

Proposals Toward a Future UK Renewable Industry

"Energy is The Power to Make Us Do Things"

(Alexander Age 5)

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1 Executive Summary

The UK has the best wind and wave Energy resources in Europe, the wave energy market alone could be as much as £2billion per year. UK policy has failed to develop an indigenous renewable industry and will rely on the import of around £2billion of wind turbine equipment from countries such as Denmark and Germany to meet its Renewable Energy obligations.

The UK must accept that it is unlikely to develop an indigenous large wind turbine industry in the near future, although smaller wind turbines like other technology would provide a significant market. Longer term, an indigenous UK wind industry would allow us to capitalise on changes in technology and allow us to capture some of the large wind turbine market.

Although present policy provides both direct price support in the market and funding for Research & Development, it leaves a gap in funding at a key stage in development that prevents new technology reaching commercialisation. The lack of an indigenous UK industry, the hole in the market at a key generator size and the high entrepreneurial risk, mean that there is no intra-company funding to support development through the initial rollout of technology to the field. This together with institutional barriers to grid connection within the electricity industry and the uncertainties of planning, create an insurmountable barrier to both company and technological growth.

To remove this barrier, market support must be provided for renewable equipment in the size range 10kW to 100kW (and wave perhaps to 500kW) via schemes such as community net-metering. Also government must act to remove institutional barriers and develop a planning framework and clear guidelines for renewables.

The Highlands and Islands is a key area for the uptake of this technology and these communities could benefit from smaller renewables systems. Capital grants would help the uptake in this area.

The Renewable Obligation will create a chaotic market that hits smaller generators up to 37MW. This financial uncertainty will discourage new technology projects. Government must provide a mechanism to stabilise prices for smaller generators such as guaranteeing the purchase of Renewable Obligation Certificates.

Bridging the policy gap is estimated to cost at most £10million/year most of which could be obtained without additional burden on government.

2 Introduction

The UK has the best wind and wave Energy resources in Europe. Much is untapped and the total viable wave energy resource alone is estimated to be between 7 to 10 GW (20% of electricity consumption) and the wave energy market alone could be as much as £2billion, a significant economic opportunity for the UK.

However, UK policy has failed to develop an indigenous renewable industry. Other countries, notably Denmark and Germany, have succeeded and their large growing industrial sectors provide significant economic benefits. Looking specifically at the wind energy market, the UK is now so far behind its commercial competitors that no UK Company is in a position to sell turbines to the 1billion market created by the Renewable Obligation.

However, it would be wrong to criticise previous policy with the benefit of hindsight. Policy created to provide diverse low-cost supply as a result of the oil crisis, successfully prevented the UK developing a sector that still requires subsidy. It did not address recent changes in priorities necessitated by concerns over global warming.

Present policy, however, must now take into account the considerable weight of scientific evidence that shows CO₂ emission levels need to be reduced. The logical conclusion is that the relative value of renewable energy will increase as fossil fuel output is reduced. Renewable energy is therefore a growing worldwide market and provides a significant opportunity for a UK exporting industry.

The aim of this document is to move government policy toward viewing renewable energy as a key industrial sector and an economic opportunity for the UK. Based on experience and research into the UK wind industry and by comparing the result of present government strategy to the successful experience of the Danish industry this report seeks to outline changes to government policy that are essential to establish an embryonic indigenous UK renewable energy industry.

3 Government Aims

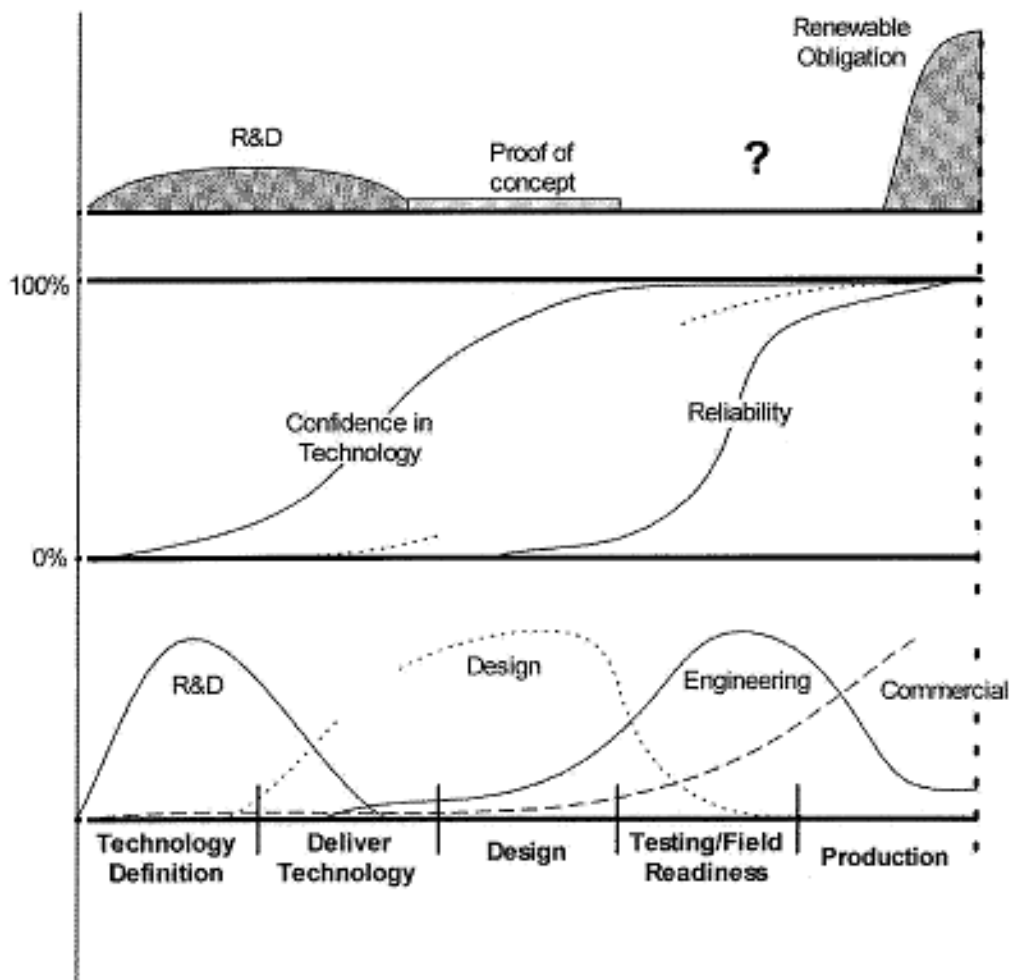
Government is clearly aware of the need to ensure that the UK develops its renewable industry as is shown by the following:

