# How can we address the high cost of renewables?

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1. Background

- I have worked on environmental & energy economics for > 25 years including being co-author of the World Bank's review of climate change in 1991 and recently led large international studies on adaptation to climate change.
- I spent many years dealing with investment planning for large energy projects in formerly socialist economies. The UK's target-driven policies for renewables share many (bad) features with policies in centrally planned economies.
- If environmental policies, especially those which favour specific technologies, are to succeed, they must be cost-effective.
- In this talk I will focus on large scale, on-grid, applications of renewable energy, in particular the UK target of ~30% electricity generation from renewables by 2020. In practice, this means reliance upon wind power since no one believes that any other form of renewable generation can make a significant contribution to meeting this target.

2. Some simple facts

- Wind power is very expensive – on a per MWh basis about twice the cost of gas-fired generation – including a carbon price of £30 per tonne of CO2. Solar PV is even more expensive.
- Wind power is very capital-intensive – on a like for like basis the investment required is 9-10 times that for gas-fired power plants. About 36 GW of wind capacity will be required by 2020 with a system cost of £110 billion on top of what would be required to meet the same demand from gas-fired generation.

- The additional investment will be equivalent to 8-10% of the UK's total business investment over the decade. Since there is no magic pot of money to fund the investment, the consequence will be a large diversion of resources from other forms of productive investment into electricity generation.

- Claims about the employment benefits of investing in wind generation entirely neglect the consequences of lower investment in the rest of the economy and are, therefore, totally misleading at a macro-economic level.

- Wind power is also very difficult to combine with other base load generation, particularly nuclear power, in market systems because of fluctuations in availability for wind and the need for stability for nuclear.

- Current targets imply ~ 36 GW of wind capacity by 2020. Allowing for "must-run" nuclear this exceeds demand for 60% of annual hours – Figure 1.

- Consequence: (i) if the wind blows - wind generation must be constrained, (ii) if the wind doesn't blow, there is a huge requirement for backup capacity.

- On a system-wide basis, wind power saves very little CO2 – and under some conditions none at all. The cost per tonne of CO2 saved is greater than £250 per tonne under the most favourable assumptions and would be ~£400 per tonne under entirely reasonable assumptions. This is more than 10 times the floor carbon price contemplated for 2020.

- Costs for current technology may fall in future, but don't rely on it. In the US, the total installed costs of onshore wind stopped falling in 2005. The same is true for solar installations.

- Warning: don't confuse turbine or PV module costs with total costs. The cost of some components may fall while installed costs rise because locations are less favourable and 65-85% of the installed cost of renewable power is civil works & standard electrical equipment. Over 20 years the cost of gas-fired power plants has fallen significantly more than the cost of wind plants.

3. Why are the costs so high?

- This is largely due to costs imposed on the rest of the electricity system – transmission, backup capacity, impact on non-renewable generation. It is very costly to combine large quantities of capital-intensive but non-dispatchable generation with conventional generation. The consequence is heavy reliance on fast response open cycle gas turbines (OCGT) or very large amounts of spinning reserve.

- The costs do not include any allowance for environmental costs. Given objections to the impact of both wind farms and transmission on the landscape, these are potentially large for onshore wind in the UK. If the costs had to be internalised, as is required for other technologies, the cost of onshore wind would be significantly higher.

4. The value of wind is negative.

- A standard calculation of the value of water for hydro-power – or any other natural resource - can be transferred to value wind as a natural resource. The reference case is to meet future demand (due to the retirement of existing coal-fired and nuclear capacity) using gas combined cycle turbines (CCGT).
- Levelised costs tell us little, because it is changes in the market value of electricity by time of day and season that drive the return on investment earned by generators – Figure 2. Currently, base load price is set either by the marginal cost of running gas or coal plants, peak prices by the cost of utilising OCGT or old coal plants.
- Assumptions about future gas prices play a large role in any projections. DECC's comparisons between renewables and thermal generation rely upon an extrapolation of recent increases in UK prices. This is disingenuous since a key factor in recent trends was a structural shift as the UK switched from being a net exporter to being a net importer. This was a once-off event and was exacerbated by policy & regulatory failures with respect to investment in storage, the management of the remaining reserves, and a failure to address monopoly power in the EU gas market – particularly with respect to the link between gas and oil prices.
- Worldwide, gas is an abundant fuel whose supply responds strongly to higher prices. That is the real lesson of shale gas. High prices in the US lead to a strong increase in investment in and production of gas. The same forces operate in many other countries, whether or not the UK discovers large reserves of shale gas.

