WIND POWER
Greenwire
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Plans to build hundreds of wind farms throughout Scotland and the rest of Europe will have little effect on reducing greenhouse gas emissions, according to an Oxford Institute for Energy Studies report released last month.

Under the most optimistic assumptions, the report says, wind and other renewable sources of energy will have a "minor impact" on reducing carbon dioxide emissions. The study comes as the Scottish Executive pursues plans to build 70 new wind farms in hopes of cutting CO2 levels by at least 20 percent over the next 15 years. Under current plans the country would have 2,500 turbines in operation by 2020.

"Wind farms will not deliver the reductions that governments are hoping for," said senior research fellow Malcolm Keay. "Even if wind farm targets are met, then it will only have a very small impact on reducing carbon dioxide."

Other opponents of wind power point to the experiences of other European countries, including Denmark, where CO2 emissions have continued to rise because coal-fired power plants have been forced to make up shortfalls in electricity when wind levels are low.

Keay said governments should focus their efforts on other technologies, including nuclear energy, which has played a role in reducing CO2 levels in France over the past two decades (Jeremy Watson, Scotsman, Feb. 27).

The Oxford report follows a German study released last month that said wind farms are an expensive and inefficient way of generating sustainable energy. That study, released by the country's energy agency, called for governments to shift their focus from building new wind turbines to making houses more energy efficient (Greenwire, Feb. 28).

[see Oxford report – below]

http://www.oxfordenergy.org/comment_prn.php?0502

Comment

February 2005

CO_2 Emissions Reduction: Time for a Reality Check?

Malcolm Keay

The Kyoto Protocol is due to come into effect this February and we are already more than half way from the signing of the Protocol to the beginning of its first commitment period (and three quarters of the way there since the baseline date of 1990). The world also needs to look beyond Kyoto. Many countries, including the UK, have set themselves ambitious longer term goals, to reduce emissions by 60% or even 75% by 2050. Meanwhile, a number of recent studies – for instance, the climateprediction.net project based on distributed computing and the International Climate Change Taskforce – have stressed the magnitude of the risks and the need for early and effective action.

So it is timely that reviews of progress towards Kyoto targets for the UK and EU have come out recently (the Consultation Paper *Review of the UK Climate Change Programme* in the UK and the European Environment Agency (EEA) Report *Greenhouse gas emission trends* on progress in the EU, both published in December 2004). This Comment considers whether these reports amount to a realistic assessment of the policy measures adopted to meet the targets.

At first sight, the impression given is that everything is more or less on track. The UK Paper says that "our latest projections on the impact that our policies and measures will have on our emissions suggest that the UK remains on course to comfortably achieve its target under the Kyoto Protocol", though admitting that more needs to be done to meet the 20% reduction in CO_2 emissions set as a national goal. The EEA report is more cautious: it acknowledges that the EU is only a third of the way towards meeting its goal (greenhouse gas emissions in 2002 were 2.9% below the 1990 base, as compared with the target of 8 % for the period 2008-2012). However, it suggests that with policy measures in the pipeline and use of the Kyoto mechanisms, the target could be met.

What neither report states is that the evidence contained in them could lead to a much more pessimistic conclusion: that the policy measures favoured in the UK and EU have not delivered significant CO_2 reductions and are clearly inadequate to the longer term challenge.

Emissions data

First it is worth looking at the data. Like all statistics, emissions data can conceal as much as they reveal, and they need to be analysed carefully.