- *To stimulate the development of new technologies necessary to provide the basis for continuing growth of the contribution from renewables into the longer term*
The Renewable Obligation (Scotland) Statutory Consultation.
- *To assist the UK renewable industry to become competitive in home and export markets and in so doing to provide employment.*
The Renewable Obligation (Scotland) Statutory Consultation.
- *UK securing at least its relative GDP share of business opportunities stemming from Kyoto mechanisms by 2010.*
DTI -Reducing Greenhouse Gas emission -The strategy (WWW)

4 Government Policy

Policy will provide market support both through the climate change levy and the Renewable Obligation (around £ 1billion by 2010). and funding of R&D (Research and Development) stated as £100million. The market support is an extension of the NEFO (Non Fossil Fuel Obligation) and favours large mature technology such as large wind, whilst R&D support is for "non-commercial" innovative projects.

This leaves a huge gap between R&D and market support. This gap is at the point where stabilisation of design and solution of engineering and reliability issues (during the rollout into initial in-field operation) is bringing project risk under control, and because renewable generation is particularly sensitive to project risk, (see section 6) this gap creates an insurmountable barrier preventing R&D reaching commercialisation. In normal markets, this gap is funded from intra-company profits from pervious product. But without a UK industry, this source of funds is not available.



To illustrate the problem, the following diagram shows the availability of support funding at various stages in the development cycle and shows how this relates to phases of a project.

The diagram is a simplification of project planning guidelines within industry. The bottom section shows the relative effort at various stages in the development cycle. The middle shows how growth in key metrics relates to project phase and the top shows available funding for renewable energy development.

Initially a project concentrates on technology innovation through R&D. Early R&D concentrates on theoretical understanding of technology, later R&D is more "hands on" implementation on early prototypes. Confidence in the technology allows design work to start and "bench" testing to begin. The design must be stable before reliability testing can commence so that incremental engineering improvement is not undermined by changes in design. Finally, when the design is stable and reliability proven, the commercial sales of the product becomes the main focus of the project team.

At the top of the diagram the available support funding is shown. R&D support for renewables come from a variety of sources such as university research and SMART. Some funding is also available in the concept demonstration phase (Scotland). The Renewable Obligation will concentrate funding toward the end of the production phase on mature technology. (See section 8.2)

Although the government are clearly providing more money than previously to renewable energy, the above diagram shows that more money into the same framework does not bridge the gap between R&D and commercialisation. Furthermore, by focussing on R&D funding for technology development, the government is forced to "select winners", whilst market support allows the market to select the most appropriate technology for its needs.

Danish Experience

A clear alternative to this policy is the early experience of the Danish wind industry. Early support was given through grants and market support to enable small communities and individuals to purchase wind turbines. This encouraged a number of innovative companies and individuals into the field providing a testing ground to tackle key engineering problems such as reliability and efficiency. Also by providing relatively small amounts of funding to ensure that there was a profitable market, the result was to bring in much large quantities of external funding which naturally selecting the most effective designs and provided intracompany funding for further incremental development.

The result was to develop a number of successful companies with tried and tested designs and key personal with the necessary skills and experience. This pool provided the foundation which allowed the large agricultural companies to come in and scale up production, thus establishing Denmark as the pre-eminent producer of Wind Power products.

5 Policy and the Economy

It is extremely difficult to see how anyone can suggest that current government policy is good for the UK economy. Perhaps these commentators refer to the jobs in renewable generation, but although some jobs will be created in the UK renewable industry, there will also be losses in jobs in conventional power generation, not only in operating plants, but also in companies supplying equipment for new build and companies involved in future R&D.

However, whereas the impact on jobs is clearly debatable the impact on UK balance of payments is fairly clear. The lack of indigenous renewable industry to supply equipment means equipment must be purchased from abroad thus hitting UK balance of payments.

This problem is particularly acute in the UK wind turbine market where there is no UK companies currently supplying turbines for UK wind farms. Any growth in wind energy therefore, will increase UK imports.

