

COMMENTARY ON THE “UK RENEWABLE ENERGY STRATEGY CONSULTATION” FROM THE DEPARTMENT OF BUSINESS, ENTERPRISE AND REGULATORY REFORM, JUNE 2008¹

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September 2008

1 Introduction

There is much to commend in the renewable energy strategy consultation from DBERR [DBERR2008] but this commentary focuses mainly on areas where I believe that changes are needed.

Although I am the Coordinator of TREC-UK,³ *the opinions expressed here are my own* (except where I have quoted the opinions of others). There will be a separate submission for the TREC-UK group and other members of TREC-UK may offer their own commentaries.

Since conservation of energy and renewable forms of energy will often be referred to together, I shall, for sake of brevity, use the word *conren* to stand for them both. For the same reason, the UK renewable energy strategy consultation document will be referred to as *stratcon*.

The following sections make some observations on the problem of promoting conren in the UK and the wider problem of decarbonising the economies of the UK, Europe and the world, with comments on stratcon and its bearing on those problems.

In the broadest terms, I believe the renewable energy strategy that is described in stratcon could be improved in three main ways:

- It would be good to see greater attention paid to the need for simplicity and transparency in systems designed to encourage the development of conren.

¹ An electronic copy of this document, with live links, may be downloaded from

http://www.mng.org.uk/gh/resources/dberr_re_consultation_2008_commentary5.pdf.

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³ TREC-UK is a group of volunteers aiming to raise awareness of the DESERTEC concept developed by the Trans-Mediterranean Renewable Energy Cooperation (TREC), an international network of scientists and engineers. The TREC website is at www.desertec.org and the TREC-UK website is at www.trec-uk.org.uk.

- Although it is natural to divide the problem into sub-categories, there is a need to look for solutions that cut across the boundaries between one category and another. If the focus is too narrow, good solutions may be missed.
- For similar reasons, I believe there is a need to widen the geographical scope of the strategy to take advantage of significant opportunities that open up when conren in the UK is seen within the context of conren across Europe and beyond.

More specifically, there are some significant omissions from stratcon. These include the DESERTEC concept, the Supergrid concept, Zero-Carbon Eco-Renovation, and Enhanced Geothermal Systems (EGS). Even if the Government decides not to include one or more of them in its renewable energy strategy, they should at least be recognised and their pros and cons should be discussed.

2 Incentives

To a large extent, the problem of encouraging conren is a problem of providing the right framework of incentives for people and organisations, especially financial incentives, so that everyone has a substantial reason for “doing the right thing”. The following subsections discuss aspects of this problem in relation to proposals in stratcon.

2.1 Remove overt or hidden subsidies for non-renewable sources of energy

There is no mention, anywhere in stratcon, of the fact that the “playing field” for energy supplies is tilted against conren. This clearly has a bearing on what the UK’s strategy should be to encourage conren.

In a report published in 2004,⁴ the New Economics Foundation made a conservative estimate that worldwide subsidies for fossil fuels amounted to about \$235bn a year—and there seems not to have been much change since then. In most countries where it operates, including the UK, the nuclear power industry benefits from substantial hidden subsidies.⁵ Since aviation fuel is not taxed, it is in effect subsidised compared with other fuels which are taxed.

An obvious first step in encouraging the development of renewable energy and the saving of energy is to remove all overt and hidden subsidies for non-renewable sources of energy. The Government has relatively direct control over subsidies that originate in the UK and it may work with other governments to remove them elsewhere.

2.2 The need for simplicity and transparency

Stratcon says (para. 3):

Our main policy for achieving carbon reductions involves putting a price on carbon, notably via the EU Emissions Trading Scheme, which caps emissions in the

⁴ See <http://news.bbc.co.uk/1/hi/sci/tech/3818995.stm>.

⁵ One of the biggest hidden subsidies is limitations on liabilities for the effects of a Chernobyl-style accident or worse—see http://www.mng.org.uk/gh/no_nukes.htm.

power and other heavy industry sectors in the EU. However, in line with the principles of the Stern Review into the economics of climate change, we also encourage behavioural change to reduce energy use, and we provide support for specific low-carbon technologies.

I agree that putting an appropriate price on CO₂ emissions is the key to encouraging conren but I believe there are two main deficiencies in what has been proposed in stratcon:

- The EU ETS is only a partial scheme that leaves out many sources of CO₂.
- There is too much complexity in the plethora of other schemes that has been proposed to encourage conren: the Carbon Emissions Reductions Target (CERT), Energy Performance Certificates, the Market Transformation Programme, the “Act on CO₂” campaign, Climate Change Agreements, the Carbon Reduction Commitment, the Climate Change Levy, Energy Performance Certificates, banded Vehicle Excise Duty, the Safe and Fuel Efficient Driving Campaign, the Renewables Obligation (RO), Feed-In Tariffs (FITs) for microgeneration, Renewable Heat Obligation or Renewable Heat Incentive, Community Energy Solutions, and so on.

This complexity of special schemes and measures is likely to create several problems:

- It represent a cost to the Government in the amount of administration that is involved
- More importantly, it represents a cost to industry and the general public in the amount of effort that is needed to understand the schemes and comply with them.
- Since few people will be willing to put in all the effort that would be required for a full understanding of the schemes, it is likely that many of these schemes will not be fully taken up or there will be muddle and inefficiencies in the way schemes are taken up.
- There are likely to be many anomalies and inconsistencies. One such example is the way that the Renewables Obligation makes it impossible for anyone to buy fully-renewable electricity. This is because the sale of ROCs by electricity supply companies nullifies any claim that they may make to be selling 100% renewable electricity.

I believe that substantially greater simplicity and transparency in the way incentives are provided for conren, can be achieved via the following three-way scheme:

- The scope of carbon rationing should be extended so that it provides a steadily decreasing cap on a much wider range of CO₂ emissions than is currently covered by the EU ETS. This may be done by either or both of two main methods:
 - Via a system of Personal Carbon Allowances (PCAs).⁶
 - Via a version of the Kyoto2 proposals [TICKELL2008].