- DECC's central assumption that UK gas prices will rise rapidly in real terms over the next two decades is completely unwarranted. Instead, a more reasonable assumption is that gas prices will remain broadly constant in real terms over the life of new generating plant.

- Figure 3 shows annual distribution of load against price compared with average levelised costs of wind and gas CCGT - assuming a cost of capital of 8% and gas prices constant in real terms. Any form of generation only breaks even if a sufficiently high proportion of output can be sold when prices exceed its average levelised cost.

- For technical reasons larger amounts of wind power will reduce future prices at the bottom of the distribution and increase them at the top end - negative correlation between market prices and wind availability. This makes cost recovery even more difficult.

- Even ignoring transmission, backup & environmental costs the value of wind with current technology is about - £65 per MWh and will increase to - £75 per MWh on 2020 due to the impact of more wind capacity on the price distribution.

- The implication is that the UK is made significantly poorer by investing in renewable energy. The cost is diffuse but real. A part of loss will be felt through lower incomes and employment, the rest via higher prices for energy and higher taxes to subsidise landowners and investors in wind farms. But, on any basis it is a transfer from the mass of the population to a privileged few.

5. How can the costs of renewable generation be reduced?

- The most important issue is the cost of storage. When wind or solar power can be matched by equivalent quantities of storage hydro capacity, the hydro can be managed to optimise the return from wind generation. This will work in Brazil, China & even the US Pacific region. But Britain and Western Europe have far too little hydro capacity to get a large benefit.

- Bring down the cost of capital – the extra system cost of wind power relative to gas CCGT reduced by 50% if the cost of capital falls from 8% (real) to 5%. This will only be possible by completing restructuring contracts so that generators get a guaranteed but regulated return on capital.

- BUT, with a cost of capital of only 5%, nuclear power is by far the cheapest form of large scale generation – even allowing for the UK's inability to manage large scale projects on time and on budget. In the rest of the world, nuclear power has a huge cost advantage in Asia, which is what matters for the attractiveness of the UK as a location for manufacturing activity.

- Feed-in tariffs – effectively guaranteed prices for power that is offered to the system - will completely undermine the operation of electricity markets. In practice, we will revert to a publicly-owned entity as the single buyer with administered wholesale prices. If this is going to happen, then efficient contracts should be structured as capacity payments plus marginal operating costs.

- The result will be an extremely politicised structure because the key issue will be how to recover the huge fixed costs of providing system capacity. DECC appears to believe that the issue of capacity payments can be deferred for 5 or more years. This is patently wrong, but the consequence is to bundle capacity payments with guaranteed prices. The result will be an expensive mess.

- No contracts should be offered wind or nuclear or any other kind of generation with no backup provision. Single source generation contracts simply encourage generators to transfer system costs to everyone else. As a basic principle, either (a) generators should be paid to match the demand curve by pooling different types – and locations - of generation, or (b) they should be heavily penalised for offering non-dispatchable generation.

- Technology: the key priority for technology development is dispatchable forms of storage. This may involve improvements in the operation of existing hydro infrastructure or entirely novel ways of storing large quantities of power.

- Much of the rampant lobbying for technology funding is simply pursuing the self-interest of the academic and engineering community. Apart from conventional funding for basic research, any commitment to R&D funding should be time-limited and should rely primarily on payment for results, not payment for inputs – e.g. large prizes or contracts similar to those offered by the GAVI Alliance for new vaccines.

6. Incentives.

- Reliance upon investment and/or production targets when future costs and technology are uncertain encourages the development of grandiose and extremely costly projects. Learn the lessons from the failure of Soviet-style planning and focus on getting the right incentives.
- What is the maximum premium that we are prepared to pay for renewable energy? How should this decline over time?
- Cap the annual budget for subsidies, since they are financed by direct – though hidden – taxes on electricity consumption.
- Governments are really bad at identifying and promoting new technologies. Pay by results, not by inputs into R&D. Remember that most infant technologies never grow up, but that does not stop them asking for more money – e.g. nuclear fusion – so focus on paying for technologies that are viable without continuing subsidies. George Yarrow will have more to say on this.
- Ultimately, the only reason for promoting renewable energy is to reduce CO2 emissions. The most efficient and transparent manner of doing this is to put a tax/price on carbon. It seems that the price required to meet renewable energy exceeds the premium that is publicly acceptable. Draw the obvious conclusion – and that is not to hide the true cost of subsidies.