Wind represents around 20% of the various NEFO. Assuming a moderate increase in wind to 30% the impact is easy to calculate:

According to Danish statistics wind turbines cost around £3 15k for 600kW units. According to the BWEA the yearly output can be estimated as:

$$\text{Output} = 600 \text{ kW} \times 0.3 \times 8760 = 1.6 \text{ GWh}$$

So the cost per kWh (yearly) of each turbine is

$$\text{Cost/kWh} = 1000 \times 315,000 / 1.6 \text{ GWh} = \text{£}0.20.$$

Given an average UK electricity consumption of 37 GW, of which 10% is renewable, wind at 30% would represent:

$$10\% \times 30\% \times 37 \text{ GW} \times 8760 = 10 \text{ TWh}$$

So the total cost of UK imports will be $10 \text{ TWh} \times \text{£}0.2 / \text{kWh} = \text{£}2 \text{ billion}$

Small "screwdriver assembly" plants such as the one at Cambeltown where £10.2million of government money is creating 150 jobs is very insignificant compared to the £2billion worth of imports, the 6000 jobs at a wind turbine company like Vesta (turnover £500million) or the total of 15,000 jobs in the Danish industry.

However, the major loss to the UK economy of buying technology from abroad is from "lost opportunity" rather than directly through lost trade. The cost of lost trade is obvious, but, the impact of the loss of intra-UK investment in engineering design/development capability, creates an impact which will affect the UK long after the present crop of renewable energy generators.

Unlike a "sub-assembly" plant that is relatively simply to relocate worldwide, Design and development is a key capability, which fixes a company to the locality of its key employees. Development companies rely heavily on a multitude of outside companies, many of which will be local, creating a multiplying effect to increase the total economic turnover several times.

Also, a design and development company by its nature invests considerably in personnel training and experience and given the natural turnover of personnel these skills permeate through the local economy resulting in the "nourishment" of further design and development either through new start-ups or via cross-fertilisation of ideas. Also R&D can help to build "critical mass" for a cluster of R&D companies.

6 UK Renewable "Industry"

There is very little industrial effort in the UK wind, wave and other renewable sectors.

In wind energy, all new wind farms use turbines from foreign companies. The only UK companies which design and manufacture wind turbines survive on off-grid applications and the size of their largest turbine is less than 1/100th the size of current wind farm machines. Having said this, UK companies have a worldwide reputation for a rugged reliable turbine developed to deal with the UK climate.

The UK has one wave generation scheme with a single 0.5MW unit in place. In the present climate, this unit is not commercially viable.

Solar electricity is an industry without a market. The UK has successful companies such as BP solar, but this success has been built without a home market for grid-connected electricity generation. A larger market could allow sufficient volumes of production to bring down prices and

7 Renewable Energy and Risk

7.1 Higher Overall Project Risk

Many commentators on renewable energy fail to appreciate the impact of risk on the viability of renewable energy projects, with the result that exploiting these resources is mistakenly seen as a technology challenge requiring more R&D.

7.1.1 Risk from Extreme Loading

A simple analysis of renewable energy such as wind or wave shows that the maximum peak output is much greater than the average and that the peak energy encountered during storm conditions is orders of magnitude larger than normal stresses.

	Maximum Output /Average
Conventional	2:1
Wind	10:1
Wave	100:1

Approximate levels of maximum loading against average

In addition, even in normal conditions, the systems are constantly under stress. This increases the need for large scale reliability testing after proof of the concept. A useful comparison is the average car mileage of around 10,000 miles is 100~ of the distance travelled by a wind turbine blade (i.e. 1million miles a year.) In renewable energy systems, reliability is critical

7.1.2 Financial Risk on Capital

With high capital and low running cost, unlike conventional fuel burning where the fuel represents a substantial cost, most of the cost on a renewable energy project is incurred before generation commences. Compared to similar fuel burning apparatus, the initial capital cost is higher but this is compensated by the higher unit return. Therefore given the same period for income to breakeven with project costs, renewable energy has higher debt, so, the financial risk of early engineering is significantly higher.

For example, consider a renewable energy installation at £10million returning £1million per year, compared to a conventional system of £5million but with a lower return of £500k. At any time before the ten year payback period, the renewable energy installation has twice the debt of the conventional system. (£5million compared to £2.5million at five years)

7.1.3 Government Imposed Risk

Only about one in ten large wind projects get through the planning stage. Similar problems are also experienced by smaller projects although statistics are not available. This lottery creates a risk that can only be amortised over a large number of applications thus penalising individual developers. There is clear precedent for government to act to enable the development of industrial sectors such as mobile phones.

7.1.4 Large Project Risk

Common engineering practice reduces the risk of development by splitting the development into smaller more achievable stages. Contrary to good engineering practice, government funding has favoured large revolutionary projects hoping that these will solve all the problems of the technology and allows further funding to finance rollout into the field. But large projects inherently have large risks and can only be justified once other strategies have failed.

Good engineering starts with simplest, lowest cost configuration. When the problems of the simplest configuration are solved, it is used as the basis for the next configuration. Obviously,

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the first configuration tends to be the smallest least innovative. Large quantum leap projects break this rule and are only achievable if broken down into a series of smaller increments. Supporting smaller projects and incremental development is the first priority.

7.1.5 Entrepreneurial Risk

It is often said that entrepreneurs are failing to invest in renewable energy. But, entrepreneurs are sensible people and if we consider the total project risk on renewable projects, the reason becomes clear. Although each element of the risk may be acceptable within other projects, the combining of each risk element multiplies together creating an overall project risk which is unacceptable. It is therefore not surprising that venture capitalists are reluctant to invest.

