centre for sustainable energy

Common concerns about wind power (2nd edn)

Chapter 3
Wind power costs and subsidies

This is one of a series of chapters of evidence-based analysis drawing on peer-reviewed academic research and publicly funded studies.

For other chapters, see
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Centre for Sustainable Energy, June 2017

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The first edition of Common Concerns about Wind Power was published in 2011 to provide factual information about wind energy, in part to counter the many myths and misconceptions surrounding this technology.

Since 2011, much has changed in the legal and economic sphere, and a second edition became necessary. Research has been carried out for this edition since 2014. Therefore, this edition is formatted as a series of individual chapters available for download at www.cse.org.uk/concerns-wind-power-2017

All chapters written and researched by Iain Cox.

Centre for Sustainable Energy, June 2017
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The Centre for Sustainable Energy is a national charity committed to ending the misery of cold homes and fighting climate change.

We share our knowledge and practical experience to empower people to change the way they think and act about energy.

We are based in Bristol although most of our work has relevance and impact across the UK. Our clients and funders include national, regional and local government agencies, energy companies and charitable sources.

Chapter 3
Wind power costs and subsidies

Summary

Although it is argued that wind power is unfairly subsidised to make it more competitive with conventional forms of electricity generation, fossil fuels and nuclear power both benefited from government support in their early years of development, and continue to do so today. The transition away from an energy economy dominated by conventional fuels and centralised power distribution towards a more diverse set of renewable energy sources is essential to the development of a sustainable, low-carbon future, something that cannot be achieved within existing energy infrastructure.

Renewable energy subsidies are motivated by the need to displace fossil fuels within a power system that was never originally designed to accommodate renewables, creating a 'level playing field' for newer technologies and smaller producers in liberalized, competitive energy markets. In fact, the generating cost of onshore wind power is comparable to conventional generation, largely thanks to the opening created by financial support mechanisms, which started in the 1990s, which have allowed the wind industry to expand, gain experience, improve efficiency and performance. However, subsidies for onshore wind have were removed completely in 2016 due to the UK government's desire to set a cap on the total overall cost of subsidizing renewable energy through the Levy Control Framework. This unanticipated removal has had a detrimental impact on investor confidence in wind power in the UK and has the potential to undo some of the positive impacts of 25 years of investment in wind.

The UK is also a leader in offshore wind development, and higher subsidies for this form of generation reflect this maturing, but still relatively nascent, industry. Subsidies to renewables also acknowledge the benefits derived from removing the wider burdens placed on the environment by conventional generation; these burdens incur sizable costs for society as a whole. The majority of these costs are not internalised into the present-day costs of energy generated from fossil fuels and nuclear power, which obscures the true cost of conventional generation and reinforces its apparent competitive advantage over more sustainable sources of energy.

What is this based on?

Subsidies for renewable generation methods are not unique, in one way or another governments worldwide provide financial support to the energy industry, including fossil fuels and nuclear power generation. Readily affordable electricity generated by burning fossil fuels has been supported by governments and consumers because of the continual, rapid economic growth and development this has facilitated. Support for fossil fuels remains strong globally, with governments maintaining a range of measures to support consumption, through price reductions for the consumer, or production, through price guarantees for producers and through lowering the cost of production.[1,2]

Production subsidies for fossil fuels, which are the main tool used in industrialised countries, including the UK, are much less transparent than the more direct payments to renewable energy, and usually involve a complex arrangement of tax deductions and credits, capital expenditure write-offs, and liability protections, all of which vary between countries.[3] In addition, consumption patterns for energy derived from conventional sources are maintained by tax concessions to producers and consumers alike. Lowering prices for providers and end-users in energy markets discourages energy efficiency and creates a dependency, or 'lock-in', for particular fuels; thus, the development and commercialisation of alternative forms of energy that may be more beneficial cannot be fully realised.[3]

However, concerns about climate change mean that the UK government is committed to ambitious and legally binding targets for reducing carbon emissions in the energy sector.[4] Given the suitability of wind for generating renewable electricity and the availability of this resource in the British Isles, both onshore and offshore wind are likely to be the largest contributors in the generating sector to reaching these targets to 2030.[5,6] To make wind competitive, within an energy market locked-in to fossil fuel generation, government subsidy to promote investment, industry growth and R&D, to the point where the cost of wind is comparable to conventional generation methods, was the only option.