7. Conclusions

- Investment in renewables will not generate significant employment. At best it will simply divert investment and employment from other sectors of the economy. More likely it will reduce employment income through the impact of higher energy prices on the rest of the economy.
- The UK can have renewable energy on a large scale or a substantial manufacturing sector. It cannot have both, at least as long as renewable sources of energy remain as expensive as at present.
- Investment in wind power is an extremely expensive way of reducing CO2 emissions. Neither the UK nor the world is going to mitigate climate change if this is the best option available.

- Setting quantity targets for renewable energy and then favouring particular forms of generation is a classic example of the failures of central planning. The strategy is made worse by the fact that it is obvious to any well-informed analyst that the targets cannot be met and will eventually be deferred or abandoned. Hence, the policies being followed are not only very expensive but also pointless.
- Governments are very bad at identifying and supporting new technologies. In as far as intervention is required to reduce carbon emissions and / or to promote renewable energy, this should take the form of incentives to innovate and reduce the cost of renewable sources of electricity generation.

Figure 1 - In 2020 wind capacity will exceed non-nuclear demand for 60% of each year

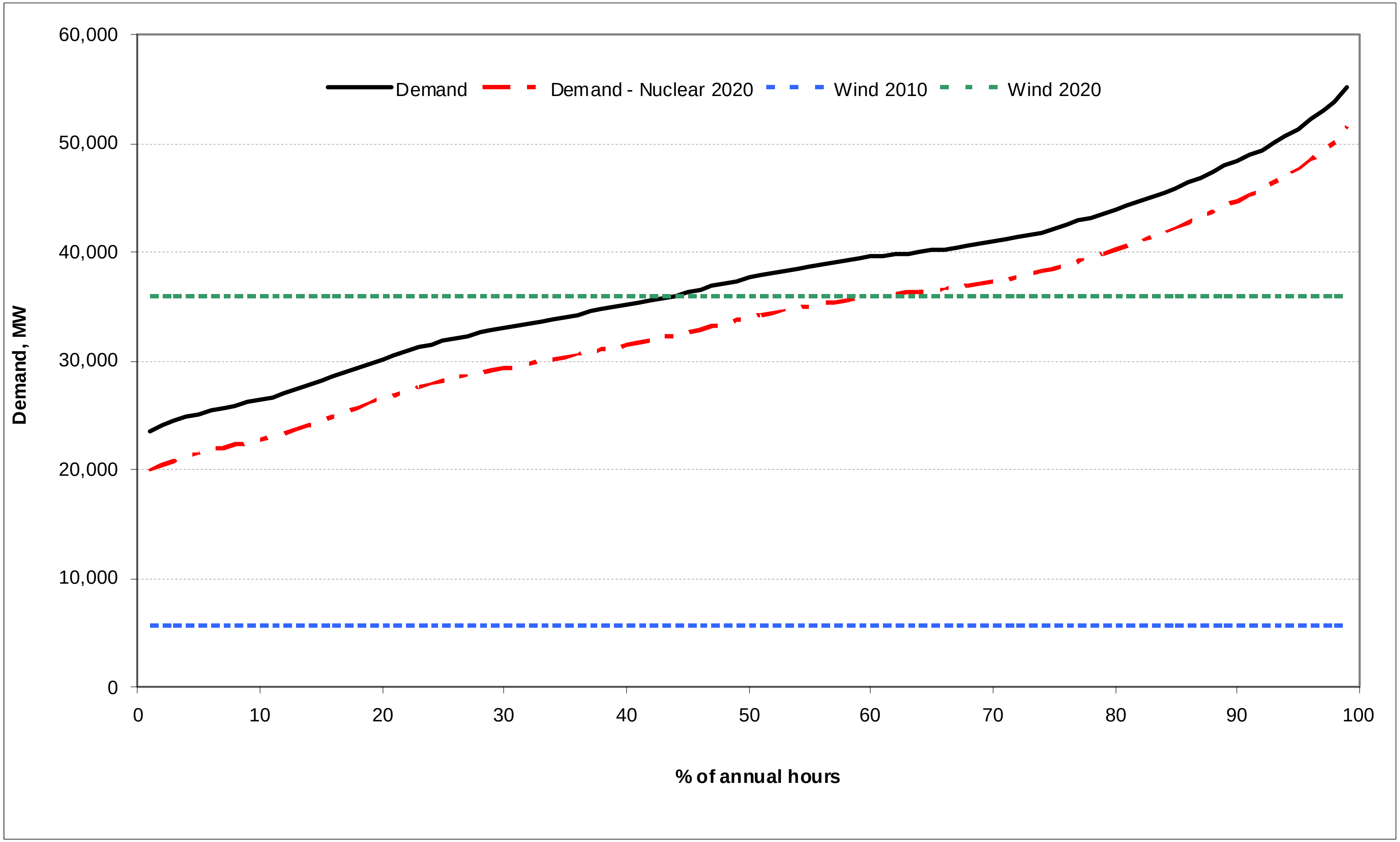

Figure 2 – Variations in market prices by time of day and season drives the return to generators