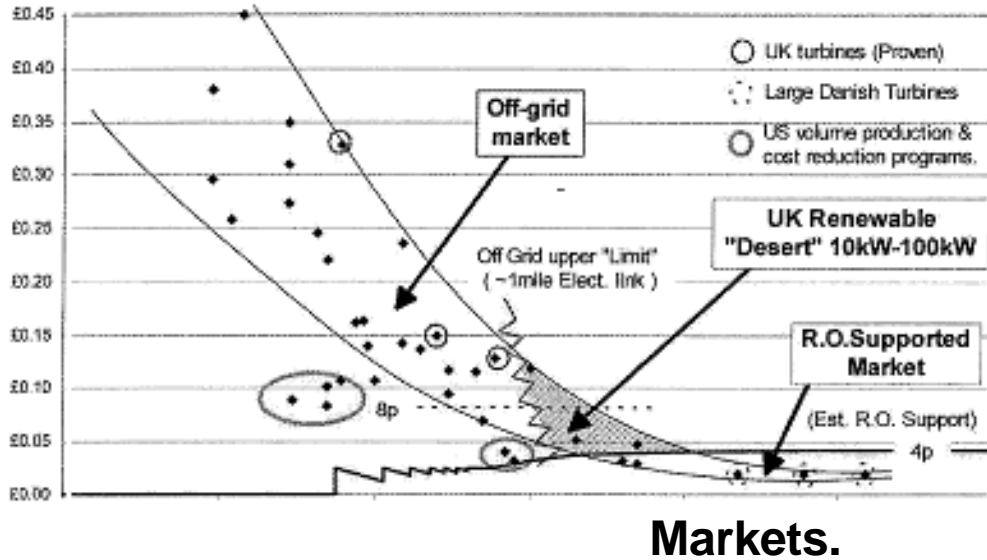
Attracting outside money to renewable projects can only be achieved if the risk to the investor can be considerably reduced. Simple measures such as removing the lottery of planning, allowing smaller incremental development and support for early rollout to the field could help bring the project risks to an acceptable level.

7.2 R&D Increases Risk

The very nature of R&D is to create new innovation. The act of innovating resets the reliability clock creating new uncertainty that can only be re-established by testing the technology over time in different environments.

The result of focussing on R&D to the exclusion of engineering improvement is that the technology fails to mature. Furthermore, by innovating without the discipline of field-testing, funding tends to go to the "most interesting" outcome from the previous funded projects thus concentrating funding on the areas most interesting to the R&D community rather than the technology with most utility. This approach allows R&D to go into interesting technology which is in fact a reliability/engineering cul-de-sac.

8 Structural Problems in Renewable Energy



8.1 Hole in the Market

The Renewable Energy "Desert" Between R.O. support and Grid Connection

Effect of Wind turbine Size and Capital Cost against Average Output

The above diagram was compiled using data from the USA Department of Energy, British and Danish Wind Energy Associations and from "Home Power" the journal of small-scale renewables. The diagram shows the amortised cost of a wind turbine installation over a ten-year period on the vertical axes against the rated output power of the turbine.

A fixed period term was chosen to avoid problems due to the calculation of interest rate. (Ten years is equivalent to an operational life of 15 years at an interest of 4.8% above inflation or 20 years at 7.5% above inflation.)

Each point represents one type of turbine. The higher up the graph it is, the more expensive it is for each kWh of energy produced in a typical situation (10mph average wind). The graph clearly shows a general downward trend of price with increasing wind turbine size even though there is a large spread of prices. The two curved lines represent the limits to the normal market. Two groups, however, are outside this area because they have been significantly lower prices than the main grouping. Both represent turbines where considerable extra investment has brought down costs. (Perhaps a warning that even what wind industry the UK has faces increasing foreign competition whose large home markets allow them to scale-up production and bring down costs)

The diagram shows that government price support creates three distinct market segments:

8.1.1 Off-Grid Market

The off-grid market has little government support. Turbines are used where main electricity supply is not available either because it is physically not present or because the application is

mobile. It is usual to use battery to store electricity for periods when wind is unavailable, however this analysis does not take battery costs into account. As the size of the application increases so does the cost of the turbine. For many applications the economic limit is dictated

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by the cost of installing mains electricity and this is around 10kW. At this size of turbine, the unit cost is appreciably higher than the 1-2p that is available for general electricity sale.

8.1.2 Renewable Obligation Supported Market

Renewable Obligation market support will represent around 60% of income for the majority of large turbines. From the diagram it is clear that the lower limit for the size of turbines in this market is around 100kW, as below this size, the unit price is higher than the expected value of the Renewable Obligation. This limit is much larger than the present size of UK turbines and limits this market to foreign turbines.

8.1.3 Renewable "Desert"

Between 10kW and 100kW, there is a market segment whose unit price is too high to compete with current electricity supply and whose purchase price is higher than most off-grid applications in UK. Turbines in this area have been developed in foreign markets where population is more disperse and the cost of connection to the grid is greater.

However, even in the UK, there is a market for the size of wind turbine in this sector, but only where generated electricity reduces electricity taken from the grid. This niche market is for specific applications where electricity is used continuously, for example for heating greenhouses, and the turbine electricity is used in separate electrical circuits to provide additional heating which reduced demand from the grid. In this circumstance, the net value to the user is nearer 7p/kWH rather than the 1-2p/kWH of normal supply.

8.1.4 Regulatory Barrier

In addition to the hole in the market, the UK electricity industry is notorious for their lack of enthusiasm for small-scale renewables. Any person considering connecting a small-scale generation system to the mains is presented with an institutional barrier created by the rules, regulations, pricing, procedures and attitude which at best are only suitable for larger systems.