⁶ Information about PCAs, including a discussion of their several advantages over carbon taxes may be seen on <http://www.mng.org.uk/gh/dtcrs.htm>.

- To provide support for new technologies until costs can be brought down via economies of scale and refinements in the technologies, there should be a comprehensive and international system of Feed-In Tariffs covering all kinds of technologies where cost-reductions have not yet been achieved.
- To make good any shortcomings in the first two types of scheme, there may also be a need for a range of other measures including public education, support for research and demonstrators, and various kinds of laws and regulations.

Regarding the third point, there is certainly a need for measures tailored to particular technologies or situations but I believe that there would be substantially fewer such measures in what I have proposed than in what has been proposed in stratcon, and there would be much greater overall simplicity and transparency.

Stratcon's suggestion that the RO should be retained for large-scale projects (para. 3.8.14), and that FITs might be introduced for microgeneration (Annex 2) would simply add to the complexity of support measures for conren. The arguments that are presented in stratcon for retaining the RO system are not convincing and, since that system has so far been a failure compared with the success of FITs in other countries, there is every reason to make FITs the standard form of support for all forms of renewables. An additional reason for standardising on FITs is given in the next subsection.

PCAs and variations thereof have been thoroughly investigated in the last ten years and in one form or another, the concept is clearly workable. Apart from the trading of allowances, PCAs are essentially the same as the kind of rationing 'points' that were applied in the UK to food and other necessities during World War II. If rationing could be made to work using the lo-tec methods that were available then, they can certainly be made to work now. In many ways, PCAs are similar in their complexity to the workings of a credit card system or the kind of system of loyalty points operated by many supermarkets. Any computer company that has been successful in setting up that kind of system should have no difficulty in implementing a PCA system.

Of course, PCAs could be applied throughout the EU, with a corresponding multiplication of their benefits.

Several of the benefits and advantages of PCAs, especially in comparison with green taxes, are described on www.mng.org.uk/gh/dtcrs.htm. An interesting feature of the PCA system is that emissions permits can be attached to imports to reflect the amount of CO₂ released in their production. This can help to protect UK manufacturers from unfair competition and to reduce or eliminate any incentive to move manufacturing to countries with lax controls over CO₂ emissions. In a similar way, it should not be too difficult to develop a formula to apply emissions permits to aviation and shipping. If multinational companies can be taxed in an appropriate manner that takes account of their ability to move money from place to place around the world, it is certainly possible to ensure that the operators of planes or ships that use any UK sea port or airport pay an appropriate amount for the CO₂ emissions that their operations produce.

The "Kyoto2" system for rationing fossil carbon at source (TICKELL2008) means rationing carbon "upstream" at the point where fossil fuels are extracted from the ground instead of "downstream" at the level of consumers. For a circumscribed area such as the

UK or the EU, fossil carbon may be rationed at the point where it is imported. The imports to be rationed may take the form of oil, coal, gas or derivatives thereof but, as with PCAs, they may take the form of fossil carbon embodied in manufactured products that are imported into the UK such as cameras, cement, bricks, and so on. Again, it should be possible to ensure that the aviation and shipping industries pay an appropriate amount for the CO₂ emissions associated with journeys to and from the UK.

Although I believe that PCAs have many benefits, I am persuaded that the Kyoto2 proposals are probably better. Compared with PCAs, the Kyoto2 proposals have two main advantages:

- Since there are relatively few places where fossil fuels are extracted from the ground or imported into an area such as the UK or the EU, it should be relatively easy to apply controls at those places, compared with the administration involved in providing rations to millions of individual consumers.
- The money derived from the sale of carbon permits would go into a central fund which would be applied to provide support for conren and to pay for projects designed to provide protection from the effects of climate change. With PCAs, money derived from the sale of carbon allowances simply goes into the pockets of people who are selling the allowances, with no attempt to channel the money towards the mitigation of climate change or adaptation to it.

The two schemes are not mutually exclusive. In some countries or regions, there may be a case for using them together.

2.3 The need for international harmonization

Across the EU, 7 states are using an RO type of system of support for renewables, 18 states are using a FIT type of system and there are variants of both kinds of system. From the point of view of energy supply companies, many of which operate in many different countries, this is highly unsatisfactory. It adds to the complexity of assessing the economics of renewables across a range of member states and it adds to the cost of the administration that is associated with these schemes.

It would be advantageous if the systems of support for renewables were to be harmonized across the EU and, for reasons described in Section 3, there are good reasons to try to introduce a single system of support for all the countries of Europe, the Middle East and North Africa (EUMENA).

Since FITs have proved their worth in several different countries, since the RO system has been a relative failure, and since FITs are used in many more countries than are RO types of system, it would be best if all countries of EUMENA were to establish a uniform system of FITs.

3 Concentrating solar power and the DESERTEC concept

In his speech to the inaugural meeting of the Union for the Mediterranean in Paris on the 13th of July 2008, Gordon Brown said:

... in the Mediterranean region, concentrated solar power offers the prospect of an abundant low carbon energy source. Indeed, just as Britain's North Sea could be the Gulf of the future for offshore wind, so those sunnier countries represented here could become a vital source of future global energy by harnessing the power of the sun. So I am delighted that the EU is committing at this summit to work with its neighbours—including Egypt, Jordan, Morocco and the League of Arab States—to explore the development of a new 'Mediterranean Solar Plan' for the development and deployment of this vital technology from the Sahara northwards.

