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# **The economics of wind power: submission to the inquiry by the House of Commons Select Committee on Energy and Climate Change**

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**Centre for Climate Change Economics and Policy  
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## HOUSE OF COMMONS SELECT COMMITTEE ON ENERGY AND CLIMATE CHANGE INQUIRY: THE ECONOMICS OF WIND POWER

Submission by Samuela Bassi and Sam Fankhauser, Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science

### 1. What do cost benefit analyses tell us about onshore and offshore wind compared with other measures to cut carbon?

1.1 Onshore wind has the lowest cost of all forms of low-carbon electricity generation. It is also competitive (or will soon be competitive) with fossil fuel-based power, once the economic costs of carbon are fully factored in. Offshore wind, in contrast is still a relatively expensive technology.

1.2 However, the visual impact of onshore wind is a non-trivial local issue and should be built into cost calculations. First, onshore wind developments should not be allowed in areas of outstanding natural value. Second, people value natural landscapes and are willing to pay to preserve them. Studies indicate that willingness to pay could range from 0.3 to 4 p/kWh. This would add between 3 and 60 per cent to the current levelised cost of onshore wind (which is 6.6 to 9.3 p/kWh). Such local environmental constraints can make more expensive renewable technologies – such as offshore wind or solar photovoltaics – potentially attractive. One can think of their extra cost as the premium society is willing to pay to avoid the local environmental cost of onshore wind.

1.3 There is a distributional aspect to wind developments in that those bearing the local environmental cost (local communities) are different from the beneficiaries of a project (electricity consumers and producers). In addition to concern about costs and benefits, there are therefore questions of adequate benefit sharing with (or financial compensation for) local communities.

### 2. What do the latest assessments tell us about the costs of generating electricity from wind power compared to other methods of generating electricity?

2.1 The UK is bound, under the [Climate Change Act \(2008\)](#) and the subsequent carbon budgets, to cut its annual greenhouse gas emissions by half by 2025, compared with 1990. This requires a power sector that is virtually carbon-free by the mid to late 2020s. With this in mind, the issue of wind energy deployment becomes a choice between this and other low-carbon energy sources, not between wind energy and fossil fuels.

2.2 It has been argued that efficient combined cycle gas turbine (CCGT) power plants may be a cheaper way of meeting our 2020 targets. However, the further decarbonisation required in the 20s cannot be achieved by relying heavily on unabated gas power stations. Prioritising penetration of CCGT plants rather than wind energy risks higher costs in the long run as undesirable technologies are locked in that would then have to be scrapped prematurely.

### 3. How much support does wind power receive compared with other forms of renewable energy?

3.1 Renewable energy subsidies can help overcome the market failure related to introducing relatively immature technologies to the market. These market failures mean that new low-carbon technologies will not develop at all or quickly enough if the market forces alone are relied on, for instance because of the so-called 'valley of death' between the *push* of publicly-funded research and the *pull* of commercial development. Renewable energy subsidies complement (and, where the carbon price is too low, partly replace) policies to put a price on carbon. Carbon must be priced to reflect the environmental cost of climate change and remove the implicit subsidy fossil fuels enjoy for their greenhouse gas pollution.

3.2 Renewables subsidies should be gradually reduced and removed as technologies mature and overcome the market failures. For onshore (but not offshore) wind we can expect this process to be relatively quick. For example, some estimated that onshore wind could be economically competitive with older conventional sources of energy in 5-10 years (see e.g. [Bloomberg NEF, 2011](#)). It is important that the phasing-out of subsidies is done in a predictable way, with the criteria and timetable for decisions being clear and transparent. Ad-hoc and sudden changes in subsidy levels creates policy risks which act as a disincentive to private investors and increase energy costs.

3.3 It is worth noting that fossil fuels also benefit from a range of direct and indirect subsidies. Subsidies for fossil fuels are mostly direct consumption subsidies through the lower rate of VAT on domestic electricity (although this may also benefit non-fossil-fuel electricity) and other tax rebates. The [OECD \(2011\)](#) estimates that subsidies for coal, gas and petrol in the UK were in the order of £3.6 billion in 2010. Furthermore, fossil fuels benefit from direct exploration and production subsidies, such as the £65 million support for the development of fields west of the Shetlands announced by the Chancellor in the last Budget ([HM Treasury, 2012](#)).

