

**Input to DECC review of OFGEM  
from Steering Committee of amenity groups in South Suffolk & North Essex**

***Introduction***

This submission has the following structure:

- Analysis of OFGEM'S current duties and policies on the environment
- Assessment of current position against good regulatory practice
- Consideration of whether neglect of environmental issues is material
- Explanation of OFGEM's role in energy investment and the environment
- The general principles on which OFGEM, and others involved with design and decisions on energy infrastructure, should work
- The possibility of generic solutions
- Summary of recommendations

Supporting Annexes:

- 1 OFGEM's Powers & Duties
- 2 OFGEM statement on visual amenity
- 3 The cost of undergrounding to the ultimate consumer
- 4 Environment value of offshore wind power.

It is made on behalf of a number of amenity groups in South Suffolk and North Essex which have come together to oppose the proposals by National Grid (NG) for a new 400kV line between Bramford west of Ipswich and Twinstead south of Sudbury. Some are long-established and with a general remit - the Suffolk Protection Society (the Suffolk branch of CPRE), Colne-Stour Countryside Association, Dedham Vale Society - some were established in reaction to NG's proposals - Bury not Blight, Stour Valley Underground. Our opposition is based on concepts which we believe can and should be applied generally. The present submission is an example.

Electricity pylons are by far the most significant single form of visual blight in our diverse and highly valued landscape. This statement is generally accepted and yet, throughout the relevant regulatory framework, the value of visual amenity is afforded little more than a footnote. Moreover, past and current regulation is deliberately and heavily biased in favour of overhead power lines, irrespective of ongoing developments in alternative forms of transmission and the potential for change through active promotion of innovative solutions.

The current changes in the energy landscape offer the ideal opportunity to re-evaluate the basis on which regulation is formulated and to develop policies that preserve and benefit the natural landscape. It could be argued that this is a function of planning, rather than market regulation. In the case of energy infrastructure this argument does not stand close scrutiny. Planning regulation is reactive, responding to applications from parties with, in the main, simple economic interests. Achieving change in the market-oriented energy sector requires fundamental re-balancing of the regulator's perspective and priorities. The consumer must still be protected against excessive cost but by taking account of issues such as whole life cost, the consumer's interests can still be safeguarded. However, because of higher initial costs (capex) OFGEM's formulas will need to reflect the new amortisation profile.

### ***OFGEM duties and policies on the environment: current situation***

OFGEM's current Powers & Duties are set out in a statement on their website (at Annex 1).

The totality of what this says with respect to the environment is that (1) "in carrying out [its] functions, [OFGEM shall] have regard to the effect on the environment" (1.9, end) and (2) it "must also have regard to . . . certain statutory guidance on social and environmental matters issued by the Secretary of State".

The DECC guidance<sup>1</sup> has just one paragraph on environmental issues. This runs "Given the Authority's duty to have regard to the need to contribute to the achievement of sustainable development, the Government expects the Authority to exercise its duties and powers (consistent with its principal objective and general duties including its sustainable development duty and its duty to secure a diverse and viable long-term energy supply) in the manner best calculated to support this goal."

An earlier passage in the DECC guidance on Government social and environmental policies makes clear that sustainable development is equated with addressing climate change (and fuel poverty). Effectively it equates environmental matters with sustainable development, and sustainable development with climate change. By implication it reinforces the thrust of the National Policy Statements, that virtually everything must give way to the supreme goal of mitigating climate change. It offers no guidance on environmental matters to do with amenity/aesthetics/heritage, or to do with bio-diversity.

The OFGEM Transmission price control review 2006 has a passage on visual amenity (at Annex 2). This recognises that "visual amenity has a value to consumers" and refers to the arrangements to "fund the replacement of overhead [distribution] lines with underground cables in environmentally sensitive areas". It goes on to note that "There is much less transmission in sensitive areas . . . the visual impact is much greater per km because of the size of transmission pylons . . . the costs of replacing a km of transmission line with underground cable are also significantly higher." But it comes to no conclusion on either the outcome to address this issue, or the methodology by which it is to be addressed: "we think that our approach to visual amenity in respect of transmission should also be on a case-by-case basis".

The conclusion is that grossly insufficient attention is given to protecting the environment in its full sense. The only purchase of environmental factors such as amenity/aesthetics/heritage, or bio-diversity, is via an utterly bland and general "have regard to the effect on the environment, case-by-case"<sup>2</sup>.