- **Baseline** Focusing on overall progress since the baseline of 1990 draws attention away from developments in recent years. EU-15 ghg emissions fell significantly in the early 1990s, then bottomed out. Since then, ghg emissions have risen. UK ghg emissions also fell significantly through the 1990s and have since broadly stabilised. In other words, the recent trend (ie ironically, since the signing of the Kyoto Protocol) shows a relative deterioration in performance.
- **Coverage** The position is complicated by the fact that figures sometimes refer to greenhouse gas (ghg) emissions, sometimes to CO_2 emissions. The biggest proportional reductions have been in non-CO_2 gases. Although the five non-CO_2 gases in the Kyoto basket currently account for only around 15% of ghg emissions in the UK, they have contributed fully **half** the emissions reduction to date; across the EU they account for the **whole** reduction (indeed, more than the whole reduction - ie CO_2 emissions in the EU 15 have actually increased since 1990). A lot of this reduction comes from one-off changes in industrial processes; in any event, as the proportional contribution from the non-CO_2 gases declines, the scope for significant additional savings also declines. So non-CO_2 ghgs cannot be expected to contribute a major proportion of the future reductions required: it is important to look at the record on CO_2 emissions to get a realistic picture of progress. This Comment focuses on CO_2.
- **Definitions** A further quirk is that the fastest growing source of CO_2 emissions – international aviation and navigation – is not covered by the Kyoto Protocol or EU policies and measures. While currently a relatively minor source (c 6% of emissions) the rate of growth – 44% across the EU between 1990 and 2002 – must be a cause for concern. Were these emissions included in the calculations, they would wipe out nearly all the small reduction in ghg emissions since 1990 across the EU.

Looking at underlying CO_2 trends over a longer period, the recent picture stands out as indicating worse, not better performance. Significant reductions in CO_2 have taken place in the past - before the Kyoto Protocol came into being. For instance, between 1970 and 1995, CO_2 emissions fell in many major EU countries: in the UK, France and Germany by 20% or more. Emissions across the EU as a whole also fell over that period.

This was hardly noticed at the time (or since) and was not of course due to Kyoto measures but to other factors – the growth of nuclear power, especially in France; replacement of coal by gas, especially in the British residential and power generation sectors; industrial restructuring in the UK and Germany (in the UK alone, more than half the reduction in CO_2 emissions during the period came from industry). This long term CO_2 reduction up to the mid-1990s has now gone into reverse, as the trends which brought it about have more or less worked themselves out.

Policy measures

That deterioration in performance, one would have thought, might be reason to question whether the existing policy consensus is the right one, or at least to scrutinise the effectiveness of the measures in some detail, but in fact most countries seem to be drawing the opposite conclusion: that their existing measures need to be intensified.

The EEA summarises the position as follows: "domestic policies and measures in EU-15 Member States that are projected to help most in achieving the targets include promotion of energy from renewable energy, promotion of combined heat and power (CHP), improvements in energy performance [and energy efficiency]". With the addition of the EU emissions trading scheme (ETS), the UK is relying on essentially the same package. The purpose of this Comment is not to question such measures in themselves – they will certainly have a part to play in any climate change programme – but to ask if it is realistic to rely on them to deliver the Kyoto targets and the further deeper reductions many countries are aiming at.

The evidence shows that there are two fundamental practical drawbacks with the chosen measures: first, that the relevant targets will not be met; second, that even if they were, they would deliver little in terms of CO_2 reduction.

Renewables

The EEA admits that the EU renewables target is unlikely to be met (as with previous EU targets). Most commentators also expect the UK to miss its 2010 renewables target (again, like previous targets). The consistent track record of failing to meet such targets is not surprising: the targets underestimate the real practical, economic (and environmental) obstacles to the development of new renewable sources.

But many people also overestimate the potential contribution of renewables. Even if the UK target is met this would only save around 2.5MtC in 2010 (on the UK Government's own figures). Compare that with the 10 MtC reduction between 1990 and 1995 in emissions from energy supply (mainly due to replacement of coal by gas and nuclear in power generation) or with the UK domestic target of reducing CO_2 emissions by over 30 MtC. Renewables, even on the most optimistic assumptions, have only a minor impact, despite their prominence in the public debate.

CHP

CHP also attracts unrealistic expectations. Again, as the EEA notes, the EU targets are very unlikely to be met. But even if the targets were met, it is not clear how significant the savings would be. Proponents of CHP often quote efficiencies of up to 95%. The EEA itself says "CHP utilises over 85% of the energy in the fuel rather than the average of about 35 to 45% in current plants producing only electricity." This sort of efficiency assumption is used to drive expectations of energy and emissions savings.

