in 2013. Tidal lagoons are still only on the drawing-board globally, however, a lagoon has been proposed for Swansea bay. Applications for development consent and marine licensing have been submitted and, at the time of writing, are being examined.[87]

Tidal range is particularly pronounced in the Bristol Channel, from North Wales to South West Scotland, off Kent and in the Wash. Barrage and lagoon projects are often proposed at similar locations.

As for offshore wind, there are many estimates of the marine energy resources that might be harnessed. Some of these are in table 3.3 although most do not cover each of the types of resource.

81 A list of main types is available on the European Marine Energy Centre website, bit.ly/1DeHffY

82 Pelamis Wave Power, website, bit.ly/1qJ5UVP

83 Carbon Trust, UK Wave Energy Resource, October 2012, p.iv & Appendix Two, bit.ly/1lR9why. Also see Crown Estate, UK Wave and Tidal Key Resource Areas Project, October 2012, p.9, bit.ly/1BJ0bBG

84 National Oceanic and Atmospheric Administration, FAQ – Tide Predictions and Data, 1.usa.gov/1tYBgc8

85 European Marine Energy Centre, Tidal Devices, bit.ly/1BJ0Kva

86 Parliamentary Office of Science & Technology, Environmental Impact of Tidal Energy Barrages, June 2013, bit.ly/1uQVuSr

87 Tidal Lagoon Swansea Bay, Planning Process, bit.ly/1u6RZ9A

88 Offshore Valuation Group, The Offshore Valuation, May 2010, bit.ly/1vBb8FZ

89 Crown Estate, UK Wave and Tidal Key Resource Areas Project, October 2012, p.8, bit.ly/1BJ0bBG

90 Carbon Trust , UK Wave Energy Resource, October 2012, bit.ly/1lR9why

91 Carbon Trust, Accelerating Marine Energy: The Potential for Cost Reduction, July 2011, bit.ly/1qJ4tqt

92 Low Carbon Innovation Coordination Group, Technology Innovation Needs Assessment (TINA): Marine Energy, August 2012, bit.ly/1rlwyQT

93 Centre for Economics and Business Research, The Economic Case for a Tidal Lagoon Industry in the UK, July 2014, bit.ly/1k7tnO1

94 Centre for Alternative Technology, Zero Carbon Britain, 2013, p.61, www.zerocarbonbritain.org

Table 3.3 » Estimates of wave and tidal practical resources

	Wave, TWh	Tidal Stream, TWh	Tidal Range (barrages &/or lagoons), TWh
Offshore Valuation Group[88]	40	116	36
Crown Estate[89]	69	95	Barrage 96; Lagoon 25
Carbon Trust, 2012[90]	32–42		
Carbon Trust, 2011[91]	50	21	
Low Carbon Innovation Coordination Group, “very high scenario”[92]	40–50	20–30	
Centre for Economics and Business Research[93]			30 for six lagoon projects
Centre for Alternative Technology[94]	25	42	

Converting these energy values to GW of installed capacity gives ranges of 10–25 GW for wave and 20-90 GW for tidal. While below the values for offshore wind, they are still substantial.

4 EMPLOYMENT COMPARISON

Job numbers

The Renewable Energy Association estimated that in 2012 there were 110,000 jobs in the renewable energy sector, including its immediate supply chains.[95] Larger figures have been offered by the Department for Business, Innovation & Skills – around 270,000 jobs – but this includes employment "further along the supply chain".[96] Throughout this briefing we aim to use employment figures that relate to an intuitive understanding of the supply chain: that is, renewable energy specific activities and the supply of materials and components to these.

Similarly, estimates of current jobs in wind energy (both onshore and offshore) are wide-ranging, from 32,000 to 94,000,[97] and we will use the lower figure. In 2013, offshore wind was about half of the wind total.

Offshore wind jobs

Estimating potential job numbers

In calculating the number of jobs that will result from an expansion of offshore wind energy, we use estimates for the number of jobs that are required for the design, manufacture and installation of each GW of wind capacity.[98] We also need to include jobs operating and maintaining the turbines once they are installed.

To do this, we follow a report by the Global Wind Energy Council and Greenpeace.[99] This uses assessments of the employment effects of onshore wind power in Germany, Denmark, Spain and the Netherlands to estimate the number of jobs that are required for the manufacture and installation of each new GW of installed capacity. They estimated that there were 15,000 jobs required for each GW, including both direct and indirect jobs,[100] decreasing as processes are optimised to 11,000 per GW by 2030. Ongoing operations and maintenance are calculated separately as they apply to the cumulative total of installed capacity. The report estimated that maintenance required 330 jobs per GW of installed capacity.

95 Renewable Energy Association, Made in Britain, April 2012, bit.ly/1gOiV5K, only the summary is available online. The report also projects that the number of jobs would climb from 110,000 to 400,000 by 2020 if the UK met its objective of 15% of energy consumption being from renewables by then.

96 Department for Business, Innovation and Skills, Low Carbon Environmental Goods and Services Report for 2011/12, July 2013, bit.ly/1ku0FXA) and DECC, UK Renewable Energy Roadmap Update 2012, December 2012, p.21 bit.ly/1qkjRWR

97 RenewableUK states that there were 32,000 wind jobs in 2013 (RenewableUK, State of the Industry Report 2013, October 2013, bit.ly/1gazFoy). The 94,000 figure is for 2011/2012 and comes from the Department for Business, Innovation and Skills (BIS, Low Carbon Environmental Goods and Services Report for 2011/12, July 2013, bit.ly/1ku0FXA). RenewableUK says there were at least 6,800 direct jobs in offshore wind in 2013, bit.ly/1oYulfw

98 For a sense of scale, one GW of installed capacity would require 200 5MW turbines

99 Global Wind Energy Council & Greenpeace, Global Wind Energy Outlook 2008, October 2008, p.45, bit.ly/1hjQ3aC

100 We take 'direct' jobs to mean those employed in renewable energy specific activities, and 'indirect' to be those jobs created in supplying the 'direct' sector (as used, for example, by RenewableUK, Working for a Green Britain Volume 2, July 2011, p.5, bit.ly/1AabAtv).