### ***Current situation at odds with good regulatory practice***

The current situation is wholly unsatisfactory. "Have regard to, case by case" is flagrantly at odds with good regulatory practice, specifically with 1.10 of OFGEM's Powers & Duties, "under which regulatory activities should be transparent, accountable, proportionate, consistent . . ." As things are, no one knows where they are - not National Grid or other applicants, not planning authorities, not the IPC, least of all the general public.

This vagueness is the more important, given that, by contrast to the position when the British electricity market was first privatised, the main players are now foreign or like NG multi-national, and unstable in the sense of being subject to merger or acquisition.

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<sup>1</sup> [http://www.decc.gov.uk/en/content/cms/what\\_we\\_do/uk\\_supply/markets/regulation/regulation.aspx](http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/markets/regulation/regulation.aspx)

<sup>2</sup> And any over-riding general requirements such as might emanate from the EU. (If there are any such, OFGEM and DECC seem oblivious of them.)

### *Does it matter?*

It seems to be implicit in the DECC guidance, and indeed of the National Policy Statements, that the big issues of visual amenity/bio-diversity and energy infrastructure are cut-and-dried. Specifically, it appears to be assumed in the present context, that the over-riding national and indeed international interest requires Britain to build nuclear power stations and wind farms, and to transmit their electricity to market, and the only viable ways of achieving this involve loss of visual amenity/bio-diversity. Any environmentally-friendly alternatives are dismissed as absurdly costly (“undergrounding costs 12 to 17 times as much as pylons”). This is well-established – it will be argued – by decades of protest, debate, public inquiry and decision.

If this is so, it is natural to conclude that the only issues of visual amenity/bio-diversity about which there can be real doubt are local and specific and diverse, such that the only practical approach is case-by-case. But it is not so. There are acceptable ways for Britain to meet its energy security and climate control requirements without major loss of amenity/biodiversity.

We contend that

*New technologies and the structure of the emerging energy economy make different solutions possible.* Gas-insulated transmission lines appear to cost materially less than conventional undergrounding (half to one-third the costs). Large-scale offshore wind generation fits well with high voltage direct current transmission and undersea grids.

*The cost comparisons are on an inappropriate basis.* The “12 – 17 times” soundbite is misleading, even as a cost comparison, because it refers only to the cost of the pylons themselves, not to the whole project cost for a transmission scheme. On a worst case scenario, undergrounding doubles whole project value. But the relevant measure for environmentally-friendly alternatives is not the ratio of their cost to the base case, but the cost per typical consumer. See Annex 3 The minimal impact of transmission costs has been accepted by OFGEM and these costs have been described as “marginal” (minutes of GEMA meeting June 2006). Even if transmission capex is doubled the cost remains marginal.

*The public value the damage done by large scale energy infrastructure highly.* Revulsion is not too strong a word. It is wrong to assume that this is confined to those with the installations constantly in view.

*The decision to invest in wind farms offshore rather than onshore implies spending very large amounts for visual amenity: public willingness-to-pay may well be material in scale.* The excess cost of offshore wind is of the same order as the excess costs of undergrounding 400kV transmission lines. See Annex 4

*Incentives to reward environmentally-friendly innovation are needed.* Irrespective of arguments concerning the true cost of undergrounding, rather than concluding that the cost-benefit ratio makes alternative forms of transmission uneconomic, it would have been equally logical to argue that financial incentive for innovation is required in order to ensure a cut in – for example – the cost of underground cabling. In this sense, rewarding efficiency – one of OFGEM’s stated ‘outcomes’ – is not just about rewarding the least expensive option, it can also be about rewarding effective solutions that have the greatest long term benefit.

Within this context innovation is not only about technological advance but also involves innovation in managing regulatory finance.

### *The place of OFGEM*

All this is to do with decisions on energy investment, and so might seem to be a matter for the IPC<sup>3</sup>, nothing to do with OFGEM. But investment decisions are driven by the return on the investment, hence by the revenue obtainable. So the role of the regulatory body is central.

### *What is required*

First, decisions need to be at the appropriate level. Government should set out the principles to be applied, since they have important financial and environmental consequences, beyond the remit of a body such as OFGEM. But others - OFGEM or IPC or the relevant industry players, depending on the issue - should apply the principles, since Government doesn't have the knowledge. For Government to take particular decisions on energy infrastructure is liable to detract from transparency and consistency. It is therefore right that DECC's role on behalf of Government should be to set the rules by which OFGEM (and other public bodies eg IPC) operate.