What is the current evidence?

The Non Fossil Fuels Obligation

The current subsidy system in the UK grew out of the non-fossil fuel obligation (NFFO). Growing concerns over the environmental impact of burning fossil fuels in the 1980s led many governments in Europe to begin investing in alternative energy sources or to expand programmes that had been instigated in response to the oil crises of the 1970s.[7] In the UK, the NFFO was introduced in 1990 and funded through the fossil fuel levy, which was set at 10% or 11% of consumers' bills between 1990 and 1996; however, the main purpose of the levy was to help prop up the nuclear industry that had been found unable to support itself following privatisation of the British electricity market.

Despite raising an average of £1.2bn a year from 1990 to 1996, renewable projects funded by the NFFO only received between 1% and 8.6% each year; the remainder went to support the nuclear industry. When the state-owned Nuclear Electric was privatised in 1996 the fossil fuel levy was reduced to 2.2% of consumer bills. When nuclear was removed from the NFFO scheme altogether the levy fell even further, ending at just 0.3% of customer bills by 1999, at which point it became the effective subsidy to the renewables industry. However, whilst the NFFO helped kick-start the nascent onshore wind industry in the UK, many renewable energy schemes awarded contracts under the NFFO were never realised because they were subsequently found to be uneconomic in practice.[8]

The Renewables Obligation

Realising it was not performing as planned, having failed to provide any significant investment to the renewable industry, the government replaced the NFFO with the Renewables Obligation (RO) in 2002. The RO intended to create a competitive market for renewable energy rather than directly setting the prices of MWh. By dictating that power suppliers must obtain a certain proportion of their electricity from renewable sources, it aimed at incentivizing investment in renewables. Accredited generators received a Renewables Obligation Certificate (ROC) for every megawatt of electricity produced from renewable sources, which they were free to sell directly to suppliers, along with their electricity, or on certificate trading markets to brokers.

The RO penalised the failure of suppliers to meet their quota of ROCS with a 'buy-out price', originally set at £30/MWh shortfall. Compliance was rewarded by recycling these penalties (known as the 'buy-out fund') back to suppliers in proportion to the number of ROCs they had submitted.[9]

The regulator of the RO scheme is Ofgem, who recover their adminstration costs from the buy-out fund itself. These operating costs are minimal, amounting to £3.5m for administrating the RO in 2012/13, which is just 2% of the £164m eventually recycled from the buy-out fund back to suppliers.[10] The suppliers that paid the cost of non-compliance passed these costs to their customers; in the early days of the RO, the total pass-through costs to consumers was estimated to be 2% on the average domestic electricity bill, which subsequently rose to 3% (equivalent to £17 a year) by 2010.[11,12] Compare this to the NFFO fossil fuel levy that was set at 10%–11% between 1990 and 1996, almost all of which went to support nuclear power.[8] Despite the low impact of the RO subsidy on energy bills, customers saw their total bill rise considerably between 2008 and 2010, driven largely by a sharp increase in the price of natural gas rather than the subsidy framework itself.[12]

However, there is definitely evidence that suppliers were 'gaming' the system under the RO in its original form to achieve the most profitable balance between the buy-out fund and traded ROCs, which meant renewable quotas were consistently under-fulfilled whilst compliance costs were still being passed onto consumers.[9,12,13] Because the cost of both ROCs and the buy-out fund fluctuated, opportunities arose to save money by deliberately not purchasing ROCs and planning to pay directly into the buy-out fund. The government identified that the RO was encouraging this problem, and so introduced a 'guaranteed headroom' to the RO in April 2009, which added an extra percentage (around 8%–10%) to the obligation in excess of what the expected renewable generation was going to be. This new mechanism was an effort to do away with the incentive for suppliers to deliberately fall short of RO targets.[9]