#### **4. Is it possible to estimate how much consumers pay towards supporting wind power in the UK? (i.e. separating out from other renewables)**

4.1 The impact of renewables is embedded in the cost of the Renewables Obligation, the main subsidy mechanism for renewable energy. Using official estimates of future electricity consumption and generation capacity ([DECC, 2011](#); [CCC, 2011](#); [ENSG, 2012](#)), and assuming an average Renewable Obligation Certificate (ROC) price of £45 per MWh, it is possible to obtain an indicative value for the contribution of wind technologies to the overall bill. This would be about 0.18p/kWh in 2011 and 0.37p/kWh in 2020 for onshore wind, and about 0.29p/kWh in 2011 and 1.47p/kWh for offshore wind. Assuming the average household consumption of electricity will remain unchanged at 3,400 kWh per year<sup>1</sup>, this would imply an additional annual cost of £6 in 2010 and £13 in 2020 for onshore wind, and roughly £10 in 2010 up to £50 in 2020 for offshore wind.

#### **5. What lessons can be learned from other countries?**

5.1 Experience from Germany and Denmark, which have wind capacities respectively of 27,000 MW and 3,700 MW), confirms that the involvement of local communities is crucial when developing new installations. Unlike the UK, where the majority of onshore wind projects are developed and owned by commercial companies, the majority of projects in Germany and Denmark (up to 80 per cent in Denmark) are characterised by a 'community ownership' model, where local communities pool resources to finance the purchasing, installation and maintenance of projects, and individuals are entitled to a share of the annual revenue which is proportional to their investment ([CCC, 2011](#)).

#### **6. What methods could be used to make onshore wind more acceptable to communities that host them?**

6.1 A study by [Bowyer at al. \(2009\)](#) investigating UK, Danish and German experiences confirms that to create an effective planning system that respects concerns about nature conservation whilst securing rapid onshore wind development, a number of requirements must be met. These include: early engagement of stakeholders, clarity over nature conservation concerns and high quality environmental impact assessments. It is advisable that such elements are taken into account in the context of the UK planning framework.

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<sup>1</sup> The Department of Energy and Climate Change uses instead a higher estimate of 4,000 kWh. For consistency we adopt here an assumption based on the Committee on Climate Change. This is also more consistent with Ofgem's estimates – see footnote 16.

6.2 In turn, wind investors will want to see wind developments to be regulated by sound policy-making. As outlined by [Bassi et al. \(2012\)](#) key measures should include: a clear price on carbon; a planning system that (i) reduces the costs for developers, (ii) factors in local environmental concerns and prevents developments in important environmental areas and (iii) ensures appropriate compensation in areas where local impacts are acceptable; and flanking measures e.g. better interconnectivity of grids, are required to ensure that the electricity system can cope with intermittent resources.

## **Appendix 1**

### **HOUSE OF COMMONS SELECT COMMITTEE ON ENERGY AND CLIMATE CHANGE INQUIRY: THE ECONOMICS OF WIND POWER**

**Supplementary evidence submitted by Samuela Bassi and Sam Fankhauser, Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science**

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#### **Rationale and future prospects for onshore wind subsidies**

##### **The rationale for subsidies to renewable energy in a carbon constrained world**

Corrective subsidies are justified in situations where the market does not provide the socially desirable outcome, i.e. where there are market failures.

The main market failure in the case of energy is that **the market does not incorporate the environmental cost of climate change in the price of goods and energy**. This means fossil fuels are implicitly subsidised for their greenhouse gas pollution, and therefore do not compete on equal ground with low carbon technologies. This market failure can be directly addressed by attributing a price to carbon emissions. The EU Emissions Trading Scheme does this for about 40% of the UK's greenhouse gas emissions. However, the current carbon price set by the EU ETS has not been stable, certain or high enough to encourage sufficient low-carbon investment in the UK (Her Majesty's Government, 2011). The UK government therefore decided to introduce a carbon price floor to encourage additional investment in low-carbon power generation, by providing greater support and certainty to the carbon price. This will be introduced in April 2013 at around £16/tCO<sub>2</sub>, and will gradually increase to reach £30/tCO<sub>2</sub> in 2020 and £70/tCO<sub>2</sub> in 2030 (both in 2009 prices) (Her Majesty's Treasury, 2011).