The essential step for environmental issues is to specify rules which permit and encourage appropriate expenditure on environmental protection and enhancement.

We should accept that for energy infrastructure, the ultimate consumer pays, as is the current position with offshore wind farms. "The polluter must pay" is a splendid grandstanding slogan, implying that we the public have a free lunch and the moral high ground, but the reality is that any serious investment in the environment would bankrupt even firms like NG.

The principles should then comply with good regulatory practice, as above. They must be concrete enough for industry players (and other interested parties) to be able to design projects that normally stand up to challenge, whether on environmental grounds or on consumer cash outlay grounds. Correspondingly, those scrutinising proposals for energy investment need to know what arguments, objections and alternatives are cogent. Those who adjudicate need to know where the decision is a matter of checking the arithmetic, and where judgement is legitimate or indeed required.

The weight given to considerations of visual amenity and bio-diversity should be appropriate, neither too little - as now - nor too much. It needs to respond to technical change, and to reward environmentally-friendly innovation.

So what should those principles for decisions on energy investment be?

We propose that the assessment of options to mitigate the adverse effect of energy investment on visual amenity/bio-diversity should be based on social cost-benefit analysis, whereby all relevant considerations (costs & benefits, pros & cons) are brought together on a consistent basis - so far as practicable<sup>4</sup>. This implies principles such as life-time costing and time discounting using a suitable social time discount rate, for which there are well-developed public sector procedures especially the Treasury Green Book<sup>5</sup>.

The value to be ascribed to visual amenity/bio-diversity should if practicable be expressed in the same terms as the conventional financial costs. Ideally, this would be done by

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<sup>3</sup> Or its replacement

<sup>4</sup> This applies equally to other costs and benefits not captured by the financial calculations of the applicant ("externalities") such as tourism, health and economic effect to property

<sup>5</sup> [www.hm-treasury.gov.uk/d/green\\_book\\_complete.pdf](http://www.hm-treasury.gov.uk/d/green_book_complete.pdf). This is also interesting on environmental effects, and bullish on public willingness-to-pay - see page 63 on.

gathering evidence of public willingness-to-pay for the environmental benefits in question. Failing that, values could be derived by analogy from accepted cases (as at Annex 4).

Social cost-benefit analysis (SCBA) would provide the basis for the decision. The decision would often involve judgement (as against arithmetic) except where the figures left no room for real doubt. But the final judgement would be conditioned and disciplined by the SCBA. Defiance of the underlying logic would be demonstrable, and should be subject to disciplines such as judicial review.

Once the decision had been taken, financing it would be a separate matter (so the social time discount rate and the financing rate for the relevant utility can differ). SCBA would eliminate any unduly short time horizons for the decision (again, the financing arrangements could differ).

The fact that the ultimate consumers pay the cost of environmental protection reinforces the case for seeking to take account of environmental factors by assessing public willingness-to-pay<sup>6</sup> for them.

Any decision to spend significant amounts on visual amenity/bio-diversity should be taken by a public body, rather than a private firm. But the rules should be sufficiently clear to enable an applicant such as NG to put forward environmentally-friendly solutions which represented appropriate use of consumers' money; and the rules should provide that the applicant should not be financially disadvantaged by so doing. If they successfully made the case for a solution with higher financial costs, on environmental grounds, they should be entitled to an appropriate return.

These principles should be embodied in OFGEM's Powers & Duties<sup>7</sup>.

### *Generic solutions*

Many energy infrastructure projects share important common features so far as environmental impact is concerned. Pylons and wind turbines are salient examples. OFGEM should aim to produce values for environmental impact for generic infrastructure, in consultation with interested parties. These values would ideally indicate how they varied with important parameters eg landscape status<sup>8</sup>. Debate about particular projects could then focus on how the particular departed from the generic.

### *Summary of recommendations*

The assessment of options to mitigate the adverse effect of energy investment on visual amenity/bio-diversity should be based on social cost-benefit analysis

Any decision to spend significant amounts on visual amenity/bio-diversity should be taken by a public body, rather than a private firm.

The rules should be sufficiently clear to enable an applicant to put forward environmentally-friendly solutions which represented appropriate use of consumers' money; and the applicant should not be financially disadvantaged by so doing.

OFGEM should produce values for environmental impact for generic infrastructure, in consultation with interested parties, indicating how they varied with important parameters eg landscape status

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<sup>6</sup> Strictly, public requirement-to-be-compensated for the loss of eg visual amenity

<sup>7</sup> And those of other public bodies in this area, especially the IPC

<sup>8</sup> National Park/AONB, etc.