Despite this emphatic endorsement by the Prime Minister of concentrating solar power (CSP) and its potential, and despite the fact that it has now been endorsed by several other high-profile individuals and organizations,⁷ *there is no mention of it in stratcon.*

CSP in desert regions, coupled with transmission of electricity throughout EUMENA⁸ are key elements in the 'DESERTEC' concept developed by the 'TREC' group of scientists and engineers.⁹ Here are some of the reasons why these ideas are relevant to the UK and should be part of the UK's energy strategy:

- *The DESERTEC concept is credible.* It requires only proven technologies that are available now. The concept is backed by detailed research at the German Aerospace Centre (DLR), the US Department of Energy, and elsewhere.
- *The quantities of clean energy that are available are colossal.* Using CSP, less than 1% of the world's deserts could generate as much electricity as the world is now using.¹⁰
- Concentrating solar power (CSP) is *already* feeding electricity into the European transmission grid.¹¹ CSP plants are quick to build and capacity may be ramped up fast.
- *The UK may start to benefit from CSP quite soon.* It is not necessary to wait until the proposed HVDC Supergrid has been completed. The UK may receive solar imports indirectly via a 'cascading' principle using the existing transmission grid.¹² As the quantities of electricity increase, the existing transmission grid may be upgraded by removing bottlenecks, by introducing "FACTS" technologies, by converting existing HVAC lines to HVDC, and by building new HVDC transmission lines.¹³ The end

⁷ See <http://www.trec-uk.org.uk/endorsements.html>.

⁸ See Section 4.

⁹ A relatively short summary of the DESERTEC concept may be seen on <http://www.trec-uk.org.uk/index.htm>. There is an even shorter summary on http://www.trec-uk.org.uk/csp/in_brief.htm.

¹⁰ This calculation has been made by researchers at the DLR and has been confirmed to Gerry Wolff in a personal communication from Dr Franz Trieb, project manager for the TRANS-CSP and MED-CSP reports [TCSP2006 and MCSP2005].

¹¹ "PS10 solar power tower", Wikipedia, http://en.wikipedia.org/wiki/PS10_solar_power_tower.

¹² See http://www.trec-uk.org.uk/elec_eng/cascade.html.

¹³ See http://www.trec-uk.org.uk/elec_eng/kickstart.html.

result will be the creation of the Supergrid but the UK may start to benefit from CSP imports using the existing transmission network.

- CSP in desert regions can provide power that is clean, safe, plentiful, inexhaustible, globally distributed, technologically proven, quick to build, dispatchable (available on demand), not dependent on scarce materials or dwindling supplies of fuels, and with a good EROEI.¹⁴ *Few other sources of power have so many positive features.* A particular point is that CSP plants with heat storage and hybridisation with gas firing can deliver any combination of base-load power, intermediate load, and peaking power, and this flexibility can be a particular benefit in ironing out variations in supply and demand.
- Taking account of environmental and hidden costs, CSP is cheaper than nuclear power,¹⁵ it is probably already cheaper than electricity from “clean” coal¹⁶ and it is likely to become one of the cheapest sources of electricity throughout Europe.¹⁷ CSP costs are falling while the cost of electricity from fossil fuels and from nuclear power are both rising.
- Because the energy potential of deserts is so large, the DESERTEC scenario can increase the energy security of all countries around the world by helping to head off the worst effects of “peak oil,”¹⁸ “peak coal”¹⁹ and the anticipated “global grab for energy.” In the scenario for Europe up to 2050 proposed in the TRANS-CSP report from the DLR [TCSP2006], there would be an overall *reduction* in imported sources of energy and an *increase* in the diversity of sources of energy, with CSP imports providing only a part of Europe’s electricity. In this scenario, *the entire renewable energy supply system would be significantly more secure than what we have now.* There is more about security of energy supplies under the DESERTEC scenario at www.trec-uk.org.uk/csp/security.htm.

More information about the DESERTEC concept may be found on www.desertec.org and www.trec-uk.org.uk.

¹⁴ “Energy Return on Energy Invested”. The energy payback time for CSP plants is about 6 months.

¹⁵ When all the hidden costs are added in, nuclear power is one of the most expensive sources of electricity (see http://www.mng.org.uk/gh/no_nukes.htm).

¹⁶ Speaking about CSP at the Solar Power 2006 conference in California, US venture capitalist Vinod Khosla said “... we are poised for breakaway growth—for explosive growth—not because we are cleaner [than “clean” coal-fired electricity] but because we are cheaper. We happen to be cleaner incidentally.”

¹⁷ The TRANS-CSP report from the German Aerospace Centre (DLR) [TCSP2006] calculates that CSP in desert regions is likely to become one of the cheapest sources of electricity throughout Europe, *including the cost of transmission.*

¹⁸ “Steep decline in oil production brings risk of war and unrest, says new study”, The Guardian, 2007-10-22, <http://www.guardian.co.uk/business/2007/oct/22/oilandpetrol.news>. See also *The Last Oil Shock* by David Strahan, 2007, ISBN-13: 978-0719564239.

¹⁹ “Coal: bleak outlook for the black stuff,” David Strahan, *New Scientist*, 2008-01-19, pp 38-41.

3.1 Imports of renewable energy into the EU and the UK

Since the DESERTEC proposals involve imports of renewable energy into the EU, it is important to consider how this relates to the EU renewable energy target for each country in the EU. In that connection, stratcon says (para. 22):

A particular issue under discussion is whether trading with other EU member states or investment in renewable projects outside the EU should be allowed to count towards the target. The measures set out in this document relate to increasing renewable deployment in the UK. But because the cost of renewables projects in some other countries (both within and outside of the EU) are lower than the cost in the UK, allowing a specified and limited proportion of our target to be delivered abroad would make the task significantly less expensive – we estimate that trading one percentage point of the target could save 15 to 20% of the costs of meeting the target domestically, with a correspondingly lower impact on energy prices. Supporting the deployment of renewables outside the EU could also provide investment in clean energy technology in poorer countries. We want to hear your views about the extent to which we should seek to use such opportunities.

In relation to the issues raised in that paragraph, the TREC group is clear on two points:

- Renewable energy that is produced outside the EU and delivered to consumers that are *outside* the EU (eg wind energy in China) should *not* count towards any EU target for renewable energy.
- Renewable energy that is produced outside the EU and delivered to consumers *within* a given country within the EU *should* count towards the renewable energy target for that country.