**There are additional market failures in the case of renewable energy that justify additional intervention.** They have to do with the speed at which innovative new technologies are being adopted by the market. New technologies like renewables can be stalled by the so-called 'valley of death' that exists between research and development in the laboratory and widespread commercial deployment in the field. It is often a very expensive and lengthy process to find the cheapest way of manufacturing new products on a large scale.

Overcoming these barriers and accelerating the deployment of renewable energy sources is the purpose of the Renewable Energy Obligation. By improving technology through learning-by-doing and economies of scale, this subsidy helps to reduce the cost of renewable energy technologies through time. It also ensures that the UK will meet its European Union commitment of meeting 15 per cent of the annual consumption of energy from renewable sources by 2020.

It is worth noting that **fossil fuels also benefit from a range of support measures** - mostly direct consumption subsidies through a lower rate of VAT on domestic electricity (although this may also benefit non-fossil-fuel electricity) and other tax rebates. The OECD (2011) estimates that subsidies

for coal, gas and petrol in the UK were in the order of £3.6 billion in 2010. Furthermore, fossil fuels benefit from direct exploration and production subsidies, such as the £65 million support for the development of fields west of the Shetlands announced by the Chancellor in the last Budget (HM Treasury, 2012). Renewable energy sources may therefore require a certain amount of support to compete on equal ground with subsidised fossil fuels.

### **The UK Renewables Obligation**

In the UK **the main subsidy to renewable energy sources, since 2002, has been the Renewables Obligation**. This requires electricity end-suppliers to purchase a given fraction of their annual electricity supply from producers using specific renewable technologies, obtaining in exchange a certain amount of Renewable Obligation Certificates (ROCs). Currently, for each MWh generated, onshore wind installations receive 1 ROC, offshore wind installations 2 ROCs, and other renewable technologies between 0.25 to 2 ROCs. Where end-suppliers do not obtain a sufficient amount of ROCs, they can either purchase them on the market at a variable price, or pay a penalty (known as the buy-out price), which is currently around £40 per ROC. From 2014 the ROCs will be replaced by new long-term contracts (Feed-in Tariffs with Contracts for Difference), which will run in parallel with the Renewables Obligation to 2017 (Her Majesty's Government, 2011).

By increasing the profitability of the renewable projects in the pipeline, the subsidies allow some of the installations, that would not otherwise be competitive, to be built, increasing the overall installed capacity of renewable energy sources and accelerating the commercial break-through of the technology through economies of scale.

**Estimating the cut-off point between profitable and non profitable projects is not a straightforward exercise**, as several pieces of information regarding cost and revenues are retained by the industry, rather than the regulator. This generates a problem of asymmetric information. *It is advisable that, in the future, it should be made mandatory for generators to disclose some information in exchange for the subsidies, in order to for the regulator to better estimate the level of support required.*

### **The impact of renewable subsidies in the UK and in other EU member states**

**The ROC mechanism increases electricity prices, which in turn are passed on to consumers' bills.** In an average electricity bill of a UK average household, which in 2011 was about £600 (14.9 p/kWh), the Renewable Obligation is estimated to account for £17 (0.5p/kWh). This is expected to increase to £48 (1.1.p/kWh) in 2020 (DECC, 2011a). The specific support to onshore wind through the ROCs is estimated to be around £6 in 2011 (0.2 p/kWh) and £13 in 2020 (0.4 p/kWh) (Bassi et al, 2012).

**Similar mechanisms are in place in other EU Member States.** We highlight here some examples from Germany and Denmark. A comparison of costs per kWh is shown in Table 1 below.