## **The Powers and Duties of the Authority (OFGEM) from OFGEM website**

1.1 This description summarises the primary powers and duties of the Authority. It is not comprehensive and is not a substitute to reference to the relevant legal instruments (including, but not limited to, those referred to below)

1.2 The Authority's powers and duties are largely provided for in statute (such as the Gas Act 1986, the Electricity Act 1989, the Utilities Act 2000, the Competition Act 1998, the Enterprise Act 2002 and the Energy Acts of 2004, 2008 and 2010) as well as arising from directly effective European Community legislation.

1.3 References to the Gas Act and the Electricity Act in this appendix are to Part 1 of those Acts.<sup>11</sup> Duties and functions relating to gas are set out in the Gas Act and those relating to electricity are set out in the Electricity Act. This description must be read accordingly.<sup>12</sup>

1.4 The Authority's principal objective is to protect the interests of existing and future consumers in relation to gas conveyed through pipes and electricity conveyed by distribution or transmission systems. The interests of such consumers are their interests taken as a whole, including their interests in the reduction of greenhouse gases and in the security of the supply of gas and electricity to them.

1.5 The Authority is generally required to carry out its functions in the manner it considers is best calculated to further the principal objective, wherever appropriate by promoting effective competition between persons engaged in, or commercial activities connected with,

- the shipping, transportation or supply of gas conveyed through pipes
- the generation, transmission, distribution or supply of electricity
- the provision or use of electricity interconnectors

1.6 Before deciding to carry out its functions in a particular manner with a view to promoting competition, the Authority will have to consider the extent to which the interests of consumers would be protected by that manner of carrying out those functions and whether there is any other manner (whether or not it would promote competition) in which the Authority could carry out those functions which would better protect those interests.

1.7 In performing these duties, the Authority must have regard to:

- the need to secure that, so far as it is economical to meet them, all reasonable demands in Great Britain for gas conveyed through pipes are met;
- the need to secure that all reasonable demands for electricity are met;
- the need to secure that licence holders are able to finance the activities which are the subject of obligations on them<sup>13</sup>; and
- the need to contribute to the achievement of sustainable development.

1.8 In performing these duties, the Authority must have regard to the interests of individuals who are disabled or chronically sick, of pensionable age, with low incomes, or residing in rural areas.<sup>14</sup>

1.9 Subject to the above, the Authority is required to carry out the functions referred to in the manner which it considers is best calculated to:

- promote efficiency and economy on the part of those licensed<sup>[1]</sup> under the relevant Act and the efficient use of gas conveyed through pipes and electricity conveyed by distribution systems or transmission systems;
- protect the public from dangers arising from the conveyance of gas through pipes or the use of gas conveyed through pipes and from the generation, transmission, distribution or supply of electricity; and
- secure a diverse and viable long-term energy supply, and shall, in carrying out those functions, have regard to the effect on the environment.

1.10 In carrying out these functions the Authority must also have regard to:

- the principles under which regulatory activities should be transparent, accountable, proportionate, consistent and targeted only at cases in which action is needed and any other principles that appear to it to represent the best regulatory practice; and
- certain statutory guidance on social and environmental matters issued by the Secretary of State.

1.11 The Authority may, in carrying out a function under the Gas Act and the Electricity Act, have regard to any interests of consumers in relation to communications services and electronic communications apparatus or to water or sewerage services (within the meaning of the Water Industry Act 1991), which are affected by the carrying out of that function.

1.12 The Authority has powers under the Competition Act to investigate suspected anti-competitive activity and take action for breaches of the prohibitions in the legislation in respect of the gas and electricity sectors in Great Britain and is a designated National Competition Authority under the EC Modernisation Regulation<sup>[6]</sup> and therefore part of the European Competition Network. The Authority also has concurrent powers with the Office of Fair Trading in respect of market investigation references to the Competition Commission.

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[1] Entitled “Gas Supply” and “Electricity Supply” respectively.

[2] However, in exercising a function under the Electricity Act the Authority may have regard to the interests of consumers in relation to gas conveyed through pipes and vice versa in the case of it exercising a function under the Gas Act.

[3] Under the Gas Act and the Utilities Act, in the case of Gas Act functions, or the Electricity Act, the Utilities Act and certain parts of the Energy Acts in the case of Electricity Act functions.

[4] The Authority may have regard to other descriptions of consumers.

[5] Or persons authorised by exemptions to carry on any activity.