Typical comments from suppliers are "driven to despair", "~£2000 of unnecessary testing", "more time on the paperwork than the installation" and "different procedures, cost etc. for every company".

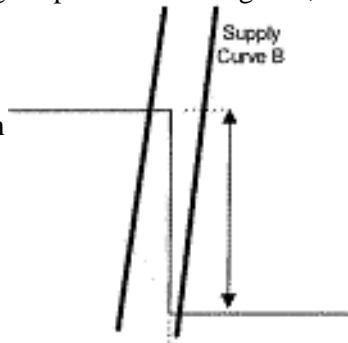
8.2 Renewable Obligation Failure to Support Innovation

The Renewable Obligation (RO) is a charge on electricity suppliers of 3p/kWh for a fixed percentage of the electricity they supply to consumers which they can offset by purchasing Renewable Obligation Certificates (ROC). ROCs will be issued to generators of green electricity who will then sell them to the generators to offset the charge. It therefore creates a market for the ROCs up to the specified limit (RO% set at 10% in 2010).

A Recipe for a Chaotic Market

The Renewable Obligation creates a market for renewable energy up to a fixed percentage of supplied electricity. This creates inelastic demand (the level of demand changes little as price changes) where the limit to demand is at an unpredictable level. At the same time, the majority of renewable energy systems are high capital low running cost, the supply is very inelastic and the supply is unpredictable.

The result is that as capacity market for Renewable Obligation approaches the demand, unpredictable, unstable and



approaches the demand, the Certificates (ROCs) will become subject to large fluctuation.

The above diagram shows the projected supply/demand curve for the industry, for simplicity we have excluded redistribution from ROCs as the value at the demand limit is minimal and its exclusion does not alter the argument. The demand for ROCs will be a fixed percentage of electricity supply (RO%). When the supply is less than RO%, the price will be close to 3p above normal levels. When the supply is greater than RO%, the price paid per kWh will fall to marginal market pricing. The demand curve therefore has a characteristic step at the RO%. At this point demand is highly inelastic. Because renewable energy systems tend to be capital intensive and low on running costs, the incentive is to generate so long as some return is available. Hence, the supply is inelastic.

As any economist will confirm, inelastic demand in a market with inelastic supply is a recipe for large price fluctuations. Put this together with unpredictable supply and unpredictable demand we have a recipe for chaotic markets. To illustrate this see the above figure. If the supply capacity is at curve A, the market price will be determined by the point at which it crosses the demand curve, in this case around S_p . However only a small change in supply pushes the capacity to curve B where the market price is around i_p (In a situation of oversupply the price will be at the lower end of normal market price). When this situation occurs, the effect of even a small change in predicted supply or demand, will create enormous changes in market price for Renewable Obligation Certificates, the result will be a spot market suffering large erratic variations in price.

Although the above is only true for short term market conditions as new installed capacity reduces elasticity of supply over longer periods, this is only true for the market as a whole and not individual companies.

8.2.2 Unfair to Smaller Generators (Less than 37MW)

Unfortunately it is the small generator who is likely to suffer most. To illustrate how this situation will adversely affect smaller suppliers, consider the effect on the price for each of the following renewable generators as supply exceeds demand. (We assume 5% over supply with around 50% of supply from large independent generators)

	Value of ROC	Average Price
Electricity supplier's own renewable energy	Offsets 3p/kWh	3p
Large generators	90% - 3p/kWh 10% - Un sold	2.7p
Smaller generators (<1% market <37MW)	No Market	Op

ROC purchasers will first use their own ROCs, then purchase ROCs from the larger players in the market and only as a last measure will they consider purchasing ROCs from smaller generators if they still require ROCs to meet their RO%. "Smaller" generators would include any supplier whose total output capacity is less than the variability between supply and demand. A rather low assumption of 1% of total market, would include any supplier with a total of less than 37MW (RO% set to 10% of supply). At current wind turbine prices, total investment for 11MW is around £6million. Therefore almost all development projects for new technology would be within this category.

Three main arguments are used to counter objections to the structure of the Renewable Obligation market: The first is that it is assumed suppliers will enter long term contracts with purchasers and so secure pricing, the second is that the government will adjust ROC level so that over-capacity does not occur and the third is that allowing ROCs to held over from a year will stabilise the market.

Firstly whether any smaller generators are able to negotiate long term contracts is debatable. The expected value of ROCs will be largely determined by the buy out price thus keeping the two close together. The result is that there is little incentive for the purchaser to be locked into long term contracts and a large incentive to avoid purchasing overcapacity at well above market price.

Secondly, it is not necessary for the situation of over-capacity to occur for it to impact the viability of smaller generators. The small independent supplier is not in a position to predict future supply. As Eaglesham Moor clearly shows, large schemes can fairly rapidly come on tap creating large jumps in capacity level. Even the possibility of this situation occurring will mean that smaller projects will need to base financial projections on the lowest potential price, which as shown above could be marginal market price of 1-2p/kWh. A project requiring, for example, 10 years to break-even, will need to consider the effect on electricity price of capacity from projects that are not even at the planning stage. Therefore funding is unlikely to be available unless schemes can

recover full costs within the development lifecycle of new capacity.

Finally, to deal with the ROCs held over from a previous year. The effect of this is to make the maximum market for one years supply, the total of the current year (less any ROCs held over) + ¼ of the previous year. If there is over-supply this year, it is most likely that the same will occur in the next year. Only if there is strong evidence that the current year is exceptional will the market be willing to purchase ROCs against future demand. At best, the effect of allowing 25% from the previous year will be to slightly reduce the variability of demand –a slight reduction in variability of a chaotic market is still a chaotic market.