I agree with both points. By extension, I believe it makes sense for renewable energy that is produced within one country within the EU and delivered to consumers in another country within the EU *should* count towards the renewable energy target for the country in which the consumers reside. Of course the trading of renewable energy between countries throughout the EU is implicit in the idea of a single European market for energy, something that is being strongly promoted by the European Commission and the UK government and is taking shape now.

3.2 Synthetic fuels

Given the enormous quantities of energy that may be captured from desert regions, there is potential for using some of it to create synthetic fuels. There is some brief discussion of the possibilities in Section 10.3. Further information may be found at www.trec-uk.org.uk/csp/synthesis.htm.

4 The Supergrid concept

Although stratcon contains a brief reference to the idea of building grid connections between offshore wind farms in UK waters to those in the seas of other countries within Europe, and to increasing the amount of interconnection between the UK grid and the European grid (para. 3.6.25) there is no recognition of the substantial benefits that may

accrue to the UK and other countries throughout the EU or EUMENA from building a large-scale HVDC Supergrid across the whole of the EU or EUMENA, as described in the TRANS-CSP report from the DLR [TCSP2006].²⁰ In that connection, EU energy commissioner Andris Piebalgs has endorsed Airtricity's proposal²¹ for a Europe-wide Supergrid composed entirely of submarine HVDC cables.^{22,23}

In general, the benefits of a transmission grid increase with the geographical spread of the grid. A relatively small grid such as the one that serves the UK can yield some useful benefits. But greater benefits may be obtained by the creation of a Supergrid across a larger region.

4.1 Benefits

The main benefits are:

- *Reduction of wastage.* If for example, the wind is blowing strongly in Scotland during the winter, producing more electricity than the local people can use, then in the absence of any economical system for bulk storage of electricity, that surplus energy is simply wasted unless it can be moved to places where it may be needed elsewhere in the UK, Europe or EUMENA.
- A large-scale transmission grid is needed to take advantage of the large amounts of energy that may be obtained from *large-scale but remote sources of renewable electricity* such as wave farms, offshore wind farms, tidal lagoons, tidal stream generators—and concentrating solar power!
- A related point is that a large-scale transmission grid can open up entirely new sources of energy that might not otherwise be considered. For example, there is potential to import geothermal energy from Iceland via a submarine HVDC transmission line.²⁴
- A grid that covers a large area like Europe or EUMENA can have a substantial impact in reducing the variability of energy sources such as the wind. The wind may stop blowing in any one spot but it is very rare for it to stop blowing everywhere across a wide area like Europe or EUMENA. Without a large-scale grid, it may be necessary to maintain conventional power stations on 'spinning reserve' to supply electricity at short notice if the wind drops, and this spinning reserve is wasteful.

²⁰ Other proposals for large-scale HVDC Supergrids are described on http://www.trec-uk.org.uk/elec_eng/grid.htm#large_scale_grids.

²¹ See http://www.airtricity.com/ireland/wind_farms/supergrid/offshore_supergrid_layout/.

²² See "EU's Piebalgs says grid infrastructure needed quickly for offshore wind energy", 2008-03-31, <http://www.forbes.com/markets/feeds/afx/2008/03/31/afx4833163.html>.

²³ Greenpeace Belgium and 3E have also proposed a "A north sea grid electricity grid [r]evolution", September 2008, [http://www.greenpeace.org/raw/content/eu-unit/press-centre/reports/A-North-Sea-electricity-grid-\(r\)evolution.pdf](http://www.greenpeace.org/raw/content/eu-unit/press-centre/reports/A-North-Sea-electricity-grid-(r)evolution.pdf).

²⁴ See "Iceland's hot rocks may be power source for UK" (Sunday Times, 2007-05-13, <http://www.timesonline.co.uk/tol/news/uk/article1782183.ece>).

- A large-scale transmission grid helps to reduce the amount of ‘plant margin’—the difference between actual generating capacity in any area and the theoretical minimum generating capacity—that is required. This is because a large-scale grid smoothes out much of the variability in electricity supply and demand and because spare generating capacity that is needed to meet contingencies can be shared across a relatively wide area, thus reducing the amount that is allocated to any one area.
- A related point is that *large-scale transmission grids help to ensure the security of electricity supplies in any one area*. This is because any shortage of supply or local peak in demand in any one country or area can almost always be met from one or more other countries or areas where there is spare capacity.
- The UK government and the European Commission wish to create a single European market for electricity (as we have in the UK), unbundling power generation from power transmission and promoting competition between different suppliers and sources of electricity. *A large-scale HVDC Supergrid is essential for the proper working of that single market.*
- *Optimisation of costs.* Transmission grids that cross time zones may increase the value of electricity by moving it, at any one time, from areas where it is cheap to areas where it will fetch a good price. More generally, large-scale grids allow customers to obtain electricity from wherever it is cheapest at any one time, and that may vary throughout each day.
- An HVDC Supergrid can help to stabilize frequencies and voltages in the HVAC grids to which it connects.
- *Export potential.* For a country like the UK, with its great potential for wind power, wave power, and power from tidal lagoons and tidal streams, an HVDC Supergrid would provide the means of exporting energy to the rest of Europe and EUMENA.

More information and discussion may be found on www.trec-uk.org.uk/elec_eng/grid.htm.

4.2 Costs

Some estimates for the cost of the DLR proposal for a EUMENA-wide HVDC Supergrid are given on www.trec-uk.org.uk/csp/costs.htm#hvdc_costs, together with some figures for the costs of some other things that governments spend money on. Bearing in mind that the cost of the Supergrid would be shared amongst many countries and would be spread over a few years, its cost is small, it is certainly affordable, and it would be excellent value in terms of the benefits it would deliver.

The substantial economic benefits of large-scale transmission grids are described in *Interstate transmission superhighways: paving the way to a low-carbon future* (RenewableEnergyWorld.com, 2008-07-30).²⁵

²⁵ See <http://www.renewableenergyworld.com/rea/news/story?id=53193>.