[6] Council Regulation (EC) 1/2003.

**OFGEM Transmission Price control review 2006****Visual amenity**

11.17. It is generally accepted that transmission assets reduce visual amenity, and that visual amenity has a value to consumers. The existing electricity transmission network has 26,550 kilometres of overhead line in GB, comprising 5,250 kilometres of 132kV, and 21,300 kilometres of 275/400kV.

11.18. On the gas transmission system, the visual amenity issues are primarily associated with compressor stations, terminals, and other above ground installations (AGIs). There are around 400 such installations, ranging in size from very large entry terminals to equipment similar in size to a small electricity sub-station. There are 25 compressor stations on the GB network, and 6 large entry terminals.

11.19. We are keen to ensure that the value to consumers of visual amenity is recognised and considered objectively in determining how the networks are developed over time. In the most recent electricity distribution price control (DPCR) we allowed a small amount of additional funding for the companies to fund the replacement of overhead lines with underground cables in environmentally sensitive areas. However, the cost of undergrounding transmission lines is significantly higher than the costs of undergrounding lower voltage distribution lines, and therefore we propose not to adopt this approach in the context of transmission.

11.20. However, for transmission we need a different approach. There is much less transmission in sensitive areas, but the visual impact is much greater per km because of the size of transmission pylons. But the costs of replacing a km of transmission line with underground cable are also significantly higher. To illustrate, based on illustrative cost estimates provided by the transmission companies, a single project to replace a relatively small stretch of overhead transmission lines with underground cable could quite feasibly cost more than the entire five-year budget for the DPCR scheme across all fourteen distribution companies.

11.21. We also need to be aware of the other processes, most notably the planning consent process, through which visual amenity and other impacts of new transmission investment are considered. These considerations are on a case-by-case basis, and we think that our approach to visual amenity in respect of transmission should also be on a case-by-case basis. We will give effect to this approach by monitoring and, where appropriate, participating in the planning consent process - and through our own analysis and consultation with key stakeholders where we think a case for funding adjustments might be justified.

### How much would it add to electricity bills to put transmission lines underground?

Transmission companies are allowed 4.4% after-tax return on capital in real terms by OFGEM<sup>9</sup>. This implies a before-tax return of about 4.8%<sup>10</sup>.

Their transmission lines will have a life of 50 years or so, so an amortisation rate of 2%.

So the additional capital cost of undergrounding represents an extra annual cost to the consumer of  $4.8\% + 2.0\% = 6.8\%$  per year of that additional capital cost<sup>12</sup>.

Assume 100% undergrounding Bramford – Twinstead in tunnel<sup>13</sup> costs £600 million more than pylons (half way between National Grid’s 12 – 17 times the cost of pylons).

6.8% of £600 million is £41 million per year.

National Grid’s income from electricity transmission in Britain is about £2.6 billion per year<sup>14</sup>. £41 million is 1.6% of £2.6 billion.

So recovering £41 million per year means an increase in their charges to the electricity consumer of 1.6%.

The typical annual household electricity bill is now £500 per year<sup>15</sup>. Transmission costs represent 3% of this<sup>16</sup>, or £15 per year. 1.6% of £15 is 24p.

So 100% undergrounding of the new Bramford – Twinstead link would add to the typical household electricity bill 24p per year<sup>17</sup>, or 2p per month. There is also an indirect effect, via the electricity used in other goods and services, about three times the direct effect. So the total effect is about £1 per year.

Bramford – Twinstead is about 30 kilometres. The total length of existing high-voltage transmission in National Parks is about 180 km<sup>18</sup> ie 6 times the Bramford – Twinstead distance. 6 times £600 million is £3.6 billion. If all existing high-voltage transmission in National Parks was put underground over 12 years, the typical household would pay, directly and indirectly, an extra 50p per year, each year ie an extra £6 per year by the end of the 12 year period.

Individuals are free to judge whether these figures represent a bargain or the opposite. Given all of us are already paying the cost of undergrounding electricity transmission for those who live in large towns, we are entitled to argue that these figures are a bargain.

What is crucial is that this approach is the only valid way to make a judgement: “What will it cost me? What will I get for the money?”

<sup>9</sup> <http://www.ofgem.gov.uk/NETWORKS/TRANS/PRICECONTROLS/TPCR4/Pages/TPCR4.aspx>

<sup>10</sup> On the basis of RAV gearing of 58% - NGET Annual Report & Accounts, page 19

<sup>11</sup> Or should it be the “vanilla return” of 5.05%?