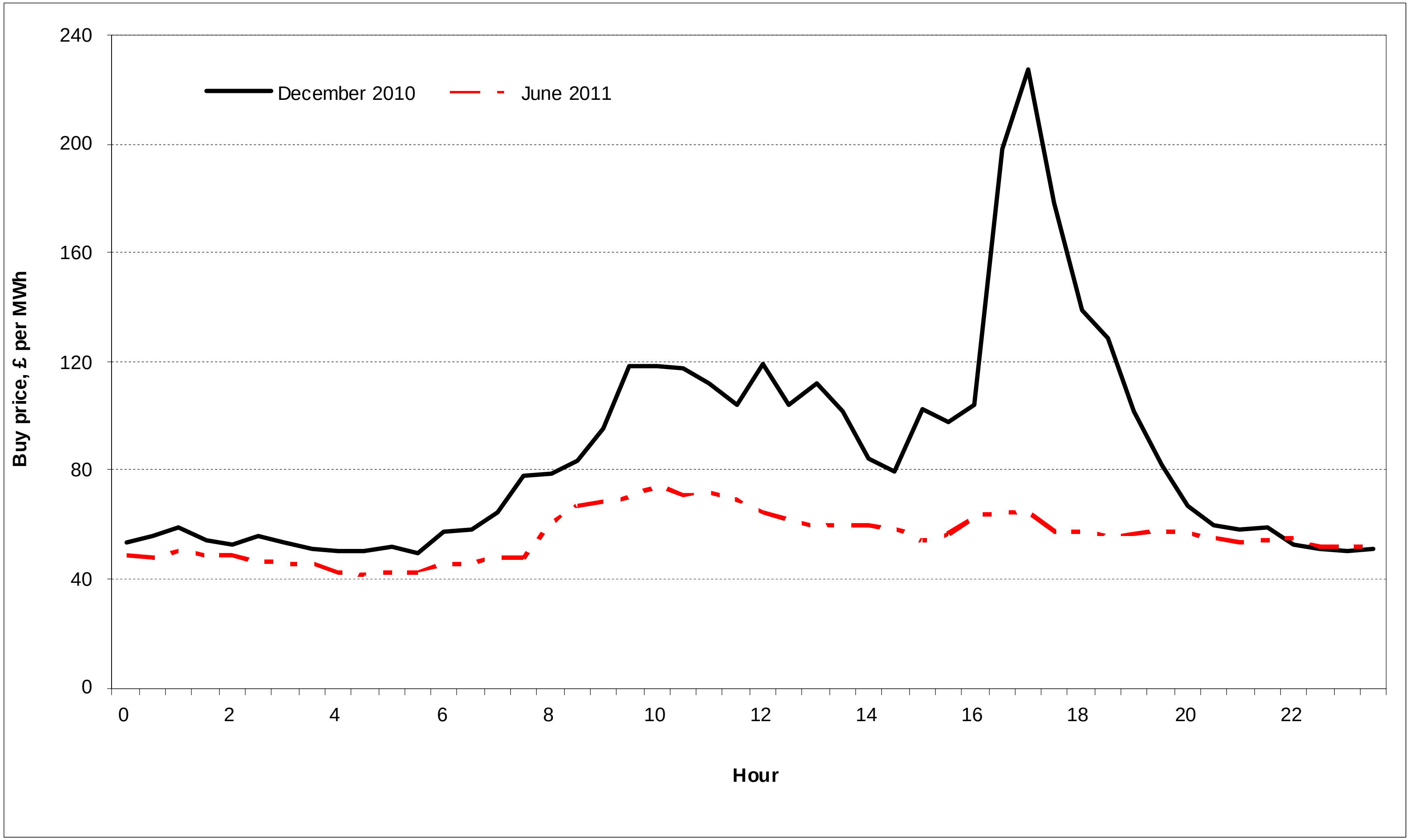

Figure 3 – More wind capacity will skew market prices and reduce the value of wind as a resource