But these figures are misleading:

- First, because CHP schemes produce heat as well as electricity; indeed, they usually produce significantly more heat. In the UK, for instance, the heat/power ratio is currently around 2.5 - ie 2.5 times as much heat as power is produced on average. Stand-alone heat generation is normally significantly more efficient than power generation (often over 80%). Comparison between CHP and power-only generation is misleading, particularly since CHP stations are generally not especially efficient at power production considered in isolation (ie a CHP station producing only power would have a lower efficiency than comparable stand-alone power generation).
- The high efficiencies quoted above are only possible when a CHP station is producing heat, as well as power, virtually continuously (and using that heat effectively). This requires suitable heat loads to be available, a relatively unusual state of affairs.
- When the comparison is made, as above, with existing power generation, it ignores the potential savings from alternative forms of new investment – new CCGT power plant can have efficiencies of well over 50% and new heat-only plant may have an efficiency of over 90%. Replacing existing stand-alone plant with new plant could of itself achieve significant reductions. A large part of the savings often quoted as coming from the promotion of CHP could come from the promotion of any efficient new investment.

In short, while the quoted efficiencies may be theoretically obtainable in ideal conditions, they are not representative of the savings achievable in typical applications.

What do the actual data show? In the UK, efficiencies of CHP have fallen since the late 1990s and now stand below 70% (on a gross basis – see Digest of UK Energy Statistics Chapter 6), amongst other things because of falling load factors. The energy savings (as compared with separate generation of the same quantities of power and heat) are not necessarily significant[1], if they exist at all. However, as with renewables, there are siting problems. The best sites, with a good match between heat and power output, tend to be exploited first, making good quality CHP harder and harder to find as penetration increases. It is in practice unlikely that new CHP stations will reach the efficiencies quoted by the EEA, and it is certainly not typical in the UK.

To do it justice, DEFRA appears to have come to recognise this: in its latest position paper on CHP it is much more cautious than the EEA, saying only “CHP can increase the overall efficiency of fuel use to more than 75%, compared with about 40% from conventional electricity generation” (indeed, it is more cautious than the UK Energy White Paper of February 2003, which quoted a range of 70-90% efficiency for CHP). The UK’s 10GW target relates specifically to “good quality CHP” and the review paper recognises the adverse conditions facing the industry. The 10GW target is not in practice likely to be met.

Energy Efficiency

What about the third pillar of the EEA policy approach, energy efficiency? This is the most important of the UK measures. The Energy White Paper says "we expect more than half the reductions in our existing Climate Change Programme – around 10MtC by 2010 – to come from energy efficiency" as well as "half the additional 15-25MtC savings we are likely to need by 2020". In other words, energy efficiency is far and away the most important single policy measure – many times more significant than renewables, which have received much more attention.

The problem with energy efficiency is not that it is not worthwhile – no-one can be in favour of wasting energy – but that it is extremely difficult to measure its impact, or indeed to know if it leads to any absolute reduction in energy use or emissions.

Again, the picture is often clouded in the presentation. The figures quoted for savings from energy efficiency tend to be of two types:

- "top-down" calculations based on energy intensity. For example the World Energy Council, in a recent review of energy efficiency, points to the 1.5% decline in primary energy intensity worldwide since 1980 and says the world thereby saved 4.2 Gtoe of energy (37% of 2002 consumption). But this is only a saving, of course, compared with a hypothetical situation where energy intensity had not declined, yet everything else in the world had remained unchanged. It is arguable whether such a situation is remotely plausible; in any event, what happened in practice is that world energy consumption rose by 40% over the same period. Whatever the status of the 4.2 Gtoe "saving", it is of little relevance to climate change targets, which require absolute reductions.
- "bottom-up" calculations based on the result of individual measures (number of efficient light bulbs and boilers installed etc). The measurement issues involved in these calculations are complex – such issues as income and substitution effects; free-riding; principal/agent slippage etc – too complex indeed to be discussed in detail here. The important point is whether any savings identified by these bottom-up calculations can be seen in overall consumption levels. If not, the measures cannot be relied on to help achieve climate change targets.