These figures are for onshore wind, so there needs to be an adjustment for offshore wind. Because offshore wind is approximately twice as expensive to install and maintain,[101] it seems reasonable to double the number of jobs per GW for both production and maintenance.[102] So we estimate that 30,000 jobs are required for the installation of each GW of offshore wind capacity, dropping to 22,000 jobs per GW by 2030. Added to this are 660 jobs per GW in maintenance each year. So the up-front jobs are design, manufacture and installation, and then as time goes by and the installed capacity increases there is a greater emphasis on maintenance.

We are not assessing the UK share of employment here. We are stating the number of jobs that are feasible and urging the UK government to maximise the UK supply chain. Also, we have not considered export jobs and these would be on top of the numbers we present. In reality the number of UK jobs would be decreased by imports, but increased by the inclusion of exports.

Comparison with other studies

The above numbers provide us with a fairly simple mechanism for converting installed capacity into employment and it is useful to compare the numbers with those of other studies.

The Offshore Valuation Group calculated the number of direct jobs per GW installed to be around 20,000-25,000. The calculations included operation and maintenance and the need for repowering the generating capacity around every 20 years.[103] They did not include indirect jobs in the supply chain, which would be substantial, or jobs arising from the need for a substantially expanded electricity grid. Nor did they include export potential.

In 2013, the Institute for Public Policy Research (IPPR)[104] collated a number of employment studies. While the methodologies varied greatly, the figures we are using fit comfortably within the range of those studies. Several of the studies include a consideration of domestic content and of exports. Interestingly, IPPR state that the UK jobs per GW tend to increase as the installed capacity increases, because benefits within the domestic supply chain and export potential both increase with scale.

It is also useful to note that for the 1.5GW of offshore wind capacity installed in UK waters during 2012-2013, employment was reported to be 16,000.[105] As only around 25% of capital expenditure is in UK,[106] this is a reasonable match.

Identifying the rate of installed capacity

Once we have the number of jobs per GW of installed capacity we need to determine the level of installed capacity in order to estimate total jobs. For this, we will consider the scenarios suggested in table 3.2, allocating averages of GW capacity installed per year.[107] The installation rate varies significantly, depending upon the total level of installed capacity and the period over which it is reached. For instance, Pöyry, the Centre for Alternative Technology and the Campaign against Climate Change have fairly similar values for total installed capacity, but the latter two are driven by their conviction that deep cuts in carbon emissions are required within 20 years and so expedite the rate of installation. The Offshore Valuation Group has a high rate for its "scenario 3" that is similar to that of the Centre for Alternative Technology and Campaign against Climate Change, but continues installation for twice as long, leading to enormous installed capacity.

101 For example, the cost of construction and operation and maintenance are nearly twice as high for offshore wind Round 3 compared to large-scale onshore wind (DECC, Electricity Generation Costs, 2013, p.60 bit.ly/1ip9Bc7). Floating wind is expected to be more expensive again than fixed wind (Offshore Valuation Group, The Offshore Valuation, 2010, p.53 bit.ly/1vBb8FZ). DECC considers the levelised cost of energy (LCOE) for offshore wind to be about 50% more than that for onshore wind for 2014. Roland Berger consultants (Offshore Wind Toward 2020, April 2013, p.19, bit.ly/1A8D4Qa) consider that the LCOE for offshore wind for Europe as a whole to be about twice that of onshore wind.

102 In this we are following Campaign against Climate Change, One Million Climate Jobs Technical Note, 2010, bit.ly/1kNeHiE

103 The level of installed capacity will at some point stop increasing, however, design and manufacturing will need to continue as the wind turbines will need to be repowered periodically. The Offshore Valuation Group give three scenarios for turbine deployment and say that under all three, "the need for repowering wind, wave and tidal stream installations every 20 years will create a self-sustaining industry beyond 2050." (Offshore Valuation Group, The Offshore Valuation, 2010, pp.41&56, bit.ly/1vBb8FZ)

104 Institute for Public Policy Research, Pump up the Volume, July 2013, bit.ly/1uJAxck

105 RenewableUK, State of the Industry Report 2013, October 2013, bit.ly/1gazFoy

106 UK Government, Offshore Wind Industrial Strategy, August 2013, bit.ly/1qvQ3EP

107 The scenarios vary in the extent to which installation is weighted towards the start or end, or is evenly spaced, and some studies do not schedule the installation, so it seems reasonable for our purposes to average each study across the total number of years they consider.

Table 4.1 » Selected estimates of offshore wind installed capacity, developing table 3.2

Source	GW of capacity installed	Average GW per year
Centre for Alternative Technology	140 by 2030	8.8
Pöyry	156 by 2050	4.1
Campaign against Climate Change	195 in 20 years	9.8
British Pugwash	76 by 2050	2.1
World Wildlife Fund	52 by 2030	2.9
Offshore Valuation Group, "scenario 2"	149 by 2050 96 by 2030	3.8 5.1
Offshore Valuation Group, "scenario 3"	361 by 2050 96 by 2030	9.3 5.1

Of course, the amount of installed capacity that is required is a matter of fierce political debate. In the first instance we will consider a level of annual installation, 5GW, that is high but well within those of more transformative proposals. 5GW installed capacity per year is that suggested by the Offshore Valuation Group up to 2030 in both "scenario 2" and "scenario 3", and is not far beyond Pöyry in its "max scenario" up to 2050. It is also well within the Crown Estate's considered maximum annual deployment of 7.5GW (for 2018).[108]

108 Crown Estate, Supply Chain Roadshow event, March 2010, (referenced in Offshore Valuation Group, The Offshore Valuation, 2010, bit.ly/1vBb8FZ)

This installation rate would result in around 150,000 jobs in the first year that 5GW of installation was achieved. Over the following 15 years, the number of jobs would stay fairly steady, but with increased maintenance requirements balancing savings in production.

Table 4.2 » Offshore wind jobs resulting from the annual installation of 5GW capacity

	1st year 5GW installation achieved	15th year of 5GW installation
Jobs in manufacture & installation	150,000	110,000
Jobs in maintenance	3,300	49,500
Total jobs	153,300	159,500

The more ambitious proposals put forward by the Centre for Alternative Technology and Campaign against Climate Change, as well as the Offshore Valuation Group's "scenario 3", envisage around 9GW being installed each year. This would mean 275,000 jobs in the first year that it was achieved. Fifteen years on, the number of jobs would be around 290,000.

