ANNEX E

Renewable Grid Issues

New investment in networks will be needed to accommodate greater levels of renewable generation

1. New, large renewable plants are likely to connect into the transmission network, particularly in Scotland where the 132kV system is categorised as transmission. Because of the geographical concentration of wind resource in Great Britain, there are likely to be complex connection issues accommodating large amounts of wind generation, in particular. Substantial increases in wind generation will therefore require parallel developments in transmission infrastructure.

2. The Government has long recognised these issues. DTI published the RETS study in June 2003 and RETS Revisited in November 2005. Ofgem also published a report between price reviews in December 2004 (Transmission Investment for Renewable Generation) that approved funding for over £560m capital expenditure, including the upgrading of the Beauly-Denny line. These upgrades could allow the connection of a further 6.3GW in Scotland, of which 1.5GW has already been consented and installed.

3. The Government also recognises that planning approval for new overhead lines will be increasingly required if renewable generation is to continue growing (see Chapter 7). In the past, approval has sometimes proven to be problematic and this is likely to be the case if the status quo remains. Increased uncertainty, risk and therefore cost can all influence developers' investment decisions.

Grid requirements will be specific to particular regions based on available wind resource, existing capacity and location within the system[1]

4. The need for new transmission capacity is determined using the criteria stated in the SQSS which was developed prior to the increase of intermittent sources. Work is currently underway to raise the capacity on the transmission network linking England and Scotland. Longer term it is possible that existing capacity may need to be doubled – provided it is efficient and economic to do so – through construction of two new major onshore or offshore links. This would allow a further 6 – 8GW of capacity. Additional generation could require substantial further reinforcement dependent upon the size and location of the new generation and any changes to existing generation and demand in the region.

1 Figures are supplied by National Grid and should be considered as broad estimates. No detailed studies have been undertaken to inform this work.

5. In northwest England there is currently very little network capacity available for new generation without significant reinforcement. Work is underway at Heysham that will allow an extra 1GW of renewable capacity, at a cost of £75m. Additional generation of around 2GW, either in the local area or in Scotland, will require reinforcements near to Penwortham and the Mersey Ring at a further cost of around £275m. The transmission network around the Thames Estuary and The Wash is currently heavily congested. National Grid believe that substantial upgrading will be required to accommodate the significant, predicted amounts of demand for capacity, around 3GW, in The Wash and in the Thames Estuary at a cost of around £600m. These very indicative figures are summarised below and show which costs are potentially significant.

Table E1: Potential costs to accommodate additional renewable generation

Area	Cost (£m)	Additional capacity (GW)	Cost per GW (£m)
NW England	75	1	75
NW England	275	2	137
Scotland	375	4-5	75-94
Wash/Thames	600	3	200
Scotland	1,000-2,000	6-8	125-333
TOTAL	**2,325-3,325**	**16-19**	**145-175**

It should be noted that these costs are not based on firm analysis. Further independent and detailed appraisal would be required before any approval for funding.

Transmission upgrades alone may not be sufficient to ensure continued growth in large-scale renewable generation

6. The Government is aware of a number of significant and pressing issues that need resolution in the context of the 2010 renewable energy target. These include current Final Sums Liability (FSL) arrangements and the "queue" created by the confluence of the Government's renewable targets, the Renewable Incentive Scheme and transitional arrangements for BETTA, given the lack of excess capacity and the time required to consent and build new transmission capacity. Resolution of these issues is imperative for the potential of renewables to be maximised and targets achieved. Ofgem and National Grid are working to resolve these issues. It is crucial that this progresses to a satisfactory conclusion.

Should renewable generation pay only a proportion of the Transmission Use of System charges paid by conventional generation?

7. All generation connected to the transmission system is required to pay charges according to investment cost reflective pricing principles – the greater the cost impact to the network the higher the transmission charge. These TNUoS charges are therefore inextricably linked to the future cost of network investment, largely defined by transmission companies' planning investment criteria.

8. Work sponsored by the DTI suggests that renewable generation may drive the need for transmission reinforcement to a lesser degree than conventional generation – which implies transmission charges should be lowered. There are two main reasons why this may be the case. First, the contribution of renewable generation to security of supply is potentially very different from conventional generation (expanded below). Although wind generation may displace energy produced by conventional plant, its ability to displace conventional network *capacity* is limited even at substantial penetrations, due to its variability. (At the low penetrations we currently have, supply displacement is similar to that of capacity displacement.) Therefore, the need for transmission network capacity to enable wind generation to contribute to security of supply would be less than conventional plant.

9. Second, when calculating the proportion of the utilisation of transmission capacity by wind and conventional plant, during peak-flow condition on a probabilistic basis, wind occupies less transmission due to its low load factors (around 35%). Wind occupies the same capacity when generating but is less likely to be operating at peak.

10. Other work (forthcoming from National Grid) suggests that network investment costs of variable and conventional generation are similar. What is agreed is that transmission charges should be cost reflective. If it can be categorically shown that classes of generation (including renewables) are not paying an amount equal to the costs they impose on the system, the TNUoS charge should be adjusted appropriately. Alternatively if preferential treatment were given for renewables this should be made explicit and the cross-subsidy justified.

11. The Government notes that there is currently a review of the GB Security and Quality of Supply Standard (SQSS) and work underway by National Grid on Condition 3 with regard to treating intermittent generation, both of which have an impact on this issue. The Government supports this work and the current transmission charging methodology principle of cost reflectivity.

Do current transmission reinforcement and connection standards have potential to overstate necessary investment requirements for renewable generation?