8.2.3 Mechanisms to Reduce Price Instability

Given enough economic sites for renewable energy, the capacity will increase until it matches ROC demand. When this happens, the market will be become unstable working on rumour and estimates.

There are simple mechanisms to reduce price instability.

- 1) To publish information throughout each year on supply and demand.
- 2) To allow supply/demand to work over longer periods
- 3) To guarantee purchase of ROCs above the RO %.
- 4) To create flexibility in demand for ROCs above the RO%

Information

Statistics on ROCs issued must be published, as otherwise this gap will be filled by rumour and inside information.

Increasing the period to match supply and demand

There is a clear environmental case to allow generators to work to reduce electricity consumption as an alternative to increasing capacity. This could be encouraged by allowing ROCs to be utilised over a period commensurate with changing either demand or capacity.

Given that demand and supply will fluctuate from year to year, and that new developments could take many years to implement, ROCs should be redeemable over a number of years. To encourage early use, the nominal value could reduce each year such as shown below:

Year	Nominal Value
Of Supply (2010)	100%
2009	100%
2008	80%
2007	60%
2006	40%
Prior to 2006	Nil

Guaranteeing demand and providing flexibility in price above ROCs %

This could be achieved by guaranteeing the purchase of ROCs in excess of demand using a mechanism that is predictable and reduces the price with quantity so as to limit demand.

A simple mechanism would be to allow all excess ROCs to be offered to an agency, and for the agency to calculate the price on a simple formula such as:

$$\frac{(0.95) \times 3p \times \text{ROC limit}}{\text{Total ROCs}}$$

(0.95 is to make this slightly less attractive than the normal market)

This would create a reducing price of ROCs above the RO limit and provide price stabilisation. Even if there were no intention to allow the market to reach this situation, as mention previously, even the threat of this situation would prevent new smaller generators from entering the market even as much as ten years before it was likely to happen. Therefore it will still be necessary to publicise that this scheme is available even if it is never intended to allow this situation to occur. It may however be limited to generators below a fixed size as larger generators are less susceptible.

8.2.4 ROC Fails to Deliver CO₂ Target

Renewable Obligations Certificates are given for each MWH of electricity supplied to the distribution grid. The Renewable Obligation is set at a percentage of electricity supplied to the consumer. Given that on average 10% of power is lost during transmission, the Renewable Obligation is inherently flawed, as it will always fall short of the target.

To illustrate this point consider the following:

Assume total electricity consumption is 300TWH per year. Then Total electricity produced is

$$300\text{TWH} + 10\% \text{ losses} = 330\text{TWH}$$

If the Renewable Obligation target is set at 10% of supply, the suppliers will need to purchase 10% of the 300 TWH of electricity supplied. To achieve this they will buy:

$$10\% \text{ of } 300\text{TWH} = 30 \text{ TWH}$$

The percentage of green energy produced as a percentage of total will be:

$$30 \text{ TWH} / 330\text{TWH} = 9\%$$

Therefore only, 9% of electricity supplied to the consumer will be from renewable energy instead

of the target of 10%.

To add to the problem, renewable energy tends to be remote from the grid. It is therefore not unreasonable to expect higher transmission losses. Although in part this is merely an accountancy error and could be compensated by raising the level of the RO it also highlights the potential reduction in CO₂ that could be achieved by improving generation and transport efficiency.

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9 Other Issues

9.1 *Planning! Quangos and Bureaucracy*

9.1.1 Planning

As mentioned previously, renewable energy suffers from a higher level of risk than other engineering. As such anything that adds to the uncertainty of renewable energy projects is adding to an already high burden. It is therefore essential that government act to remove all unnecessary uncertainty in the development of renewable energy projects.

The approach of specifically supporting renewable energy in planning applications is welcomed, however, this approach still creates the potential for uncertainty because individual projects can still be refused even if on average more get through. Clear guidelines that allow developers to assess the chances of success will significantly help, but preventing renewable energy projects from having to apply for planning permission would be ideal. Realistically, larger schemes will need to allow public consultation.

In part the problem for smaller systems is a lack of volume that makes both the developer and planner novices and unsure how to proceed. Clear guidelines on size, placement, etc. would assist both smaller developments and council planning departments.

Planning framework

The development of planning guidelines would be assisted by developing a conceptual framework of the impact of this technology to the community.

Renewable energy is a natural method of harvesting energy from the environment. In essence it is no different from the energy that grows crops, powers waves on the beaches or sways trees in the countryside. Ever since the industrial revolution, the countryside has become more industrialised with tractors, milking parlours, greenhouses etc. Planning rules clearly incorporate an understanding that agriculture requires industrial machinery. It is therefore a logical extension of this approach to view alternative technology as an extension of the agricultural business.

The environmental impact of a wind turbine is very similar to that of a similar sized tree. Indeed, trees are very efficient solar energy collectors and they also collect wind energy (some have gone as far as to harness the power from the swaying of trees). Given that wind turbines occupy similar locations to trees with similar benefit to humanity, it does not seem inappropriate to apply the same rules that we use for planning control of forestry crops to renewable energy sources.

Even in urban environments, we are surrounded by structures such as trees, streetlights, TV aerials and dishes which do not require planning consent. Renewable energy systems such solar collectors or smaller turbines are similar in size and impact and so should also be free from the bureaucracy of planning.