4.3 Timescales

The entire UK rail network, which was originally much larger than it is now, was built in the 20 years between 1830 and 1850 using little more than picks and shovels.

The HVDC Supergrid throughout EUMENA is a large project but it requires substantially less engineering than the UK rail network as it was in the 19th century. And there are many modern aids to construction that were not available then. With the right political impetus, there is every reason to believe that the Supergrid could be put in place within 10 years.

Planning issues could cause delays but there are several options for minimising or eliminating the visual impact of new transmission lines and thus smoothing the path for those developments.²⁶

4.4 Create a single market for electricity throughout EUMENA or Europe

An important adjunct to the creation of a Supergrid is the creation of a single market for electricity throughout EUMENA (best) or Europe (a good second-best). The single market provides the means of realising the full potential of the Supergrid, and the Supergrid is needed to allow the single market to function effectively.

The creation of a single market for electricity throughout EUMENA means unbundling power generation from power transmission. It should be possible for any customer in EUMENA to buy solar power from any supplier throughout the region in the same way that anyone in the UK can buy electricity from any UK supplier.

Both the British Government and the European Commission are in favour of this kind of development within the EU. But there is some resistance from commercial interests that currently enjoy monopolistic benefits from the vertical integration of power generation with power transmission.

5 Variability in electricity supplies and electricity demands

Para. 50 of stratcon says:

We would like to hear your views on the potential impacts that a large increase in renewable deployment might have on the electricity generating market. One important area is the relationship between renewable and fossil fuel plants. The intermittency and variability of wind and some other renewable generation will have implications for the rest of the electricity generating fleet, as well as presenting challenges to the system operator in the vital task of ensuring instantaneous balance on the national grid. Our initial analysis suggests that these challenges can be met through back-up generation from fossil fuel plants. Even though meeting the European target would mean a large share for renewable generation in the UK electricity mix, the need for back-up plants, along with the large numbers of conventional plants due to close in the next two decades, means that the next decade

²⁶ See http://www.trec-uk.org.uk/elec_eng/hvdc_impact.html.

will also require considerable new build of fossil fuel generation. On these assumptions, including the impact of new measures to meet the renewables target, we would expect to need over 45 GW new generating capacity by 2020 – of which around 30 GW will be renewable.

I believe there are two basic misunderstandings here:

- There is an implicit assumption that intermittency is a feature that is associated with wind power and other renewables but that fossil fuel plants operate around the clock for 365 days of every year. The truth is that *all* sources of power are intermittent. Load factors or capacity factors of all kinds of power station are always less than 100% and often by a large margin. Coal-fired power stations (and nuclear power stations) need to be shut down from time to time for scheduled maintenance and, like all kinds of equipment, they may suffer from unanticipated failures. Such unscheduled outages can be disproportionately disruptive because those kinds of power plants are normally quite large so that it can be difficult to find alternative sources of power at short notice when they fail.
- The demand for electricity fluctuates wildly, often from minute to minute—something that is barely mentioned in stratcon. The problem of the variability in the demand for electricity is not met by building coal-fired power stations because they are an inflexible sources of power that cannot respond quickly to peaks in demand.

In general, there is a problem of matching variable sources of electricity with variable demands. Although para. 52 mentions some of the techniques that are available for balancing supply and demand, there is quite a lot more than can be said on that subject (see www.trec-uk.org.uk/elec_eng/supply_demand.html). In particular, large-scale transmission grids, as discussed in Section 4, can largely overcome the supposed problem of intermittency in wind power,²⁷ and likewise for the variability of demands for electricity. It is also pertinent to point out that CSP plants with heat storage and hybridisation with gas firing can provide any combination of base load, intermediate load and peaking power and can consequently be a valuable aid to smoothing out peaks and troughs in the supply and demand for electricity.

In para. 3.9.10, stratcon says:

With a good dispersion of wind turbines, the variability of wind output over the UK as a whole can be expected to be smoother than output from any individual site or region. Nevertheless, the intermittent nature of wind power in particular will require new more dynamic ways of operating the network, and back-up generating capacity to maintain current levels of system reliability.

What is missing here is any recognition of the much-enhanced smoothing effect of a large-scale Supergrid covering a much larger area than the UK, and how the Supergrid,

²⁷ This is one of the central planks in the argument for Airtricity's proposal for a Europe-wide HVDC Supergrid composed entirely of submarine power cables (see), a proposal that has been strongly endorsed by EU Energy Commissioner, Andris Piebalgs (see <http://www.forbes.com/markets/feeds/afx/2008/03/31/afx4833163.html>).

together with other load-balancing technologies, may greatly reduce the need for backup generating capacity.

6 Zero-carbon eco-renovation

What is conspicuously missing from stratcon is any recognition of the great potential for saving energy and reducing emissions of CO₂ that may be achieved by upgrading existing buildings. There are occasional references in stratcon to the need for loft insulation or cavity-wall insulation but no recognition of the very large savings that may be achieved by the much more ambitious measures that are described below. This really is the “low hanging fruit” of energy conservation and the cutting of emissions of CO₂ in the UK, and it should be much more prominent in the UK’s energy strategy.²⁸

It is possible that these matters will be considered in the forthcoming consultations on energy savings, mentioned in paragraphs 28 and 2.3.6 but, since stratcon contains a chapter on “Saving Energy” (Chapter 2), the potential for upgrading existing buildings should be much more clearly recognized.

Housing accounts for about 28% of UK emissions of CO₂.²⁹ If we include non-residential buildings as well, the proportion is even higher. *But it is inconceivable that we would tear down the entire UK stock of buildings and replace them with zero-carbon buildings. And relying on the normal replacement rate would be far too slow.* Consequently, there is a need for a vigorous programme to upgrade existing buildings, aiming to reduce their emissions to zero or nearly so.