Table 4.3 » Offshore wind jobs resulting from the annual installation of 9GW capacity

	1st year 9GW installation achieved	15th year of 9GW installation
Jobs in manufacture & installation	270,000	198,000
Jobs in maintenance	5,940	89,100
Total jobs	275,940	287,100

UK supply chain

It should be reiterated that these are total jobs rather than UK ones. The government estimates that the UK content for an offshore wind farm was about 25% in 2012.[109]

RenewableUK reported the "industry view" in 2011 that "as long as the UK can consistently deliver at least 3GW of new offshore wind capacity a year from 2016, there will be sufficient turbine demand to convince manufacturers to locate here."[110] And the Offshore Valuation Group noted that, in order for the supply chain to be ready for Round 3 (a major expansion of offshore wind), government action was required to "promote investment in ports, factories and other supporting infrastructure" as the UK will be "competing with other countries to create a domestic offshore renewable supply chain, such as Germany, Denmark, the Netherlands and China."[111]

To reap the employment rewards of UK offshore wind development requires concerted UK government effort. This process does appear to be starting to be taken seriously with the launch of the Offshore Wind Industrial Strategy in August 2013.[112] There was also positive news in March 2014 when Siemens confirmed that it would invest £160m in major wind turbine production at Hull and nearby Paull. This is due to be operational by 2017.[113]

Marine energy jobs

We will, as for offshore wind, estimate possible marine energy job numbers from potential levels of installed capacity. There is greater uncertainty about the numbers of jobs that are likely to be created by wave and tidal energy.

Estimating potential job numbers

Wave and tidal stream are similar to offshore wind jobs in many ways. However, as the technology is at an earlier stage, the number of jobs needed to develop and install a given GW capacity is greater. The Renewable Energy Association states that "Relative to electrical output the sector has high levels of employment, reflecting the work-intensive nature of R&D and testing for emergent technologies",[114] and the Department of Energy & Climate Change (DECC) estimates that construction and operation and maintenance costs will be substantially higher for both wave and tidal stream than offshore wind during the 2020s.[115]

RenewableUK[116] states that its scenario of 2GW of wave and tidal stream capacity to be installed by 2021 will result in 15,000 jobs. Given that this level of installation corresponds to around 0.25GW per year, the number of jobs is approximately 60,000 per GW installed capacity (though it should be noted that the employment figure includes those derived from exports).

Tidal range, on the other hand, has more of an emphasis on large-scale construction than tidal stream and wave energy. A Centre for Economics and Business Research report into lagoons indicates that there would be around 20,000 direct and indirect employees required to install 16GW capacity over the course of a 12 year construction period.[117] That is, around 15,000 jobs per GW of installed capacity. There are also fewer jobs in operation and maintenance.

As the numbers for marine energy are so approximate, and as wave and tidal stream are expected to have higher employment figures than offshore wind

109 UK Government, Offshore Wind Industrial Strategy, August 2013, bit.ly/1qvQ3EP

110 RenewableUK, Working for a Green Britain Volume 2: Future Employment and Skills in the UK, July 2011, p.11, bit.ly/1AabAtv

111 Offshore Valuation Group, The Offshore Valuation, 2010, p.27, bit.ly/1vBb8FZ

112 UK Government, Offshore Wind Industrial Strategy, August 2013, bit.ly/1qvQ3EP

113 Siemens website, sie.ag/1kC1MV4 & sie.ag/1pLs0nu, Crown Estate, Operational Report 2014, May 2014, bit.ly/1rjr1tY

114 Renewable Energy Association, Made in Britain, April 2012, p.30, bit.ly/1gOiV5K, only the summary is available online

115 DECC, Electricity Generation Costs, 2013, p.60, bit.ly/1ip9Bc7. It is also worth noting the relative strike prices (i.e. energy prices guaranteed by the government) and levelised cost of energy (i.e. the average cost of energy over the lifetime of the plant). Strike prices: for 2015/16, that for wave and tidal stream is double offshore wind. (DECC, Investing in renewable technologies – CfD contract terms and strike prices, December 2013, bit.ly/1uQIZFX). There is no separate strike price for floating wind. The levelised cost of energy (LCOE) is cheapest for fixed offshore wind, followed by floating offshore wind and tidal stream, which are similar, then wave and tidal range (Offshore Valuation Group, The Offshore Valuation, 2010, p.53 onwards, bit.ly/1vBb8FZ, and DECC, Electricity Generation Costs, 2013, table 12, bit.ly/1ip9Bc7).

116 RenewableUK, Working for a Green Britain Volume 2: Future Employment and Skills in the UK, July 2011, p.19, bit.ly/1AabAtv

117 Centre for Economics and Business Research, The Economic Case for a Tidal Lagoon Industry in the UK, July 2014, bit.ly/1k7tnO1

while tidal range is expected to have lower, we will use the offshore wind employment figure as a proxy for marine energy.[118] Given that the bulk of marine power will be generated by wave and tidal stream rather than tidal range, it seems fair to assume that this figure will be on the low side and will produce a conservative number of jobs.

As for offshore wind, this calculation does not take account of the level of domestic content or exports. However, because of the UK's leading position in the field, both the content from the UK supply chain and exports to the EU are already high. The Renewable Energy Association states that "Most devices operating in the UK were manufactured in the UK and RenewableUK estimates half of EU marine energy projects have been designed and manufactured here."[119]

Identifying the rate of installed capacity

Estimates of wave and tidal resource vary substantially, as is seen in table 3.3. Given the early stage of deployment for wave and tidal stream, and that projects are only at the planning stage for tidal range (barrage and lagoon), estimates of possible and likely installed capacity require more assumptions than for offshore wind. Some estimates are in table 4.4.