Because the prices of ROCs weren't fixed, and fluctuated according to changes in the market, the RO tended to privilege well established and efficient technologies, such as onshore wind, over newly emerging technologies or less commercially viable ones. This, in turn damaged public relations as the demand for energy companies to ensure the best possible return led to them intensively developing onshore wind facilities (one of the most commercially viable technologies), many of which were unpopular with local residents.[3,14,25] Whilst the RO was more successful than the NFFO and provided quite generous subsidies for wind, comparing the amount of renewable capacity installed by unit cost the evidence suggests that the more direct feed-in tariff (FiT) subsidy method has delivered better results, with countries such as Germany and Denmark enjoying much higher rates of renewable deployment for comparable or less cost per unit capacity installed.[14,16]

The UK government took a more interventionist approach in 2009, by introducing technology banding

into the RO scheme.[15] This meant that suppliers now received differing amounts of ROCs per MWh dependent on the type of renewable generation, more established technologies received fewer ROCs. These technology bands revealed the more established nature of onshore wind compared with offshore: until 2015 suppliers received 0.9 ROCs/MWh for electricity from onshore wind, but 2 ROCs/MWh from offshore wind.[6] Other low-cost and mature technologies get even less support, for instance, landfill gas projects only receive 0.2 ROCs/MWh. The differentiation between onshore and offshore wind highlights the progress that has been made within the wind industry, namely, that onshore wind has become established enough since the 1990s that generation costs have fallen dramatically, which has been reflected in a fall in subsidies worldwide (generation costs are discussed below).[17] A fall in the cost of offshore wind is projected to occur over the next few decades as the industry comes to grip with some of the unique challenges of operating in the open sea, and by 2017 the support for offshore wind will decline to 1.8 ROCs/MWh.[6]

It is important to note that this reduction in subsidy should not be presented (as some commentators are prone to do) as a display of falling confidence on the part of government in renewable energy; a cut in the subsidy rate was a clear indicator that onshore wind, at least, was increasingly becoming directly competitive with conventional generation and thus subsidy could be gradually curtailed.

The Levy Control Framework

The costs incurred by suppliers due to this mandatory legislation, the RO, can be seen as an indirect tax. In the same way that public spending is held accountable, the levy imposed by the RO scheme is considered as 'tax and spend'. To this end, a Levy Control Framework (LCF) was put in place as a cap on the total amount of money that could be raised and spent to support the RO and, importantly, its planned successor scheme, Contracts for Difference (CfD). The budgeting of support for renewables in this way is a sensible approach to attempt to control consumer costs as low-carbon schemes expand, but the inclusion of nuclear power under the 'low-carbon' umbrella in the new Contracts for difference (CfD) scheme may have drastic implications for the total amount of cash available to renewable energy. This is discussed further below.

Note that the spending limit set by the LCF was £7.6bn by 2020/21 in 2011/12 prices. However, the OBR, and Cornwall Energy both predicted an overspend of the LCF in 2015. It was this anticipated overspend that in part led to the rapid, unexpected policy change regarding support mechanisms, including the removal of subsidies for onshore wind a year earlier than planned.[18]

This unexpected removal of the onshore wind subsidy (relating to the introduction of the LCF) in 2016 has damaged investor confidence and may cause an increase in generation costs. It was previously anticipated that the subsidy would be gradually curtailed as the technology became more competitive, as has been the case in other European subsidy regimes.[18]

Contracts for Difference

The RO closed to new onshore wind projects from May 2016 and closed to all new generating capacity on 31 March 2017. Certain grace periods remain for onshore wind projects which have been subject to unavoidable delays. These last until March 2019.[25] The RO has been replaced by Contracts for Difference (CfD) meaning projects comissioned from March 2017 onwards will only be supported by CfD tariffs.