Contrary to the rather pessimistic conclusions of the “40% House” report (ECI2005) which are echoed in para 4.7.1 of stratcon, I believe that it should be possible to upgrade the great majority of buildings in the UK to a level comparable with a German “Passivhaus”³⁰ standard so that little or no heating is required. *If the much-reduced needs for heating are supplied via such things as solar water heaters and ground-source heat pumps powered by green electricity, then it should be possible to achieve zero emissions of CO₂ or nearly so.*

I believe that this kind of zero-carbon eco-renovation can be achieved by using existing techniques.³¹ Of these, the most important are likely to be:

- Eliminating air leaks.
- Ventilation by means of heat exchangers, keeping air fresh but conserving heat.
- Triple glazing of windows using low emission glass.

²⁸ I welcome the recently-announced “Home Energy Saving Programme” (see <http://www.guardian.co.uk/politics/2008/sep/11/energy.energyefficiency>) but I believe that a lot more needs to be done.

²⁹ “Carbon dioxide emissions by end user: 1970-2004”, DEFRA, <http://www.defra.gov.uk/environment/statistics/globalatmos/kf/gakf07.htm>.

³⁰ See, for example, <http://www.passivhaus.org.uk/> and <http://www.passiv.de/>.

³¹ See, for example, BRE2005.

- *Super-insulation of roofs, walls and the ground floor at levels far in excess of the kind of cavity wall insulation that is currently used.* For a variety of reasons this is likely to mean external cladding. The thicknesses of insulation required are likely to be large, perhaps even as much as 1 metre!

Some attempts have been made to upgrade existing buildings along these lines³² but it is likely that significantly more can be achieved. **The potential of super-insulation and zero-carbon eco-renovation of existing buildings has simply not been explored with anything like the vigour and thoroughness that it deserves.** There is a pressing need for much more research into what can be done with existing buildings and for **a series of *Zero-Carbon Eco-Renovation Demonstrators***, showing what can be achieved with different kinds of building: traditional bungalow, 1960s tower block, terrace house, suburban semi, etc.

The T-Zero project³³ seems to be moving in this direction. The “BRE Victorian house of the future”³⁴ is the kind of demonstrator project I have in mind. Projects like these need to be greatly expanded.

It appears that Germany is already engaged in a programme of eco-renovation, much as I have described. Further discussion of zero-carbon eco-renovation may be found on www.mng.org.uk/gh/ecorenovation.htm.

6.1 Steps to take

Here are some of the things that can be done to bring things forward:

- As previously mentioned, there is a need for a vigorous programme of research into what can be done to achieve zero-carbon eco-renovation with a variety of types of building together with the creation of a series of **demonstrators** of what has been learned.
- Since the appearance of many buildings may be substantially improved by well-designed external cladding, especially the many ugly office buildings that were erected in the 1960s, some interesting results may be achieved by establishing a competition for architects to create designs for the upgrading of one or more identified ugly buildings to reduce CO₂ emissions to zero and to improve the appearance of the building at the same time. For each building, the winning entry may be applied to the building itself.
- Since external cladding is likely to change the appearance of buildings (as just mentioned, not necessarily for the worse), changes in planning law will probably be needed to permit this kind of upgrading, with the possible exception of buildings with great historical or aesthetic significance.

³² See, for example, the Nottingham Ecohome (<http://www.msarch.co.uk/ecohome/>) and the Yellow House (<http://www.theyellowhouse.org.uk/>).

³³ “Towards zero emissions refurbishment options in UK housing”, funded by DBERR, <http://www.bre.co.uk/page.jsp?id=825>.

³⁴ <http://www.bre.co.uk/newsdetails.jsp?id=397>.

- For householders and the owners or managers of public buildings, a proper price for CO₂ emissions and the rising prices of fossil fuels may provide sufficient incentive to do the necessary upgrades. However, there may also be a need for some system of loans to enable people to spread the cost over several years. And it is possible that additional incentives may be needed in the form of grants, tax breaks or low interest rates on loans.
- There will also be a need for good information, training courses and the like to raise the levels of awareness and skills amongst installers, householders and other interested parties.

6.2 Saving gas

A useful bonus from a programme of zero-carbon eco-renovation is that, since most buildings in the UK are heated with gas, a programme of zero-carbon eco-renovation can go a long way to reducing UK consumption of gas and can reduce the need to import supplies of gas from possibly unreliable sources abroad.

This would also be a major benefit to householders throughout the UK, especially people on low incomes, many of whom have been badly hit by recent rises in the cost of heating fuels and electricity and are vulnerable to further price rises in the future.

7 Maintaining an integrated view of energy supplies and conservation

Although stratcon contains a chapter about saving energy, it appears that the main focus on energy saving will be in the forthcoming consultations mentioned in paragraphs 28 and 2.3.6.

It is understandable that conren should be divided into sub-tasks in this way but there is a danger that too much compartmentalisation of conren will lead to sub-optimal solutions or that entire classes of solutions will be missed. Also, it would have been preferable if the consultation on energy saving had been conducted *before* the consultation on renewable energy because good solutions in the first area can make a big difference to the problems to be solved in the second area and how those problems may be solved.

The next two subsections briefly consider two examples where those principles seem to apply.

7.1 The potential impact of energy saving on the need for renewable heat

Although para. 15 of stratcon says “Achievement of the target will ... depend on the extent to which we can reduce overall energy demand.” and “... the starting point for our Renewable Energy Strategy is energy saving.”—with similar remarks elsewhere in the document—these principles seem to have been overlooked in what stratcon has to say about renewable heat. For example:

- The preamble to the Executive Summary refers to the possibility of “introducing a new financial incentive mechanism to encourage a very large increase in renewable heat.”
- Para. 52 says “Heating accounts for the largest single proportion of the UK’s final energy demand at approximately 49%, and also the largest proportion of our carbon emissions at 47%. Increasing renewable heat is therefore crucial for delivering the UK target. ...”
- Para. 54 says “we would like to hear your views on how to increase renewable heat generation in the UK.”