Table 4.4 » Some estimates of rates of potential installed capacity for marine energy

	Annual installed capacity, GW	Detail
Offshore Valuation Group, "Scenario 2" [120]	1.9	Installation during the 2020s. Wave: 0.6GW, tidal stream: 0.7GW, tidal range: 0.6GW
Offshore Valuation Group, "Scenario 3" [121]	1.6	Installation during the 2020s. Wave: 0.3GW, tidal stream: 0.7GW, tidal range: 0.6GW
Low Carbon Innovation Coordination Group [122]	0.7	From its "very high scenario" where 17GW for wave and 10GW for tidal stream is envisaged by 2050
RenewableUK [123]	0.25	2GW by 2021
Crown Estate [124]	0.2	Considering just the Crown Estate award for wave and tidal stream in Pentland Firth and Orkney waters. 1.6GW to be installed by 2020
Centre for Economics and Business Research [125]	1.3	16GW over 12 years (up to 2026) for six lagoon projects
Centre for Alternative Technology [126]	2	30GW by 2030. Wave, tidal stream and tidal range

The Centre for Alternative Technology has made a conservative estimate for wave and tidal "practical resource" (see table 3.3). This corresponds to 10GW installed capacity for wave and 20GW installed capacity for tidal (covering both tidal stream and tidal range, the latter including both barrages and lagoons). Given its 2030 timeline, this would lead to 2GW per year of installed capacity. While this is at the high end in table 4.4, this is primarily because it expedites installation.[127]

118 This follows the Campaign against Climate Change, One Million Climate Jobs Technical Note, 2010, bit.ly/1kNeHiE

119 Renewable Energy Association, Made in Britain, April 2012, p.30, bit.ly/1gOiV5K, only the summary is available online

120 Offshore Valuation Group, The Offshore Valuation, 2010, p.56, bit.ly/1vBb8FZ

121 Offshore Valuation Group, The Offshore Valuation, 2010, p.58, bit.ly/1vBb8FZ

122 Low Carbon Innovation Coordination Group, Technology Innovation Needs Assessment (TINA): Marine Energy, August 2012, bit.ly/1rlwyQT

123 RenewableUK, Working for a Green Britain Volume 2: Future Employment and Skills in the UK, July 2011, bit.ly/1AabAtv

124 Crown Estate, Wave and Tidal Energy in the Pentland Firth and Orkney Waters, May 2011, bit.ly/1kyo1vw

125 Centre for Economics and Business Research, The Economic Case for a Tidal Lagoon Industry in the UK, July 2014, bit.ly/1k7tnO1

126 Centre for Alternative Technology, Zero Carbon Britain, 2013, p.61, bit.ly/1oGHeuZ

127 It is also worth noting that several of the sources in the table do not include all of the wave and tidal technologies

The arms industry certainly believes that the renewable energy sector could make good use of its skilled workers, warning that if workers left the sector, other sectors including "alternative energy" "would mop up those people almost immediately".

Because the Centre for Alternative Technology starts from a conservative position, covers all the wave and tidal technologies, and because its figure is consistent with that of the Offshore Valuation Group, we will use the 2GW annual installation rate. We do so, though, acknowledging that it will take several years to reach that rate of deployment.

Using the figures above, we estimate that marine energy employment would be around 60,000 in the first year that 2GW installation were to be achieved, and would stay fairly steady following that.

Table 4.5 » Marine energy jobs resulting from the annual installation of 2GW capacity

	1st year 2GW installation achieved	15th year of 2GW installation
Jobs in manufacture & installation	60,000	44,000
Jobs in maintenance	1,320	19,800
Total jobs	61,320	63,800

Job numbers summary

Table 4.6 » Estimate of current UK arms industry employment

For production of arms for the UK MoD	115,000
For export	55,000
Total	170,000
(or, for exports and half MoD procurement)	(115,000)

Table 4.7 » Offshore wind and marine energy employment estimates

	1st year target achieved	15 years on
Offshore wind jobs (5GW)	155,000	160,000
Wave and tidal jobs	60,000	65,000
Total	215,000	225,000
Offshore wind jobs (9GW)	275,000	285,000
Wave and tidal jobs	60,000	65,000
Total	335,000	350,000

A move towards offshore wind and marine energy could produce more jobs than the entire arms industry employs, or nearly double that of exports plus the most controversial arms procurement, or around four times that of arms exports.

If the higher offshore wind scenario was followed, there could be around double the number of jobs of the entire arms industry.

It should be re-emphasised that there are other renewable energy sectors with substantial employment potential, not to mention wider low-carbon technologies.

Skills

There is currently a severe skills shortage in Science, Technology, Engineering and Maths – the STEM skills. In March 2014 the CBI reported that it was "threatening the recovery, as demand from firms is outstripping supply."[128] EngineeringUK estimates that the UK will need 87,000 new graduate-level engineers per year over the coming decade. In contrast, only 51,000 people became suitably qualified last year.[129]

In this context, there is little doubt that the skills of arms workers could be put to better use. Even during the economic downturn, arms industry workers appear to have been relatively able to find alternative work within the normal employment market.[130] The arms industry certainly believes that the renewable energy sector could make good use of its skilled workers, warning that if workers left the sector, other sectors including "alternative energy" "would mop up those people almost immediately".[131]

While there is no common source that allows direct comparison of skill levels in the arms and renewable energy sectors, an approximation is possible. Analysis can be made of occupational codes in the UK Labour Force survey that relate to the arms industry[132] and a survey of the renewable energy sector in Scotland has been carried out by Energy & Utility Skills which uses the same skills groupings.[133] They are set alongside each other in table 4.8.

Table 4.8 » Skills groupings

	Arms industry (UK wide), %	Renewable energy industry (Scotland), %
Science, research, engineering and technology professionals	19	24
Science, Engineering and Technology associate professionals	15	14
Skilled metal, electrical and electronics trades	23	30
Process, plant and machine operatives and unskilled	13	8
Managers, administrative staff, sales people and other supporting roles	30	25

The table shows renewable energy having higher proportions of professionals and skilled trades, and associate professional proportions being similar. The arms industry has higher proportions of "process, plant and machine operatives" and managers and support staff. Overall, the comparison points towards higher proportions of technically skilled workers in the renewable energy sector.

Many of the same engineering disciplines are utilised by both sectors. Three core disciplines are considered in table 4.9, using BAE's "current opportunities" webpages and the Renewable Energy Association's "Made in Britain" report.