<sup>12</sup> Strictly, less on average over the 50 years, as amortisation reduces the capital outstanding.

<sup>13</sup> This avoids the additional maintenance costs of trench burial

<sup>14</sup> NGET Annual Report & Accounts, page 17

<sup>15</sup> OFGEM:

<http://www.ofgem.gov.uk/Markets/RetMkts/ensuppro/Documents1/Quarterly%20Wholesale%20Retail%20Price%20Report%20November%202009.pdf>

<sup>16</sup> OFGEM Factsheet 81,

<http://www.ofgem.gov.uk/Media/FactSheets/Documents1/updatedhouseholdbills09.pdf>

<sup>17</sup> Which would be indexed to inflation to maintain its value in real terms

<sup>18</sup> CPRE Press release of 5 November 2009: Note 5, figures from National Grid

**Environment value of offshore wind**

Offshore wind power costs double<sup>i</sup> onshore wind power. The only justification for incurring this is to avoid the environmental detriment of onshore wind turbines.

Implicitly, therefore, the environmental detriment of onshore wind turbines exceeds the excess cost of offshore wind power. The environmental detriment of onshore wind turbines is analogous to that of pylons. So the excess cost of offshore wind power can give us a measure of (a lower limit to) the environmental detriment of pylons.

<i>Net present cost of offshore wind</i>			
1.	Capital cost / MW <sup>ii</sup>	£3.2m	Ernst & Young report to DECC, April 2009, page 16, <a href="http://www.bis.gov.uk/files/file51142.pdf">www.bis.gov.uk/files/file51142.pdf</a>
2.	Operating cost /MW	£79k/yr	As above
3.	Decommissioning cost /MW	£18k/yr	As above
4.	Expected life	20 years	As above, page 29
5.	Discount rate	10% real	As above
6.	Annuity multiplier	10	20 years @ 10% discount rate, rounded up
7.	Op. + decommissioning cost /MW, NPV <sup>iii</sup>	£1.0m	(Line 2 + Line 3) x Line 6, rounded
8.	Total NPV /MW	£4.2m	Line 1 + Line 7
<i>Net present cost of onshore wind</i>			
9.	Total NPV /MW	£2.1m	50% of Line 8. Onshore costs half offshore, D MacKay, Sustainable Energy, page 60, <a href="http://www.withouthotair.com">www.withouthotair.com</a>
<i>Excess cost of offshore wind</i>			
10.	Excess NPV /MW	£2.1m	Line 8 - Line 9
11.	MW /Onshore turbine	2	Each offshore turbine rated @ 3MW. D MacKay, page 63. Offshore output per turbine 50% more than onshore. D MacKay, page 60
12.	Excess NPV/Onshore turbine	£4.2m	Line 10 x Line 11 <sup>v</sup> . This gives a lower limit to the environmental detriment of onshore turbines
<i>Relative environmental detriment</i>			
13.	Offshore turbine height	115 metres	D MacKay, page 60. Including rotor
14.	Onshore turbine height	100 metres	Guess, on basis of lower power output
15.	400kV Pylon height	50 metres	NG
16.	Relative visual impact, Pylon/Onshore turbine	75%	Guess at public willingness-to-pay. Turbines twice height of pylons: pylons have connecting cables and “Meccano” structure
<i>Environment detriment per pylon</i>			
17.	NPV/Pylon	£3.1m	Line 12 x Line 16. This gives a lower limit

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<sup>i</sup> Or more, on some views. The calculation above assumes double only.

<sup>ii</sup> MW capacity ie gross. Net load factor assumed by E & Y is 38%. It is taken, in the calculations above, that figures such as “25 GW offshore wind from Round Three” refer to capacity ie MW gross

<sup>iii</sup> Net Present Value: ie the future cash flows expressed as an equivalent current lump sum, by means of the discount rate; or, future revenue costs expressed as a capital cost

<sup>iv</sup> An alternative approach is to say “Round Three offshore involves 8,333 3 MW turbines (to give 25 GW capacity). To provide the same capacity onshore would require 12,500 turbines, because the output per turbine offshore is 50% greater than onshore. So the excess cost of the 8,333 offshore turbines has to be less than the environmental detriment of the 12,500 onshore turbines, or, dividing through, one offshore turbine pays for 1½ onshore turbines. The excess cost of one offshore turbine is £2.1m per MW x 3 MW per turbine = £6.3m NPV: hence the excess cost of one onshore turbine is £6.3m / 1.5 = £4.2m