The CfD scheme is a further step towards technology-specific support, and an acknowledgement by the government that purely market-driven mechanisms do not encourage a diverse base of renewables, and have a tendency to support more established technologies.[9,19] Under CfD, renewable generators will receive a guaranteed tariff for their electricity that is dependent upon the technology used, this tariff level being termed the 'strike price'. Having an agreed strike price early in the development of a project allows for investor confidence as the finances of the project can be more confidently predicted. Crucially, once a project is built and starts operating, if the generator receives a wholesale market price for their energy that is above this agreed strike price, then they must pay back the difference.[19] This two-way mechanism is intended to prevent excessive profits that ultimately cost the consumer more and avoids technologies receiving more subsidy than is warranted, something that arguably resulted under the RO prior to its reform.[9,13,14,20]

The strike prices and the way in which they are implemented again reflect the gap in maturity between onshore and offshore wind. Offshore wind will receive a guaranteed strike price of 11.4-12p/kWh for 2016-2019. By contrast, the strike price for onshore wind is capped at 8.3p/kWh for 2016-2019. Furthermore, onshore wind generators must submit competitive bids as part of the process of their CfD allocation.[21,22]

The RO and the Feed in Tariff scheme combined (the latter covers smaller generators below 5 MW) were estimated to make up 6% of the average domestic electricity bill in 2013, although because of rising wholesale energy prices forcing total bills upwards this is equivalent to £37 a year (recall in 2010 £17 a year was 3% of the bill).[23] By 2020, the newer schemes introduced, including CfD, will also be operating, and the total subsidies are expected to add 9% to the

average consumer's total energy bill. In fact, when all low-carbon energy initiatives and climate change policies are included (such as additional carbon costs generators have to pay) it is estimated these will make up 19% of the final energy bill, hence the LCF budget expanding to £7.6bn by this point.[6,23] However, these costs will be offset by a range of policies relating to energy efficiency and rebates for clean energy use that the government is introducing over the same period.* When offset by these related policies, overall energy bills are expected to be around 7% lower on average than they would have been without these policies.[24]

Has wind power been unfairly subsidised?

It can be seen from above that support for renewable energy does make a small but significant contribution to costs on the average consumer bill, although much of this extra cost was designed to be mitigated by policies designed to lower energy bills overall. In fact, when looking at the cost of generation, onshore wind costs are increasingly competitive with conventional generation, suggesting that the subsidy mechanisms used to date have broadly delivered their intentions. The average cost† of onshore wind generation is 10.1 p/kWh, compared to 8 p/kWh for a natural gas combined cycle gas turbine (CCGT, the most cost-effective form of generation in the industry).[26] Offshore wind remains relatively expensive at 12.2 p/kWh, a function of the industry's slow development over the past decade (it is set to grow very quickly in the UK over the next decade), challenging working conditions, and the fact that this less established technology has suffered from a general increase in set up costs that have affected all forms of generation to some extent.[27] The increasing competitiveness of onshore wind is a global trend and is largely due to the support mechanisms put in place by various governments that have seen the onshore wind industry grow and mature.[17]

There was evidence to suggest that the cost of onshore wind would remain competitive compared to conventional generation, and was likely to become one of the cheapest forms of electricity as fuel prices tend to increase and higher carbon costs are imposed on fossil fuels (this includes the cost of installing carbon capture storage in addition to carbon tax). However, the future of the onshore wind industry in the UK is now less certain as a result of the unanticipated, early closure of onshore subisides.[18] As for offshore wind, whilst subsidies remain, industry learning and a lessening of supply chain constraints should cause a drop in prices, with some predictions that it could be as low as 10 p/kWh by the year 2025.[28]

Indeed, wind generally is likely to be more competitive than nuclear power, even in European countries that have greater experience with running a nuclear fleet.[29] There is a risk that nuclear generation costs in the UK could rise significantly higher than those for onshore or offshore wind, up to 16 p/kWh[30] which would make it less competitive than wind but for a much greater subsidy burden on the taxpayer.