128 CBI, press release, 21.3.2014, bit.ly/N5VNIu

129 EngineeringUK, Engineering UK 2014, November 2013, p.220, bit.ly/1nplC7Z

130 A 2014 briefing paper by the Royal United Services Institute (RUSI) surveyed employees who had left BAE Systems from 2007-2011. They found that only 7% had taken more than a year to find new work (RUSI, Defence Skills: A Shift in the Myth, June 2014, p.8, bit.ly/1wp3xd1). There are several other recent examples of arms industry jobs losses in recent years, along with detail or comment on final numbers: there was much media coverage of BAE cuts at its Brough plant from September 2011. At the end of the process there had been 21 compulsory redundancies while 360 left voluntarily (Hull Daily Mail, 4.7.2013, bit.ly/1ecQe7T); There was also extensive media coverage in November 2013 of BAE's announcement of cuts in Portsmouth. In April 2014 a local MP said the company and unions had done "a good job trying to mitigate job losses" and that "The workforce will be snapped up, but I want them to remain in the city" (The News, 24.4.2014, bit.ly/1lHBeCh). In August 2014 BAE said that at that point 70% of the 940 facing redundancy had found a new job, were being retrained or had accepted voluntary redundancy (The News, 7.8.2014, bit.ly/WwyWUr); In 2012, a local MP stated "It's a difficult climate out there, [but] there's a skill shortage in the UK, and if you take the example of the big closure in BAE Woodford, within a year most people had found jobs because of the skills they had." (BBC, 2.2.2012, bbc.in/1qkojEX).

131 Sandy Wilson, President of General Dynamics UK and VP-Defence of ADS (the arms industry's trade association) in evidence to the parliamentary Defence Committee, 8.9.2010, bit.ly/1hvitzm

132 The figures were produced using the UK Labour Force Survey for the years 2011 and 2012 and looking at the SOC2010 occupational codes for employees in industry SIC07 codes 2540 (manufacture of weapons and ammunition), 3011 (building of ships and floating structures), 3030 (manufacture of aircraft and spacecraft) and 3040 (manufacture of military fighting vehicles). See bit.ly/1exfMcb for more details on the Labour Force Survey.

133 EU Energy & Skills, Renewable Sector Skills Analysis – Scotland, July 2009, bit.ly/1qkUPqL

134 BAE Systems website, "Where could you be?" for various roles, bit.ly/1jw4w2D

135 Renewable Energy Association, Made in Britain, April 2012, bit.ly/1gOiV5K, only the summary is available online. The report identifies roles within each specific renewable energy technology.

Table 4.9 » Applications of specific engineering disciplines

Engineering discipline	Examples of arms industry applications, sourced from BAE Systems [134]	Examples of renewable energy applications, sourced from the Renewable Energy Association [135]
Electrical & electronic engineering	Maritime – naval ships Maritime Services Maritime – submarines Military Air & Information	Offshore wind • manufacture • construction & installation • operations & maintenance Wave and tidal • design & manufacture • construction & installation • support services & other Other sectors include: • onshore wind • solar PV
Marine engineering / Naval architecture	Maritime – naval ships Maritime Services Maritime – submarines	Offshore wind • construction & installation Wave and tidal • design & manufacture • construction & installation • support services & other
Mechanical engineering	Combat vehicles UK Maritime – naval ships Maritime Services Military Air & Information	Offshore wind • manufacture Wave and tidal • design & manufacture Other sectors include: • onshore wind • biomass combined heat & power (CHP) • deep geothermal

The table illustrates that many of the fundamentals are common, although it is still very likely that switching between sectors would require training. An analysis of specific job titles and roles would provide a better picture of crossover potential, but this is not available for the UK.[136]

136 A Foreign Policy in Focus report (Military vs Climate Security, 2009, pages 39-42, bit.ly/PUdjRL) sets out examples of "crossover potential" between military shipbuilding, aircraft and vehicles jobs and those in "green technology" in the US

Synergies between the arms industry and renewable energy

While not relating only to arms production, a Department for Business, Innovation & Skills report from 2014 assessed the UK offshore wind supply chain, focusing on synergies with other "parallel" sectors. One of these sectors was aerospace, of which arms is a substantial proportion. Different areas of the wind supply chain were considered. For wind turbine supply, synergies with aerospace were assessed as being high with regard to castings and forgings, and medium with respect to both turbine nacelle assembly and blade manufacture.[137]

137 Department for Business, Innovation & Skills, UK Offshore Wind Supply Chain: Capabilities and Opportunities, January 2014, bit.ly/1szaqHR

As well as looking at broad skills and synergies, it is useful to consider individual companies that are already active in both the arms and renewable energy sectors. Companies in this situation are likely to be in the best position to facilitate a transfer of resources and skills between the sectors, adjusting their activities to respond to greater renewable energy and less military demand. It is likely that this would be uncontroversial for workers.

Some sectors are particularly good candidates in this regard, with shipbuilding being even more obvious than aerospace. A variety of vessels and marine construction and support capabilities are needed for the installation and maintenance of offshore energy projects. There are already many examples of crossover and overlap between military shipbuilding and offshore renewable energy. These include:

- **Aluminium Marine Consultants** has produced numerous catamarans for the offshore wind industry and hovercraft for the military[138]
- **BMT** produce both military craft and "windfarm support vessels"[139]
- **Cammell Laird** refit warships and is "a base port for the construction of the Gwynt y Môr wind farm in the Irish Sea"[140]
- **CTruk** bills itself as a builder of craft which have "a proven track-record as offshore wind support vessels as well as numerous applications in the military and security and commercial sectors."[141]
- **Harland & Wolff**, once known for shipbuilding, now specialises in offshore renewable energy.[142]
- **Mactaggart Scott** is a major subcontractor for UK warships and nuclear submarines. It says its "experience in providing robust, highly-reliable equipment to the naval market is readily applicable to the renewable market."[143]
- **Mustang Marine**'s offerings include wind farm support vessels and bespoke aluminium vessels to "military standard".[144]

There are of course a wide range of companies producing equipment for both sectors beyond marine construction. A map of the offshore wind supply collated by RenewableUK[145] provides a list of component suppliers and many of these cover a wide range of markets including both renewable energy and the military.

One not on the list is a company that was in the news recently over its sale of arms to Israel. Schleifring Systems manufactures slip rings, an advanced electrical transmission device. It supplies these for tanks, remote control weapon systems, naval artillery, and also for the Hermes drone produced by Israeli arms company Elbit Systems.[146] However, there are many other uses for its slip rings including in offshore wind turbines. Schleifring says it "has been supplying slip rings for offshore wind applications to most European manufacturers right from the word go".[147]

In summary, the general skills base of the arms industry and offshore wind and marine energy sectors is similar, and there are already many companies already involved in both sectors.