And so on.

What seems to have been overlooked is the possibility that super-insulation and other measures, as described in Section 6, might altogether eliminate the need for any “very large increase in renewable heat” and then the issue might no longer be so “crucial”.

By considering energy saving and renewable energy together rather than separately, a whole class of problems may be sidestepped.

7.2 Eco-renovation and electricity supplies

Quite a lot of publicity has been given to the idea that “the lights will go out” unless we build nuclear power stations or coal-fired power stations. But a recent analysis shows that projected increases in the provision of renewable sources of power in the UK will ensure that there is enough electricity to meet our needs [POYRY2008]. Nevertheless, it makes sense to consider how the security of UK power supplies may be maintained in the case of unforeseen hiccups in developments.

This is where a consideration of energy saving in the same frame as power generation can provide the UK with a useful strategy to cut CO₂ emissions and, at the same time, to ensure that the lights do not go out:

- Since gas is the dominant fuel for space heating in the UK, a vigorous programme of “zero-carbon eco-renovation” of existing buildings, as described in Section 6, should mean substantial savings in the UK’s consumption of gas.
- If there is any shortfall in electricity supplies, some of the gas that has been saved in this way may be used for generating electricity. Since gas-fired power stations are relatively simple and quick to build, and since it is likely that there would be some advance warning of possible problems, there should be no difficulty in ensuring that the lights will stay on.
- Naturally, any gas that is used in that way should be burned in combined-heat-and-power units (CHP) to make maximum use of waste heat from electricity generation.

What I have just described is very much a backup strategy. There is every reason to believe that, with the right policies in place, the UK can make a decisive move towards

conren and away from non-renewable sources of power—and it can keep the lights on at the same time.³⁵

8 Enhanced Geothermal Systems (EGS)

Enhanced Geothermal Systems (EGS)—which should not be confused with ground-source heat pumps—are a source of renewable energy that has great potential but is not well known. *Although EGS may be applied in many places around the world, including the UK, it receives no mention in stratcon.*

The basic idea is to extract heat from hot rocks in the earth’s crust and use it to raise steam to drive generators and turbines, just like a conventional power station. This can be done most easily in places like Iceland where hot rocks are close to the surface. But a report from the Massachusetts Institute of Technology [MIT2006] describes how, using drilling technologies developed for the oil and gas industries, it is possible to extract geothermal heat from depths up to 10 km. This opens up a much wider range of locations where the energy from hot rocks may be used.

The report says “By evaluating an extensive database of bottom-hole temperature and regional geologic data (rock types, stress levels, surface temperatures, etc.), we have estimated the total EGS resource base [in the US] to be more than 13 million exajoules (EJ). Using reasonable assumptions regarding how heat would be mined from stimulated EGS reservoirs, we also estimated the extractable portion to exceed 200,000 EJ or about 2,000 times the annual consumption of primary energy in the United States in 2005. With technology improvements, the economically extractable amount of useful energy could increase by a factor of 10 or more, thus making EGS sustainable for centuries.” (section 1-4).

Not only is the resource very large but, like CSP, geothermal power has the attraction that it can deliver electricity that is dispatchable.

This source of clean electricity is expanding rapidly in Germany³⁶ and Google have now committed \$10.25 million to the development of EGS.³⁷ In view of these developments and the very positive findings of the MIT study, and since earlier studies of EGS in the UK were done in the days when fossil fuels were cheap and there was much less concern about CO₂ emissions, *it appears that the time is now ripe for a thorough re-evaluation of the potential of EGS in all parts of the UK and not only in places like Cornwall that have been studied previously.*

9 Security of energy supplies

Quite rightly, stratcon emphasises the need for security of energy supplies. What I have said in this document has a bearing on this issue in four main areas. To summarise:

³⁵ See <http://www.mng.org.uk/gh/energy.htm>.

³⁶ See “Geothermal electricity booming in Germany” (RenewableEnergyWorld.com, 2008-06-02, <http://www.renewableenergyworld.com/rea/news/story?id=52588>).

³⁷ See “Google’s earth heats up” (CarbonFree, 2008-09-03, <http://www.carbonfree.co.uk/cf/news/wk36-08-0003.htm>).

- At first sight, the idea of importing solar electricity from the Middle East and North Africa (as proposed in the DESERTEC scenario described in Section 3) may seem to represent a security risk. However, there are good reasons to believe that any such risk is more apparent than real. In the scenario described in the TRANS-CSP report from the DLR [TCSP2006], there would be an overall *reduction* in imports of energy into Europe, an *increase* in the diversity of sources of energy in Europe, and there would be a corresponding *increase* in the security of energy supplies throughout Europe, as compared with the energy regime that has been in place for decades. The several reasons in support of this conclusion are described in www.trec-uk.org.uk/csp/security.htm.
- As was described in Section 4, the development of a large-scale HVDC Supergrid throughout Europe or EUMENA would increase the security of electricity supplies for everyone in the region. This is because any temporary local shortfall in electricity supplies in any one area can almost always be met by the transmission of electricity from one or more other places on the grid where there is spare capacity.
- As was mentioned in Section 6.2, a nation-wide programme of zero-carbon eco-renovation of existing buildings, as described in Section 6, would mean increased security of energy supplies in the UK by reducing the need to import gas from possibly unreliable sources abroad. It may also add to the security of electricity supplies, as described in Section 7.2.
- If EGS fulfills its promise in the UK, it would add to the diversity of sources of renewable electricity and make a worthwhile contribution to the security of UK energy supplies.

10 Transport

In this section, I make a few points relating to what has been said in stratcon about the development of renewable forms of energy for transport.

10.1 Electrification of overland transport

As it says in stratcon, “vehicles powered through the electricity grid using renewable energy may have a growing part to play.”³⁸ and there would be useful benefits in terms of reductions in noise pollution and improvements in air quality.