9.1.2 Quangos

Unfortunately, the areas with the best natural resources seem to have an unfair share of quangos. The tendency of any quango is to put itself into the decision making process and thereby create

unnecessary bureaucracy and paperwork.

A wholesale review and shake-up of quangos is long overdue. Where outside intervention is necessary, this should be the minimum necessary, preferably involving one governmental agency working to clear guidelines and subject to external scrutiny.

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9.2 Renewables and Community

9.2.1 Rural Economy

Renewable energy disproportionately affects rural communities as these areas contain the main near-shore wind, wave and bio-fuel resources. Any consideration of policy toward renewable energy should also consider social and economic impacts on these communities.

At a first glance, it would appear that the development of renewable would boost the rural economy. However this is far from certain.

The high cost of development and the uncertainty of planning applications prevent most in the rural community from directly owning wind farms. They are therefore unable to tap directly into the funding from the Renewable Obligation; the main local benefit will be rent for use of land and local jobs.

Site rent typically represents only a small fraction of the income from a wind farm. This is therefore a poor mechanism to direct funds into these communities. What little income does come through this means will be disproportionately targeted to larger landowners who own the prime sites for renewable energy generation.

The remaining mechanism to support the poorest sector of rural communities is the creation of jobs for servicing and repair. However, these are skilled jobs requiring considerable training. It is quite likely that the majority of this employment will go to skilled personnel from outside the rural community.

9.2.2 Adverse Impact on Tourism

These areas also tend to be the ones most reliant on tourism. A few jobs could come from tourist centres for "renewable energy", but undoubtedly the largest impact would be to deter tourists seeking "unspoilt" wilderness who will not welcome the new industrialised landscape of wind turbines and masts.

9.2.3 Social Disparity

Policy seems to have been developed with little concern to improve social disparity. It is the general electricity consumer that will have increased bills in order to subsidise the large wind companies. The large landowners will gain, whilst the small tenant farmer and those reliant on tourism lose. Smaller "renewable energy" projects, including passive solar, home insulation and community wind turbines disproportionately assist poorer rural communities and so would help to remove social disparity.

9.3 Highlands & Islands - The Case for Regional Policy

The Highlands and Islands have the best winds in Europe and huge potential for wind and biomass. However it is debatable whether large Wind energy in this area will provide economic benefit since this area is particularly reliant on its "unspoilt" landscape to attract tourists and their economic benefit. It is a region where policy suitable for the UK in general could harm the fragile economy. It is also the best region to create a market to develop an indigenous UK Renewable

Industry.

The dispersed rural population and lack of industry mean this area is unlikely to benefit directly from reduced prices for locally generated electricity. Even the assumed benefit of a more reliable electricity grid may fail to materialise since wind farms may be connected to entirely separate networks, leaving the local population with electricity supplies that are just as prone to interruption in bad weather.

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A prominent omission from current policy is the lack of support for auto-generation such as wind turbines to provide electricity on the islands in the NW of Scotland. Although generators on the islands provide the same basic substance as mainland units, they are not connected to the grid and so do not qualify for support.

It is quite likely that following initial enthusiasm for renewable energy based on the perceived benefits, the actual reality will result in disappointment and resentment as the local community fails to benefit, or worse still suffers, from the intrusion of these industrial scale developments. To add to the insult, any communities that try to install their own renewable energy systems will come up against the same problems that have plagued our indigenous companies, creating the perception that there is one rule for outsiders and another for the locals.

Given the high concentration of renewable resource in the Highlands & Islands and the large number of small communities, this area would significantly benefit from support for 10kW to >100kW turbines. This would both make an invaluable testing ground for new commercial products and significantly strengthen the local communities through low cost electricity.

9.4 Economic Opportunity Outside Green Electricity

There is a plethora of potential technologies or simple policy changes that could either individually or in combination achieve the government CO₂ target

If the value of the Renewable Obligation were rolled out into other areas in proportion to the equivalent fuel usage (tonnes of fuel Toe), the total support would be:

	TOe	% UK	Suggested Support
Energy to reduce CO ₂			
Electricity	28.3	18%	£1.0 billion
Gas, oil, coal (e.g.Heating)	81.1	51%	£2.8 billion
Transport	55.2	34%	£1.8 billion
Total	160.1	100%	£5.6 billion
Domestic (Total)	46.8	29%	£1.6 billion

It is a little bizarre that policy is directed to support electricity given the detrimental impact of this policy on UK balance of payments. The following are included to illustrate the potential other areas have to help achieve the CO₂ target with considerably more benefit for the UK economy and probably at a significantly reduced cost compared to present policy.

Insulation

Any analysis of benefits from the various technologies clearly shows that increasing insulation is the single largest potential saving. Proportionate support would provide £80 per household per year, enough to provide loft insulation or cavity fill for all houses in 5years. Total saving for all households could be as much as £1.4billion per year.

Passive Solar

The next best method for the average household to benefit from renewables is to work on passive solar collection. This is easily achieved by large South facing windows or by various means to collect solar to pre-heat hot water. The efficiency is also much higher than other forms of renewables.

Wood burning

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Burning wood from a sustainable forest or waste is a very simple means of reducing CO₂ emissions. Some types of wood burn with virtually no smoke and including them as "smokeless" fuel would increase their use.

Walking to school

As anyone who has driven around towns between 3 and 4pm knows, a huge number of journeys are made because parents drive children to school. Apart from the benefit to children's health and the reduction in road accidents, it is quite possible that by creating incentives to eliminate the "school run" the government could achieve its CO₂ emission target at substantially lower cost and greater benefit than the Renewable Obligation.