Locations

We are considering a situation where arms exports are stopped and the MoD's arms procurement is halved. This would mean work is required for around 115,000 arms industry workers. The national/regional distribution of arms industry jobs is shown in table 4.10, and we assume that this pattern will be replicated for the arms jobs being lost in our scenario. This provides us with a broad sense of where alternative employment will be needed.

138 Aluminium Marine Consultants website, aluminium-boats.com/

139 BMT Nigel Gee website, www.bmtng.com

140 Cammell Laird website, www.clbh.co.uk

141 CTruk website, www.ctruk.com/

142 Harland & Wolff website, www.harland-wolff.com

143 MacTaggart Scott website, Renewbles, www.mactag.com/79_Renewables.html

144 Mustang Marine website, www.mustangmarine.com/portfolio/

145 Institute for Public Policy Research, Pump up the Volume, July 2013, p.13, bit.ly/1uJAxck (The map is sourced from RenewableUK)

146 Independent, 2.8.2014, ind.pn/1rlW2l6

147 Schleifring, Slip Ring Solutions: Wind Energy, September 2014, bit.ly/1sFIt1b

148 These figures were produced using the UK Labour Force Survey for the years 2011 and 2012 and looking at the region of residence for employees in industry SIC07 codes 2540 (manufacture of weapons and ammunition), 3011 (building of ships and floating structures), 3030 (manufacture of aircraft and spacecraft) and 3040 (manufacture of military fighting vehicles). See bit.ly/1exfMcb for more details on the Labour Force Survey

149 Offshore Valuation Group, The Offshore Valuation, May 2010, p.31, bit.ly/1vBb8FZ

150 RenewableUK, Offshore Wind Projects, May 2013, bit.ly/1q67TOf

151 Offshore Valuation Group, The Offshore Valuation, 2010, pp.13&39, bit.ly/1vBb8FZ

152 Carbon Trust , UK Wave Energy Resource, October 2012, p.iv, bit.ly/1lR9why

153 Crown Estate, UK Wave and Tidal: Key Resource Areas Project, October 2012, p.9, bit.ly/1BJ0bBG

Table 4.10 » National/regional distribution of arms industry jobs[148]

South West	18.3%
East Midlands	16.7%
South East	14.5% (0.7% in London)
Scotland	10.4% (5.7% in Strathclyde)
North West	9.2% (2.6% Merseyside & 1.6% Manchester)
West Midlands	8.6%
North East	8.1%
Northern Ireland	6.2%
Wales	3.8%
Yorkshire and Humberside	2.8%
East Anglia	1.5%

The national distribution of wind and marine energy practical resource identified by the Offshore Valuation Group is provided in table 4.11. It shows that, overall, England has the greatest resource but not very far ahead of Scotland. Wales' wind and marine energy resources seem small, but its share is greater than the relative size of its population.

Table 4.11 » Offshore Valuation Group estimate of practical resource for offshore wind and marine energy[149]

Off which coast	Fixed Wind, GW	Floating Wind, GW	Wave, GW	Tidal Stream, GW	Tidal Range, GW	Total
Scotland	46	123	15	18	4	206.0
Wales	6	19	1.5	8	5	39.5
England	63	209	1.5	7	6	286.5
Total	116	350	18	33	14	

Offshore wind resource: the Crown Estate's leasing rounds give designated areas for offshore wind. The three largest zones are off the east coast of England, from Essex to the North East. There are two medium size zones: one to the east of Edinburgh, and one between Northern Ireland, North West England, and North Wales. There are smaller zones in the Moray Firth, off West Scotland, off Northern Ireland, in the Bristol Channel, near the Isle of Wight, and off Sussex.[150]

In addition to this, floating wind will need to start becoming significant over the coming decade. There are no designated sites for floating wind yet, but the resource is in three broad areas: off North East England as for fixed wind, and larger concentrations off South West England and South West Wales and also off North Scotland.[151]

Wave resource: about half of the practical wave energy resource stretches out from the west of the Hebrides, about a quarter is found off the north coast of Scotland, around Orkney and Shetland, and about a quarter is off South West England and South West Wales.[152]

Tidal stream resource: the largest tidal stream resources are in northern Scotland, concentrated in the Pentland Firth between the Scottish mainland and Orkney Islands. However, there are also substantial resources down the west cost of Scotland and Wales, in the Bristol Channel, around the Isle of Wight and off Kent.[153]

Tidal range resource: Tidal range is particularly high in the Bristol Channel, from North Wales to South West Scotland, off Kent, and in the Wash.[154]

154 Crown Estate, UK Wave and Tidal: Key Resource Areas Project, October 2012, p.9, bit.ly/1BJ0bBG

Locations of different employment roles

The location of workers will depend on both the overall type of job – whether manufacture and installation or operation and maintenance – and also on the equipment being manufactured and the position in the supply chain.

Operation and maintenance of the wind/wave/tidal farms: Employment has to be relatively close to the generation capacity because speed of repair will have a significant effect on the total production of the wind or marine tidal generation. Connections to the electricity grid also need to be maintained and these will need to be as close as possible to the generating capacity.

For the expansion of offshore wind that we envisage, there will need to be several thousand operation and maintenance workers near each of the main sites, and others distributed around the coast according to the site of wind farms.

Development, manufacture, construction and installation of wind/wave/tidal farms: Here, there are four main areas of work and these, along with the proportion of cost associated with each area, are set out in a report commissioned by E.ON Climate & Renewables into its Robin Rigg wind farm:[155]

155 E.ON Climate & Renewables, UK Content Analysis of Robin Rigg Offshore Wind Farm, September 2011, bit.ly/1ptuLGN

- Project management, 5% of cost
- Turbine manufacture, 37% of cost
- Balance of plant manufacture (such as turbine foundations, cabling, and onshore and offshore substations), 22% of cost
- Installation and commissioning, 36% of cost

Each of these will have a different profile in terms of the location of employment. Drawing on the E.ON study and a wind farm guide by the Crown Estate,[156] and applying these to a situation where the supply chain is primarily within the UK, we estimate:

156 Crown Estate, A Guide to an Offshore Wind Farm, 2010, bit.ly/1ssQ2Im

- The bulk of project management could be located anywhere in the UK
- Turbine manufacture isn't in the E.ON study as Vestas imported its turbines and the lower level supply chain wasn't within the report's scope. However, turbine manufacture can be anywhere on the coast.[157] The turbine subsystems and components that wouldn't need to be co-located (or need to be elsewhere on the coast) amount, very broadly, to around 50% of the value.[158]
- Balance of plant: the manufacture of the turbine foundations would need to be based on the coast, ideally near the wind farm. The same can be said for offshore substations. However, around 60% of the cost of the substation is the electrical system, which could be produced anywhere. The electrical system is an even higher proportion of the cost of the onshore substation.
- Installation and commissioning would need to be based at ports in the proximity of the wind farm. A substantial proportion of costs would be for vessels, which could be sourced from anywhere on the coast.