The UK White Paper quotes both sorts of number without qualification. Yet, even at the theoretical level, it is clear that careful analysis is required – consider, for example the analogy with labour efficiency (productivity). Few people would accept a top-down claim on the lines set out above, eg that a 1.5% a year improvement in productivity meant the loss of an equivalent number of jobs; or a bottom-up calculation that added up the impact of efficient new machines installed across the economy as a way of estimating levels of employment. Economies are dynamic and complex systems; the various interactions and feedbacks need to be taken into account.

These issues have not been adequately addressed in relation to energy efficiency, with the result that it is not possible to say whether the Government's programmes are having any

result – rather than go into detail, it may be simpler to quote the House of Commons Environmental Audit Committee (10th Report, session 2003-2004), which commented that

"A central theme emerging from this report is the difficulty of assessing progress on energy efficiency in the absence of robust and reliable energy projections and systematic ex post appraisals of the impact of specific policy measures…..

…..Indeed, in dealing with energy efficiency, there is a sensation of standing on shifting sands."

The fact is that it is almost impossible to say with any confidence whether any absolute savings at a macro level are being delivered by energy efficiency and there is no convincing international evidence – see following section – that it is an effective route to emissions reduction.

Yet, even though past savings have not been measured properly, the Government still relies on energy efficiency for a significant (and measurable) proportion of the expected future savings. For example, the review comments:

"Since 1990, carbon dioxide emissions from the household sector have fallen by about 3%. On the basis of current policies, carbon dioxide emissions are expected to decline by about 16% between 1990 and 2010."

The discrepancy between limited and uncertain results and the huge expected savings (with only one quarter of the period to go) is striking.

Meeting the targets – who are the role models?

It might be argued that across the EU as a whole the "virtuous" countries are seeing their efforts swamped by the sinners, or that, at least in the UK, the track record of the measures favoured by the present Administration is not long enough for their success to be evaluated.

But examination of the international evidence does not substantiate this. The problems at a European level are not confined to a small minority of countries. The EEA notes that:

§ Only Sweden and the UK are regarded as being on track.

§ Nine of the EU-15 are not likely to meet their targets, even on optimistic assumptions (Austria, Belgium, Denmark, Finland, Greece, Ireland, Italy, Portugal and Spain).

§ Other countries may meet their targets with the introduction of planned new measures.

§ However, even existing plus planned additional measures are not enough to bring the EU back on track. In fact, for the EU to meet its target would require that: a number of countries over-deliver; additional measures are introduced and work as planned; **and** that the Kyoto trading mechanisms are used.

Even this outlook depends on a confidence that the chosen policies will have the expected impacts.

It is not clear how such a confidence emerges from a review of past performance. While it is arguable that the UK has only fairly recently started taking energy efficiency and renewables seriously (though previous Governments, which have consistently claimed to be promoting them effectively, might challenge this), a number of EU countries have long experience of strong and consistent policy making in this area. Specifically, two countries can be identified as having followed the EEA policy path for considerably more than a decade: Denmark and the Netherlands. Their policies have delivered impressive concrete results in terms of direct outputs. Denmark has had an active and well-known wind programme and has achieved the highest penetration of new renewables in the EU (over 20% of electricity capacity). Denmark and the Netherlands have the highest penetration in the EU of CHP (over 50% for Denmark and 37% for the Netherlands as compared with about 6% for the UK). Both countries also have aggressive energy efficiency programmes. Indeed, the Netherlands is taken as a "case study" in the UK Energy White Paper discussing energy efficiency programmes and Denmark is frequently identified as a role model in climate change discussions.