12. National Grid's transmission investment standards are designed to ensure a safe and secure transmission network under a wide range of contingencies. A report sponsored by the DTI shows that application of these standards could be inappropriate in the case of renewables. There may exist the potential for the system to be "over-engineered" in some instances[2].

13. Less reinforcement may be required for renewable generation because wind (or marine) is variable, has low utilisation compared with most conventional plant and therefore makes less contribution to ensuring that winter peak demands can be met reliably. Currently, the transmission companies' investment standards take only partial account of this, leading to the possibility of transmission reinforcements being overestimated and charges too high.

14. The Government is aware of a review of the SQSS by National Grid, and a technical sub-group has been set up by DTI/Ofgem to assist with decisions relating to offshore transmission system security requirements.

Does transmission access policy cause unnecessary delays in connection?

15. Transmission reinforcements are currently required to be in place before renewable generation can connect and capacity allocated – "invest then connect". This, together with the particular application of the transmission companies' network planning standards, results in a transmission system designed to handle the output of both conventional and renewable generation simultaneously. The invest and connect regime means that a party wishing to connect to the system must often wait until necessary reinforcements are complete which can lead to projects being given connection dates later than when their generation development is complete.

16. This policy would be justified if renewable generation contributed to overall system security to the same extent as conventional. The role of renewable generation is not primarily to contribute to system security, but to displace the output of conventional fossil-fuel generation. In a future system with significant amounts of renewable generation, it will not be possible for all renewable and conventional generation to operate simultaneously. Nuclear and some conventional generation operates at base load and renewable generation operates whenever its primary "fuel" is available to displace fossil fuels and reduce carbon emissions. Some conventional fossil-fired generation will increasingly adopt a regulating role, operating when the availability of renewable energy is low and reducing its output to accommodate increases in output of renewable generators.

2 Centre for Distributed Generation and Sustainable Energy, "Transmission Planning and Operational Standards with Intermittent Generation".

17. This mode of operation suggests that, rather than designing the transmission system on today's "invest and connect" basis, it could be designed to "connect and manage", with renewable and conventional generation "sharing" transmission access.

18. In this situation, transmission access could be granted at an earlier – fixed – point (e.g. a number of years after application or after consents received). These options were discussed in a recent access reform report by Ofgem[3]. From the point of connection the consequences of accommodating the generation would need to be managed by the system operator. There may be some increased costs from balancing the system through constraining-off generators and contracting for reserve services. The constraint costs could be significant and would need to be assessed in developing this approach.

19. The connect and manage approach may also increase competition and allow a greater volume of renewable generation to connect. It is estimated that it could advance the connection of up to 2GW of renewable generation by between 2 and 3 years. System security would not be compromised – an excess of generation capacity would exist, managed by constraining conventional generation whenever necessary.

20. A "connect and manage" approach could also release the hidden "non-firm" capacity of the transmission system. This capacity arises because of the premise underpinning the design of the transmission system – that security should not be compromised in the event of the worst credible transmission fault.

21. These fault conditions, while onerous, are extremely infrequent and consequently Transmission capacity normally operates at relatively low utilisation. Resulting non-firm capacity could be utilised provided adequate means of recovery were in place to respond to the occurrence of a credible fault, such as arrangements for automatic generator disconnection. The variable output and low load-factor characteristics of renewable generation are well suited to the utilisation of non-firm capacity.

22. Given the recent introduction of BETTA we are not advocating a fundamental review of the operation of the market. However, with the Review's mandate to look at long-term issues renewable generation grows as a proportion of the total, some conventional plant will have very low load factors. The market needs to ensure arrangements are in place to ensure the necessary reserve is maintained. This issue has been picked up elsewhere within the Review.

3 Access Reform in Electricity Transmission: *Working group report and next steps, May 2006* (Ref No. 83/06a) and *A framework for considering reforms to how generators gain access to the GB electricity transmission system: A report by the Access Reform Options Development Group April 2006, May 2006 (Ref No. 83/06b)*, both available at www.ofgem.gov.uk

More research into managing variability and capacity contribution of renewable generation seems useful

23. A recent UKERC report "Costs and Impacts of Intermittency" concluded that the likely cost of additional electricity balancing services required to manage the variability of renewable sources, should such sources reach ~20% of supply, was in the range 0.2 – 0.3p/kWh of wind output (0.5 – 0.8 p/kWh in total). Smeared across all generation the burden on consumers would be about 0.1 – 0.5 p/kWh. These costs suggest an increase in domestic electricity bills of around 1%. Under a connect and manage approach, constraint costs could also be significant, depending on the detail of the approach adopted and this would need to be evaluated.

24. The UKERC report implies some important issues for policymakers. It would be helpful for the effect of intermittent generation to be better monitored in the future and the effectiveness of market mechanisms in delivering adequate system margin should be kept under review.

25. While not high, the costs of intermittency could be expected to increase with penetration of renewables above 20%. Furthermore, there appear to be ways to mitigate these costs through technologies such as "dynamic demand" which would provide a responsiveness of electricity demand to variations in system frequency, or the increased application of electricity storage. In turn: dynamic demand includes such possibilities as appliances that can vary their load with frequency (imbalances in generation and demand result in changes in system frequency), reducing the need to carry spinning reserves; developments in storage would allow excess energy during windy periods to be stored and released during periods of calm.

26. The Government accepts that further research into technical and commercial issues may be useful here. Areas include the impact of clustering in a UK context, adequacy of current reliability criteria and the extent to which market intervention may be required to ensure the availability of adequate levels of conventional generation. These were identified in the draft ESTISG Report, issued by the DTI in November last year and are the subject of a proposal for funding by the Centre for Distributed Generation and Sustainable Electrical Networks.