157 Although proximity to the relevant wind farm is desirable

158 Estimated using Crown Estate, A Guide to an Offshore Wind Farm, 2010, pp.20-43, bit.ly/1ssQ2Im

In order to set out indicative locations, we will assume that manufacture or services that need to be based on the coast are actually located in the region of the wind farm. As a result, the locations are put into one of two categories: a) in the vicinity/region of the electricity generation or b) anywhere in the UK. Pulling together the manufacture and services location categories for each of the four areas of production above, we estimate that approximately 70% of expenditure is likely to be in the vicinity/region of the electricity generation sites and 30% could be anywhere.[159]

For the overall total of 220,000 jobs in our main scenario (table 4.7)[160] we can estimate the potential numbers of jobs in the broad groupings set out in table 4.12.[161]

Table 4.12 » The location groupings of wind and marine energy jobs

Operation and maintenance jobs: all in the vicinity/region of the generation sites	35,000
Manufacturing and installation jobs in the vicinity/region of the generation sites	130,000
Manufacturing and installation jobs anywhere in the UK	55,000

The location profile of each of the wind and marine technologies is used to obtain the geographic breakdown of renewable energy jobs that is given in chart 4.1. They are indicated alongside the number of jobs that would be expected to be lost from the arms industry. The renewable energy jobs, not being land-orientated, don't always fit in to a tidy regional/national breakdown.

The chart indicates that there would be more jobs than were needed in Scotland, Wales and down the west and east coasts of England. The English Midlands, Northern Ireland and South East England are the areas where there isn't a clear fit. However, in addition to the geographic numbers above there are 55,000 manufacturing jobs that could be located anywhere.

There is good reason to believe that there would be substantial work in the East and West Midlands. The study of the Robin Rigg supply chain assessed the geographical spread of contract values and found that central England was one of the two largest concentrations.[162] Also, a RenewableUK map[163] of offshore wind suppliers across the UK usefully separated companies into their types of activities. Whereas the sites of turbine manufacture (proposed), vessels, engineering and construction and maintenance are, as would be expected, around the coast, components suppliers are primarily inland. There is a concentration in the West Midlands as well as inland groups further north and to a lesser extent along the M4 corridor.

While the numbers of suppliers provided by RenewableUK do not allow any conclusions to be drawn regarding Northern Ireland, the Robin Rigg study identified significant content being contracted through Harland and Wolff in Belfast, which was used as one of two construction ports for the wind farm.

The speed of the shift towards renewable energy and the decisions companies make would determine the extent to which government needed to encourage the location of renewable energy work in specific areas. The presence of skilled workers would be a natural draw for companies, but there would be many other considerations. The government should consider areas with potential difficulties, as well as opportunities, at the earliest opportunity.[164]

159 This assumes: project management – 5% anywhere; turbine manufacture – 18.5% local, 18.5% anywhere; balance of plant – 15% local, 7% anywhere; installation and commissioning – 36% local. The figures are only intended to be indicative

160 We assume that the same broad location principles also apply to wave and tidal electricity generation

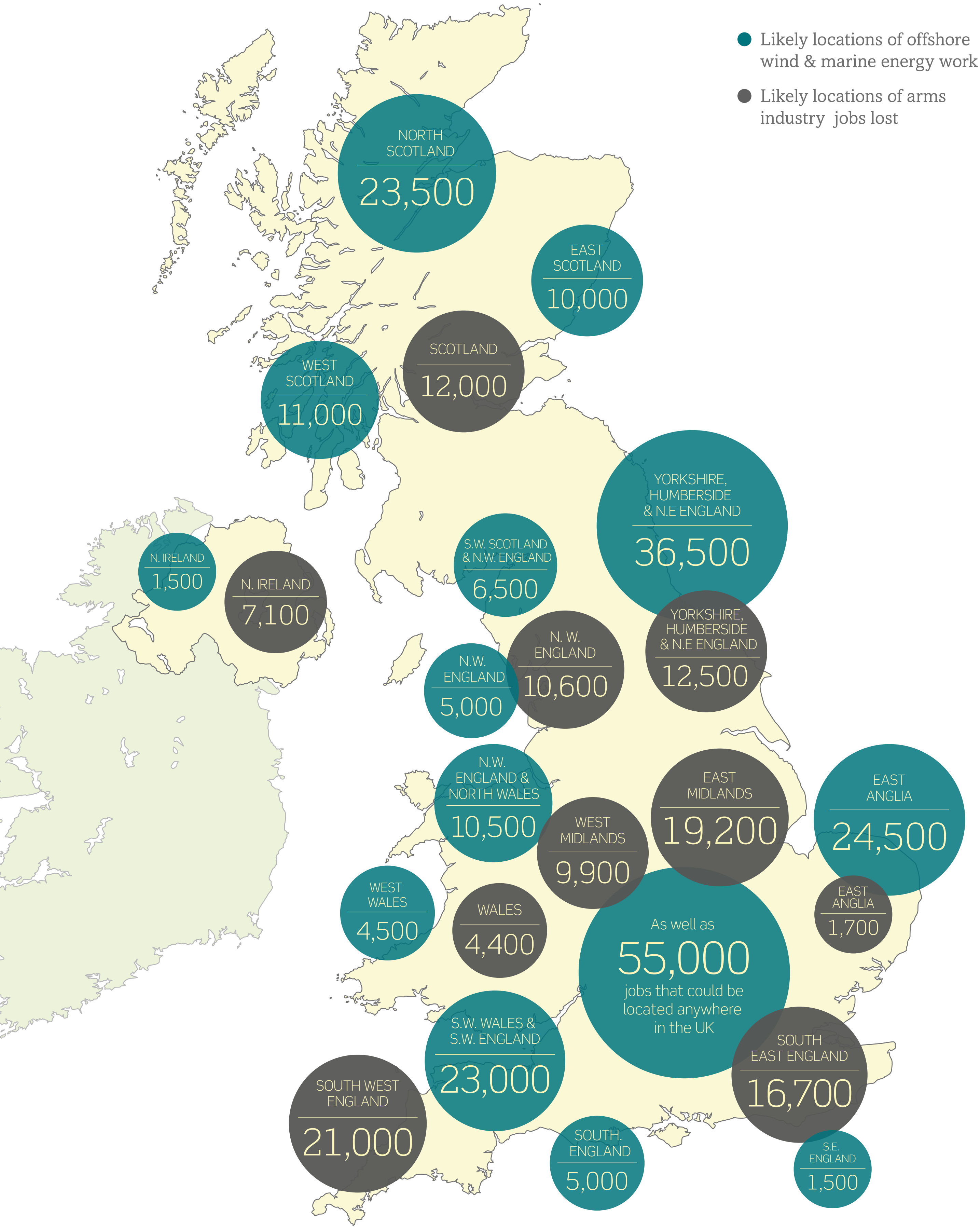
161 The estimate is for a point half-way through our main wind and marine energy scenario