But is this reflected in strong CO_2 reductions? The question seems not to be asked. Chapter 3 of the UK White Paper, for instance, compares UK energy intensity with that of other OECD countries and sets out the objective of moving up the table, ie of improving energy intensity (taken as a proxy for energy efficiency) as a way of reducing emissions. What it does not analyse (nor does the EEA) is whether there is any clear relationship between energy intensity, and the penetration of CHP and renewables, on the one hand, and overall energy use or CO_2 emissions on the other.

Table 1 below is adapted and updated from Chart 3.1 of the UK White Paper. It shows, for EU countries, energy intensity (column 1) – the figure which the White Paper itself quoted. But, unlike the White Paper, it also shows (columns 2 and 3) energy use per head and CO_2 emissions per head (this is the indicator which best measures success in meeting climate change objectives). As the table shows, there is no clear relationship between energy intensities and energy use or CO_2 emissions. Although the UK has higher energy intensity than most of the other countries listed, its CO_2 emissions per head are lower than most of those whose intensity is better, including Denmark and the Netherlands.

As it happens, the Netherlands and Denmark also have a worse track record than the UK on emissions since 1990 - CO_2 emissions have increased in both countries. Denmark is almost certainly not on course to meet its (admittedly stringent) Kyoto target; and Netherlands will only do so on the most favourable assumptions. The UK, on the other

hand, has reduced emissions and is likely to meet its target (though, as pointed out above, this is not a result of its stated CO_2 reduction measures).

Is this just a short term phenomenon reflecting the efforts previously made by Denmark and the Netherlands to reduce emissions? Again, it appears not. Since 1970, Denmark's CO_2 emissions have fallen only slightly; those of the Netherlands have increased by over 20%; but those of the UK have gone down around 20%.

This is not to decry the serious and well-intentioned efforts of these countries. Denmark and the Netherlands have no doubt benefited from their programmes; the programmes may well have contributed to an environmental performance better than would otherwise have been the case, given the many other complicating factors which have been present in practice. But, unfortunately, it is not enough for performance simply to have been better than it might have been. There are always complicating factors; achieving climate change targets means reducing emissions despite those factors. Reliance on the trinity of renewables, CHP [Combined Heat and Power] and energy efficiency, though they may have a useful contribution to make, is not a proven or reliable way of making big CO_2 reductions.

Discussion

This is the message which the two reviews should be highlighting (since it emerges from the data they contain) but they do not. For instance, the UK Review asks a number of questions about energy supply (Chapter 6 of the document). Apart from a few general points, all are focused on what more might be done to promote CHP and renewables. Similarly, in Chapter 9 (households), it asks what more might be done to promote energy efficiency. There is no serious questioning of the policy measures in themselves. And, as the EEA noted, other EU Governments are relying on a continuation and intensification of the existing policies, not considering alternative approaches.

The reason for the silence might well be that Governments simply find it too difficult to discuss the alternatives. One problem might be apparent from another look at Table 1. For a Martian visitor, it would be clear that there are two EU countries in the list which have succeeded in delivering significantly lower CO_2 emissions than their peers – France and Sweden. Unlike the Mediterranean countries, Spain and Italy, with their favourable climates, they have not done so by lower levels of energy use (energy use per head is higher than in Denmark or the UK) or by significant penetrations of new renewables and CHP. Instead, the reason is simple: they both have high levels of nuclear and hydro power, combined with high levels of electricity intensity. None of this forms part of the current EU policy prescription, or emerges from the Reviews.

Another difficult area is that of economic instruments. (There has, of course, been some action in this area, such as the Emission Trading Scheme and carbon taxes in some countries. However, the ETS only came into force at the beginning of this year and there is not yet enough evidence about the impact of the scheme). In general, there is a strong case for giving serious consideration to emissions trading or carbon taxes (essentially

very similar measures) as a way of delivering significant savings – and, more particularly, to consider extending such an approach from industry (which, as pointed out above, has already delivered significant savings while the other sectors have grown or at best stabilised) to households and transport. But these are not options Governments like to canvass.