In **Germany** the Renewable Energy Sources Act (EEG) requires grid operators to give priority electricity generated from renewable energy sources, paying the relevant statutory minimum rates to the plant operators. These costs are also passed onto electricity users. In the electricity bill of a

German average household of €792 (£706, i.e. 20.2 p/kWh)<sup>2</sup> in 2009, around €37 (£33, i.e. 0.9 p/kWh) were attributed to the EGG measure (BMU, 2009).

In **Denmark** since the 70s wind turbine owners are paid a supplement to the electricity production price, through fixed feed-in tariffs. Tariffs are set in the Danish Promotion of Renewable Energy Act, and depend on the turbine size and the year when they were connected to the grid. New onshore and offshore turbines connected after 2008 receive DKK 0.25/kWh (about 28 p/kWh)<sup>3</sup> for the first full-load hours, then they receive the market price. In addition, DKK 0.23/kWh (26 p/kWh) is paid to cover balancing costs for the full lifetime of the turbine. The supplement to the market price is recouped as a Public Service Obligation (PSO) in the electricity bills. In 2011 the PSO tariff (covering all renewables) was on average 0.08 DKK/kWh (about 0.9 p/kWh) (ENS, 2009).

**Table 1 Estimated impact of renewable energy subsidies on electricity bills in the UK, Germany and Denmark (p/KWh)**

	UK (2011)	Germany (2009)	Denmark (2011)
Total cost of electricity (p/kWh)	13.0	20.2	25.2
of which: RES policies (RO, EEG, PSO)	0.5	0.9	0.9
other environmental policies	1.4	4.0	8.8
VAT*	0.7	3.2	5.1

\*VAT on electricity is 5% in the UK, 19% in Germany and 25% in Denmark

Sources: UK data based on DECC (2011a); German data based on BMU (2009); Danish data based on Energitilsynet (2012).

### The future of onshore wind subsidies

Ultimately, once all of the failures have been overcome, it is the market that should decide from which sources the UK should obtain its energy. Renewable subsidies are not intended to be permanent and should be gradually reduced over time as more is learned about how to most efficiently manufacture and deploy the technologies, and costs come down.

It is yet unclear, however, when exactly onshore wind will become fully competitive with fossil fuel sources, notably with natural gas. Their future relative price depends both on market fluctuations of gas prices and the cost of onshore wind technologies. The figure below shows that, depending on the assumptions made, onshore wind could become economically competitive with gas as soon as in the next few years, or as late as after 2040. More realistically, onshore wind is expected to become economically competitive in 5-10 years (see e.g. Bloomberg NEF, 2011), while other renewable generation technologies could become competitive in the 2020s and 2030s (CCC, 2011a). This will also depend, however, on how effective subsidies will be in stimulating learning-by-doing and economy of scales, so that the price of technologies decreases at sufficient speed (Table 2).

<sup>2</sup> Assuming an average consumption of 3,500 kWh, as in BMU (2009). Average exchange rate in 2009: 0.891

<sup>3</sup> Average exchange rate in 2011: 0.1165



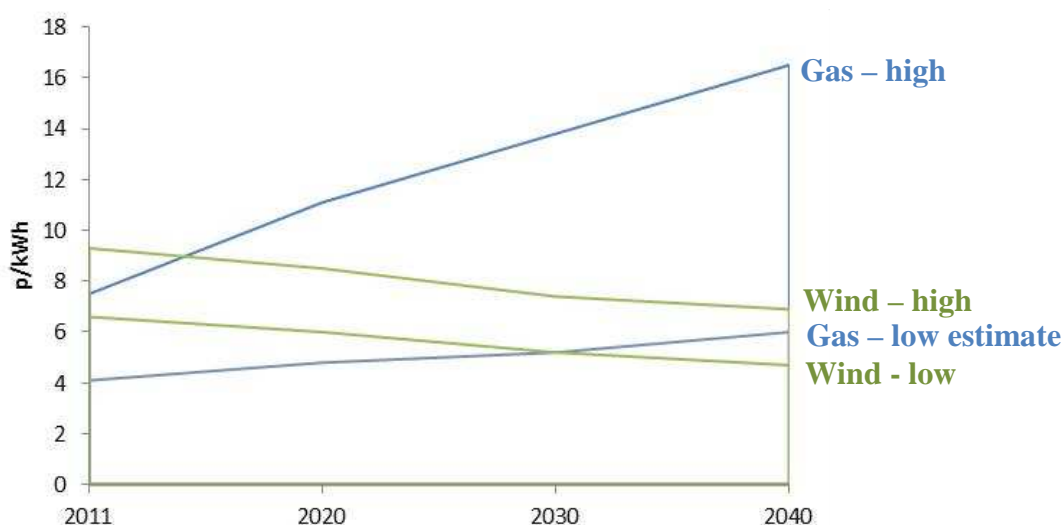
**Table 2 Levelised cost and potential development of key low carbon electricity sources in the UK**