162 E.ON Climate & Renewables, UK Content Analysis of Robin Rigg Offshore Wind Farm, September 2011, p.5, bit.ly/1ptuLGN

163 Institute for Public Policy Research, Pump up the Volume, July 2013, p.13, bit.ly/1uJAxck (The map is sourced from RenewableUK)

164 As has been proposed by RUSI amongst others for general arms industry jobs losses. RUSI suggest that of a sample of BAE workers leaving the company between 2007 and 2011, a third needed to relocate for new work (RUSI, Defence Skills, June 2014, pp.11&13, bit.ly/1nV9TOW). A need to relocate may have an unwelcome side effect for the UK skills base as greater numbers of workers may choose early retirement, with the consequent loss of their skills to the economy.

Chart 4.1 » Distribution of arms industry jobs lost if exports stopped and MoD procurement halved, alongside likely locations of offshore wind and marine energy work[165]



165 The distribution of offshore wind energy sites is drawn from the RenewableUK map of Offshore Wind Projects (May 2013, bit.ly/1q67TOf) for fixed wind, and, for floating wind, estimated using information from the Offshore Valuation Group (The Offshore Valuation, May 2010, bit.ly/1vBb8FZ). The distribution for wave and tidal energy sites is estimated using Crown Estate's UK Wave and Tidal: Key Resource Areas Project (October 2012, pp.8&9, bit.ly/1BJ0bBG)

5 CONCLUSION & RECOMMENDATIONS

The renewable energy sector is a viable alternative to the arms industry. Offshore wind is growing quickly and the UK already has as much capacity installed as the rest of the world combined. The UK is presently leading developments in wave and tidal energy. However, the bulk of offshore wind jobs, including those in the supply chain, are abroad. The issue isn't whether there will be a need for offshore wind and marine energy or whether the energy source will be in the UK; what is at stake is the scale of the sectors and the extent to which there will be manufacture and a supply chain in the UK. This requires enthusiastic government support and funding. In parallel with this support for renewable energy we are urging a change in the government's approach to security that would end UK arms exports and significantly reduce MoD arms procurement.

If the renewable energy sector were to be expanded to meaningfully address carbon emissions and meet its supply chain potential, there would be many more jobs than displaced arms workers would need, the skills required would be similar, and there would also be appropriate work available in most areas where arms workers are located. Where there wasn't work, the government should facilitate the location of renewable energy businesses. Arms workers would be valuable in a greatly-expanded renewable energy sector.

At present the arms industry receives a vast amount of political support and public money. This is despite its malign effects and the fact that it is flatlining as a sector. Just halving UK arms procurement would free up £7 billion of public funds each year that could be used far more productively. Meanwhile, the renewable energy sector, which is vital for UK prosperity, its environment and security, remains marginalised by the government. The contrast is illustrated by public Research & Development expenditure: spending on arms is around 30 times that spent on all types of renewable energy.[166]

166 UK Research & Development spending on arms was £1,306 million in 2011/12 (Department of Business, Innovation & Skills, SET Statistics 2013, bit.ly/1p5m8Gp) while R&D for renewable energy was £45.46 million in 2012 (International Energy Agency, R&D Statistics, bit.ly/1BdMiwa).

We propose that:

- the UK government starts a fundamental review of its security policy and role in the world. These are presently focused on military approaches, sidelining wider security threats and the underlying drivers of national and international insecurity such as climate change. We consider that an objective review along these lines should stop the business of exporting arms and radically cut military procurement.
- the government promotes renewable energy and low-carbon technologies. This should be through its policies and legislation, with the top priority being a binding renewable energy target for 2030 to provide the stability required for investment, and increased public funding, in particular for Research & Development and investment in infrastructure such as ports.
- the government should commit to building the domestic supply chain for renewable energy, including placing obligations on companies to locate and develop skills in local communities.[167]
- as the government radically reduces arms procurement and exports, it should prioritise early identification of areas that are less equipped to provide new jobs for arms industry workers and put effective measures in place to encourage alternative sources of work to locate there.

167 Institute for Public Policy Research, Pump up the Volume, July 2013, p.3, bit.ly/1uJAxck

> The issue isn't whether there will be a need for offshore wind and marine energy or whether the energy source will be in the UK; what is at stake is the scale of the sectors and the extent to which there will be manufacture and a supply chain in the UK. This requires enthusiastic government support and funding.

ABBREVIATIONS

ADS – the arms industry's trade association

DECC – Department of Energy & Climate Change

EDA – European Defence Agency

IPCC – Intergovernmental Panel on Climate Change

IPPR – Institute for Public Policy Research

LCOE – levelised cost of energy

MoD – Ministry of Defence

R&D – Research & Development

UKTI DSO – UK Trade & Investment's Defence & Security Organisation

Units

MW – megawatt, or one million watts. A measure of power. It is used to state the maximum power that a turbine or wind/wave/tidal farm could supply

GW – gigawatt, or one billion watts

kWh – kilowatt hour. A measure of energy: one thousand watts expended for one hour. It is the unit used in household energy bills

GWh – gigawatt hour, or one million kWh

TWh – terawatt hour, or one billion kWh