The approach by the UK government to nuclear development, which has offered a CfD strike price for the new nuclear reactor at Hinkley, runs the risk of leaving UK consumers with expensive electricity that is non-renewable for many decades (although nuclear is relatively low-carbon compared to coal). The deal made with the owners of the planned Hinkley reactor includes a 9.3 p/kWh strike price that is tied to the Consumer Price Index, which will run under the CfD scheme for 35 years (renewables are typically offered 15-year contracts, making this a much more generous deal than any wind development would be offered). In addition, £10bn of the construction cost has been underwritten with a government loan guarantee.[29] Because of the LCF imposing a limited 'pot' for total low-carbon energy projects, there is also the threat of large overspend on any nuclear development using up a large proportion of the money available, leading to a repeat of the failures seen with the NFFO more than two decades earlier, where renewables (wind included) were effectively crowded out by government support for nuclear.

Furthermore, if the wider costs to society were realised in the price of conventional generation methods end users would see that the price is much higher than it first appears.[31,32] These costs, termed negative externalities, include dispersal of pollutants to air and water, greenhouse gas emissions, environmental damage, health impacts and accident risk; they can vary from a local to a national to a global scale in their effects. These negative externalities are not factored into the cost of conventional generation such as coal and oil. However, many of the wider health impacts of energy sources have been documented for several decades at this point, and consequent revisions have closely followed developments in epidemiology to result in a broadly accepted and scientifically robust assessment.[33,34]

The most far-reaching assessment of national electricity generation pathways across 15 EU member states was by the ExternE project ('External Costs of Energy'), published by the European Commission. It found that the external costs of fossil fuel generation are significant in comparison to renewable sources of energy, in many

* These are numerous and include (or have included) the Carbon Emissions Reduction Target, Community Energy Saving Programme, Green Deal, Warm Home Discount, Products Policy, and initiatives for smart metering and better billing.

† Specifically, this is the 'levelised cost of electricity' (LCoE), which is the lifetime cost expressed per unit of energy produced over that lifetime. It is expressed in terms of present-day value, hence, LCoE values are 'discounted costs' because the costs and outputs today will not have the same value in the future.

cases doubling the cost of generation.[31] More recent analyses following the same principle have suggested that the cost of conventional generation with fossil fuels and nuclear is triple, even quadruple, the current costs.[32] Because they are not paid for by producers or consumers, these costs are passed on to society at large (often across national boundaries). The fossil fuel industry has continuously been shielded in this way from the true cost of its energy sources, since its earliest years, which effectively amounts to a staggering level of subsidy that would be unthinkable if it were suggested today as a means to support renewable energy sources.

Later impact assessments have also included ecological impacts such as climate change and acidification from emissions.[34] A salient point is that ExternE and derivative methodologies are subject to omissions of impact factor data where it is not readily available, and consequently have a tendency to produce lower values for external costs.[35] This is especially the case for climate change impacts, which are almost certainly underestimated given the artifical time horizons imposed on cost estimates (usually 100 years).[33] Indeed, it has been noted that many of the highest cost estimates from the ExternE studies that included climate change impacts were discounted because the range of estimates was so large that it could not be accurate (e.g. the true cost of coal-fired generation was found to be 100 times higher).[32,35] A review of the impact that the full life cycle of coal-fired generation has on the United States, considered conservative in scope because it discounted many of the wider ecological and atmospheric effects, came to the conclusion that the generation costs for coal should be considered two or three times the actual price per unit electricity.[36]

Conclusion

Wind power has experienced rapid development since the 1990s in terms of worldwide installed capacity, but it has also seen decreasing costs that have made it increasingly competitive with the leading conventional sources of generation. In the past, conventional sources of energy received large levels of state-sponsored support and were frequently nationalised. Over this long period of expansion and development, fossil fuel and nuclear-powered electricity generation became entrenched in modern energy infrastructures the world over. As governments and people became more aware of the detrimental impacts caused by high levels of extraction and consumption of non-renewable sources of energy, it has been realised that a transition to renewable energy sources is crucial if society is to continue developing on a more sustainable basis and avoid the worst effects of human-driven climate change.