Cost * (p/kWh)	2011	2020	2030	2040	Potential development in 2020-2030 (TWh/year)
<b>Reference technology: unabated gas (i.e. without CCS)</b>					
Gas	4.1-7.5	4.8-11.1	5.2-13.8	6-16.5	
<b>Technologies likely to play a major role in the future UK energy mix</b>					
Onshore	6.6-9.3	6-8.5	5.2-7.4	4.7-6.9	From 7 TWh in 2010 to 30 TWh in 2020, up to 60 TWh in 2030
Offshore	11-19.7	9.2-18.6	6.9-16.5	5.5-14.6	From 3 TWh in 2010 to 50 TWh in 2020, up to 180 TWh in 2030
New nuclear	5.5-13.1	4.7-12.9	3.8-12.4	3.2-11.7	From 80 Twh in 2010 to 175 by 2030
<b>Technologies that could play a major role, where deployment in the UK is important in developing the option</b>					
CCS (gas)	6.3-17	5.9-16.7	5.5-16.3	5.2-16	Uncertain
CCS (coal)	8.9-21.3	8-21	6.9-20.4	6.3-19.9	Uncertain
Tidal	16.6-39.5	12.6-37.4	9.4-34	7.4-30.8	From 0 today to <3TWh in 2020, up to 8 TWh in 2030
Wave	22.5-50.5	15.5-47.4	11-42.4	8.7-37.8	From 0 today to <3TWh in 2020, up to 7 TWh in 2030
<b>Technologies that could play a major role, but limited role for UK deployment in developing the option</b>					
PV	22.8-42.6	12.7-30.4	7.6-22.3	5.3-17	From ~0 today up to 19 TWh in 2030 (limited role in 2020)

\*Costs are for a project starting construction in that year, discounted at high and low discount rates (7-10 per cent). Estimates take into account capital, fuel and carbon price uncertainty. Additional system costs due to intermittency (e.g. back up, interconnection) are not included.  
Sources: Levelised costs from CCC (2011b); potential development to 2020 from ENSG (2012) and to 2030 from Arup (2011), except new nuclear from CCC (2011b).

As a relatively mature technology, onshore wind’s capital costs are not expected to fall very quickly in the next decades. The Department for Energy and Climate Change estimated its levelised costs to come down by around 8-9% over the period 2010 to 2030, and devised to cut the level of subsidy by a commensurate amount as from 2013 (DECC, 2001b) . Any further decrease of the subsidy should be accompanied by a careful analysis of future costs improvements.

**Figure 1 High and low estimates of levelised costs for onshore wind and unabated gas (2011-2040)**



Source: Based on data from CCC (2011b) – high and low interest rate (7-10 per cent)

Overall, it is important that the gradual decrease and eventual phasing-out of subsidies is done:

- **in a robust way**, so that the subsidy reduction is proportional to the expected reduction in technology costs. Issues of asymmetric information can be (at least partially) addressed by requiring renewable electricity generators to disclose some of their cost-related information to the regulators in exchange for the subsidies.
- **in a predictable way**, with the criteria and timetable for decisions being clear and transparent, in order to avoid ad-hoc and sudden changes in subsidy levels creates policy risks which act as a disincentive to private investors and increase energy costs.
- **In a consistent way** which is coherent with public policies on climate change, including the national carbon reduction targets and the renewable energy targets.

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