This brings us to another major problem area: transport. Between 1990 and 2002, ghg emissions from transport in the EU-15 rose by 22%; the EEA projects an increase of 34% by 2010. This increase is taking place despite an improvement in the efficiency of new cars – the average CO_2 emissions of new passenger cars reduced by about 11% from 1995 to 2002, for instance. Yet, despite the poor track record, the main measures being relied on in the transport sector parallel those for other sectors discussed above – i.e. energy efficiency (particularly the efficiency of new passenger cars) and renewables (biofuels in transport). The transport sector is not the main focus of this Comment, but similar messages seem to emerge – that existing measures are not proving effective at reducing CO_2 emissions. EU climate change measures have had little impact on transport (or, therefore, oil) demand to date and the continuing focus on renewables, CHP and energy efficiency which the EEA highlights means that little change is likely.

It is just possible that some reconsideration is taking place. It is striking that perhaps the most successful transport policy of recent years – the London Congestion Charge – relied on economic incentives, and there are some opaque suggestions in the UK Review that the UK Government might be considering the implications. Section 8.10 says:

"The Government remains committed to using economic instruments, such as vehicle taxation, as a way of reducing the environmental impact of road transport. The Government will ….keep under review the possibility of new measures in the future."

This very cautious statement is, however, about as far as the Reviews go in considering whether new approaches might be considered, in the face of the limited impact of the current measures.

Conclusions

- despite the encouraging tone of the Reviews, and despite some past successes, EU countries have not in recent years made progress in reducing CO_2 emissions.
- the measures on which EU Governments are focusing are unlikely to deliver reductions on the scale they say is required.
- other measures deserve to be given closer consideration, but they involve much greater political sensitivity.
- it is time for the UK and other EU Governments to face up to these realities, and open up a wider debate.

Table 1

Country		Energy Intensity (toe/000 95$US)	Energy Use (toe/capita)	CO_2 Emissions ($t\ CO_2$/capita)
Denmark		0.09	3.67	9.52
Austria		0.11	3.78	8.21
Germany		0.13	4.20	10.15
Ireland		0.13	3.91	10.86
Italy		0.14	2.98	7.47
France		0.15	4.34	6.16
Luxembourg		0.15	9.06	20.80
Netherlands		0.15	4.83	11.02
UK		0.16	3.83	8.94
Sweden		0.17	5.72	5.62
Spain		0.18	3.24	7.48

Source: IEA Key World Energy Statistics 2004

References

European Environment Agency *Greenhouse gas emission trends and projections in Europe 2004*

HM Government *Review of the UK Climate Change Programme: Consultation Paper* December 2004

DTI *Energy White Paper: Our energy future – creating a low carbon economy* February 2003

International Energy Agency *CO_2 Emissions from Fuel Combustion 1971-2002*

World Energy Council *Energy Efficiency: A Worldwide Review* London, July 2004

Malcolm Keay, February 2005

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[1] To illustrate this, consider a simplified example of a CHP station supplying 3.5 units of output, 2.5 of heat and 1 of power. At an efficiency of 85% (the EEA assumption) this would take 4.1 units of fuel. If the alternative heat production had an efficiency of 80% and the power production an efficiency of 36%, 5.8 units of fuel would be required – the

CHP plant shows a very useful saving. But different assumptions produce different results. If the CHP plant had an efficiency of 70% (still better than the UK average) it would require 5 units of fuel. If the alternative heat production had an efficiency of 90% and the power generation 55% (reasonable for new plant), the combination of stand-alone plant would require only 4.5 units of fuel, ie in this case the CHP plant uses more fuel and therefore is likely to produce higher emissions. Clearly the actual situation is unlikely to be at either of these extremes and will depend on the particular circumstances, but the calculation serves to demonstrate how complicated it is to forecast the energy savings from CHP. Estimating CO_2 savings involves further assumptions about the fuels being replaced. CHP stations are predominantly gas-fired and may appear to produce emissions savings, compared with the existing generation mix; the apparent savings may be reduced or disappear if the comparison is made with new gas-fired generation.