Serious research, development and commercial deployment of renewables began in earnest in the UK during the 1990s, but this coincided with a period that also saw the widespread dismantling of nationalised generation and supply companies during the advent of liberalised (privatised) energy markets. Renewables have been faced with establishing themselves in this newly competitive marketplace, within which the incumbent conventional generators had long enjoyed uncontested dominance and benefit from an existing infrastructure that was never designed to accommodate the more distributed and variable forms characteristic of renewables. Thus, support for the nascent renewable energy sector has been necessary to ensure the industry and technology can become established and competitive, as was the case for all forms of conventional generation in their early days.

For onshore wind in particular, subsidies have achieved remarkable success in creating a low-margin and cost-competitive form of electricity generation, and it will play an important role in the decarbonisation of the generating sector as a whole. Indeed, in contrast to the success of onshore wind the sixty-year-old nuclear industry still requires comparable levels of support, and its costs are likely to climb at the same time as all forms of commercial wind power continue to fall. In addition, although fossil fuels remain the most cost-competitive, the nominal cost of these fuels excludes many negative externalities that, if accounted for, would push up the cost of generation substantially. By being able to pass on these wider costs to society at large, producers and consumers of fossil fuels benefit from what are effectively enormous subsidies.

Whether directly or indirectly, consumers in the UK have historically footed the bill for subsidies of all forms of energy, but given that large-scale renewable energy development has occurred following privatisation of energy markets these subsides have been increasingly transparent. Consequently, the impression is that renewables are unique in the level of subsidy they receive, but the more complex and unaccounted costs associated with conventional generation shows this is not the case. Even when at their highest level, consumer levies relating to alternative energy sources (under the NFFO) were almost entirely paid to the UK nuclear industry, a supposedly established and competitive form of electricity generation. Since these levies were replaced by the market-driven Renewables Obligation, renewable electricity has enjoyed a much higher level of support.

Whilst it is true that this level of support has arguably been in excess of the amount of renewable generating capacity delivered, the total contribution to consumer energy bills has been very small, within two or three per cent. The largest single driver of increasing energy costs for consumers has been the steady increase in fuel costs, and this is likely to remain the case when fossil fuels remain the dominant source of energy.

Through Contracts for Difference, the UK government is introducing a fundamental change to the national renewables subsidy mechanism that will align it more with feed-in tariff policies that have delivered greater expansion of renewables (for less cost per unit installed) in countries like Germany and Denmark. The removal of subsidy for onshore wind reflects its market maturity, however, it remains to be seen whether or not this will have the negative impact that is predicted on the development of the industry. Offshore wind continues to receive support, this may still stimulate a rapid and large-scale expansion of this sector, but the lack of investor confidence in onshore wind in the UK may have a domino effect on this industry too. Whatever happens with offshore wind it is unlikely to ever be as cheap as onshore wind.

The cut in subsidies to onshore wind a year earlier than planned have introduced a high degree of uncertainty in investment. Ostensibly the introduction of the LCF is intended to protect consumers from high fuel bills and create a secure investment environment; however, it is likely that the budgetary constraints imposed by the LCF will undermine both of these goals.[41] This, combined with the closure of the RO and the establishment of CfD means that UK energy policy has undergone yet another sea-change. It remains to be seen what the long-term effects of these changes will be, particularly in light of the 2016 referendum on membership of the European Union; the UK's relationship with EU law on renewable energy targets could fundamentally change. The short term effect has been to damage investor confidence and create confusion over how the government aims to meet its commitment to have 15% of energy come from renewable sources by 2020.[41]

As renewable electricity generation increases, subsidies will form a greater proportion of consumers' energy bills, although this cost will still be outstripped by increasing fossil fuel costs. Since renewable energy expansion goes hand-in-hand with national strategies to reduce household energy demand, the small increase in bills due to renewable subsidies will be offset by lower energy consumption. It is unlikely that future reductions in energy consumption will be able to compensate in a similar fashion for future increases in fossil fuel prices. Furthermore, as wind power comes to replace significant amounts of conventional generation, the wider external costs of conventional energy that society bears at present will lessen.

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