Given the truly monumental quantities of electricity that may be generated in deserts (Section 3) and the very substantial quantities of renewable electricity that may be generated from other sources,³⁹ there is considerable scope for powering trains and road vehicles with clean electricity.

As can be seen from the following calculations, to replace fossil fuels in overland transport with renewable electricity would require less than 50% more electricity than we currently use.

³⁸ From the summary of stratcon’s Chapter 6.

³⁹ See <http://www.mng.org.uk/gh/energy.htm>.

In 2005, the quantities of energy consumed in transport by road and rail were as shown in the following table:⁴⁰

Type of transport	1000s TOE ⁴¹	TWh
Road		
Cars	26834	312
Freight	15501	180
Rail		
Electric	740	9
Fossil fuels	869	10
Total	43944	511

To simplify the calculations, I shall focus on the $312 + 180 = 492$ TWh of energy used for road transport and ignore the relatively small amounts of energy used for rail.

If the whole of road transport was electrified, then at first sight, the UK would need an additional 492 TWh of electricity, over and above the 407 TWh that was used in 2005.⁴² But batteries and electric motors are relatively efficient:

- “The coulometric charging efficiency of nickel metal hydride batteries is typically 66%, meaning that you must put 150 amp hours into the battery for every 100 amp hours you get out.”⁴³
- “Electric motors often achieve 90% conversion efficiency over the full range of speeds and power output and can be precisely controlled.”⁴⁴

If we take those two figures as representative, the overall efficiency of an electric vehicle would be about 90% of 66% or 59% overall, ignoring losses of energy elsewhere in the vehicle. By contrast, the efficiency of an internal combustion engine is normally about 20%.⁴⁵

With our current road transport system, based almost exclusively on the internal combustion engine, the useful energy obtained from an input of 492 TWh will be about $492 \times 0.2 = 98.4$ TWh. To obtain this amount of useful energy from electric vehicles with an efficiency of 59% would require $98.4 \times 100/59 = 166.8$ TWh of electricity. This is less than 50% of the 407 TWh that we currently use.

⁴⁰ From “Table 2.1. Transport energy consumption by type of transport and fuel, 1970 to 2005”, Department of Trade and Industry statistics, <http://www.dti.gov.uk/energy/statistics/publications/ecuk/transport/page18043.html> .

⁴¹ Tons of Oil Equivalent.

⁴² The latter figure is from DBERR2006a, p 114.

⁴³ <http://www.powerstream.com/NiMH.htm>.

⁴⁴ Wikipedia, “Fuel efficiency in transportation”, 2007-06-24.

⁴⁵ Wikipedia, “Internal combustion engine”, 2007-06-24.

10.2 Organisation of overland transport

Trains have been powered by electricity for many years and the technology is mature, but battery technologies are not yet good enough to give electric vehicles the range and convenience that we are used to with petrol and diesel power. However, there are several ways of dealing with this problem until such time as battery technologies improve:

- Plug-in hybrid electric vehicles (PHEVs) are a good compromise that can provide much greater range than all-electric vehicles.
- Given that the electricity distribution network is already well-developed, it should be relatively cheap and easy to provide charging points for vehicles at car parks, fuel stations and the like.
- We may move to a pattern of using electric vehicles for shorter distances and trains and ships for longer distances.
- Greater use may be made of shipping along the east and west coasts of the UK to move heavy or bulky goods.

10.3 Synthetic fuels

A topic that seems not to be mentioned anywhere in stratcon is the possibility of creating synthetic fuels from renewable sources of energy. These could be useful for transport by road and rail, but they could be more significant in providing the means of weaning the aviation industry off its heavy dependence on fossil-derived aviation fuels.⁴⁶

To repeat a point that has been made more than once already, the quantities of energy that are available from desert regions are enormous (Section 3). As was mentioned in Section 3.2, there is considerable scope for using this energy to create synthetic fuels. For example, hydrogen may be generated by the electrolysis of water using solar electricity and there is potential to create it by direct thermal cracking of water in CSP plants. There is also potential for the synthesis of hydrocarbons using the solar heat of CSP plants. These are matters that require more research.

There is some discussion of these possibilities, and pointers to relevant sources of information at www.trec-uk.org.uk/csp/synthesis.htm.

10.4 Shipping

Wind has been the main source of power for shipping for thousands of years and it can be so again. The advantage that we have now is that there is great scope for the use of modern technologies, as in the proposed 'Orcelle' cargo ship.⁴⁷ There is also scope for radical new possibilities such as the SkySails system,⁴⁸ as is mentioned in stratcon (para. 6.4.15).

Synthetic fuels (Section 10.3) would also be useful in decarbonising the shipping industry.

⁴⁶ Even if aircraft can be powered without any net emissions of CO₂, there may still be problems arising from the fact that jet engines release other greenhouse gases into the atmosphere, often at altitudes where their effects are disproportionately damaging.

⁴⁷ See, for example, <http://www.rense.com/general63/sea.htm>.

⁴⁸ See <http://www.skysails.info/index.php?L=1>.

10.5 Public transport, bikes and feet

Public transport by buses and trains is generally much more fuel-efficient than cars and should be encouraged.

Walking and cycling should also be encouraged. In particular, *there is a pressing need for a comprehensive nation-wide network of traffic-free routes for walkers and cyclists, to bring things up to the standards that have been enjoyed for many years in countries like Germany and Holland.* The Sustrans charity⁴⁹ is building a national network but this important work would be greatly accelerated if a small portion of the £13bn that the Government is spending on roads⁵⁰ were transferred to the building of traffic-free routes for walkers and cyclists.

11 Conclusion

There is much to commend in the consultation document but I believe the UK's strategy for renewable energy could be improved by a greater emphasis on the need for simplicity and transparency in systems to encourage energy saving and renewable energy, by considering those two things together rather than separately, by widening the geographical scope of the strategy, and by including the several possibilities described in this document that have not so far been incorporated in the strategy.

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⁴⁹ See <http://www.sustrans.org.uk/>.

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