Communications Network

Although not often considered for its impact on energy, changes brought about by improved communication will impact energy consumed by transport. The main blockage is bandwidth and problems with the tariff structure.

The tariff structure of the telecommunications network penalises high information delivery on a network designed for voice communications and discourages networks from increasing bandwidth. High bandwidth is necessary to be able to provide picture quality in sufficient detail and within a short enough time for users to be able to use internet as a replacement for travel. High bandwidth allows high quality pictures and video. Detailed pictures would greatly improve the acceptability of web shopping. Video conferencing would become preferable to the burden of travel if the quality/bandwidth were available to allow simultaneous one to one conversations between different members of a meeting with sufficient clarity to enable the nuances of non-verbal communication to be conveyed.

10 Economic Importance of Smaller Renewables

It is a misconception to suggest that smaller renewable energy systems are economically unimportant. History is filled with commentators who failed to see the importance of the early stages of industrial sectors, for example commentators said that the first aeroplane was just a toy and would go nowhere.

There are good reasons for the UK to invest in smaller renewables: Firstly, smaller renewable systems represent a key stage in the development process for new technology at the point where R&D is first being rolled out into the field. The lack of a market at this key stage creates a barrier to the adoption of new technology into commercialisation.

Secondarily, there is considerable potential market outside the UK particularly in third world countries where the electricity grid is not well developed. Typical use would be providing power for schools or hospitals in rural populations.

A third argument is simply that a large number of small systems are quite capable of producing the same output as a small number of large systems. Indeed there are additional advantages of distributed supply, as reliability is increased and transportation costs are reduced.

Finally, renewable energy is a growing market. The UK cannot afford to ignore the future potential of this sector. We must create the skill base of companies and individuals that will be required for future technology. Investing in a market for small renewables is the most cost effective mechanism to provide the UK with this skill-base.

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10.1 Small-Scale Renewables – Potential to Stabilise Supply.

Supply fluctuation is an inherent problem caused by short-term mismatch of power supply and demand (e.g. Coffee break during the World Cup). If demand increases, the voltage delivered to the consumer drops until the network can respond by bringing more capacity into operation. Modern electricity networks have contingency built in to provide flexible spare capacity and special tariffs to allow the network to control demand from industry.

By assuming that smaller renewable generators will operate outside this structure, commentators have wrongly concluded that smaller renewable systems must increase problems with supply fluctuation. The key to coping with fluctuating electricity supply systems is either to control demand or control supply through communication from network to supplier or industry. Industry is offered special tariffs if it agrees to reduce demand when network capacity is at a limit. Generators have better tariffs if they provide flexible output.

However, changing industrial demand can incur additional costs to industry and lowering output from fuel burning generation results in inefficient operation and increased costs. Reducing output capacity from renewable energy such as wind is virtually free of cost and CO₂ requiring only that the blades be turned away from the wind. The key to tackling network fluctuation has always been good communications and therefore, by providing communications links to all renewable generation, the total short-term output can be controlled thus removing much of the need to run conventional plant at below optimum efficiency.

Smaller renewables distributed through the network could provide very quick response to high demand in specific areas. For example, small combined heat and power equipment can be switched on or off to cope with short term supply variation with virtually no effect on utility as heat is retained in houses for long periods. The response time could be as short as one second which is better than most conventional plant.

Moreover, in smaller renewable systems, electricity is often converted to DC voltage for battery storage prior to conversion to mains voltage. These systems provide the potential mechanism to provide fast response to supply line fluctuation. Although individually, the output may be as small as a few kW, if sufficient units are sold the total generating capacity would be substantial (e.g. 1% of households with a 3kW unit could provide 0.6GW within milliseconds).

10.1.1 Solar heating To Stabilise Supply

Passive solar pre-heating of water is a very efficient mechanism to capture renewable energy. In essence it involves the capture of heat from the sun and its storage in a well insulated water container. Most systems also include additional heating to compensate when sun is lacking. By being smart, it is relatively simple to use these systems as a huge storage system for energy. In addition to the direct economic benefit and reduction in CO₂ provided by passive solar, by controlling the heating elements in the storage tanks, the electricity supply network could control 7GW of demand equivalent to 20% of average electricity supply (7GW = 10% of 20million

households with 3.7kW heating elements) and hence soak up huge amounts of excess power produced, for example, on windy days. Because sunshine occurs mostly in the summer and wind in the winter, the maximum sinking capability would occur when most wind energy is available.

11 Bridging the Policy gap

The result of the market "hole" in the renewable market (at 10kW-100kW for wind turbines) and the gap in funding between R&D and commercialisation creates a block to development at a key size, both in terms of the growth of indigenous companies and also on the rollout of new technology into the field. This size represents a key stage in the development process of new technology. For example, SMART funding at £45,000 would not be able to fund a wind turbine project much larger than 20kW.

With only one wave machine at 500kW, more information is required to assess whether the smallest viable rollout size of this technology would also be within this range. Although there is at least one application to our knowledge, where a suitable off-grid wave machine in the 1-10kW range could sell perhaps 30 units in the UK and more worldwide. Wave generators of less than 1kW are also available for navigational lighting so there is no fundamental reason why wave power could not be developed in this range. The same analysis should be true of other technologies although more information is required.

Therefore (with the above proviso) the gap in funding and market together with institutional barrier created by the electricity to small-scale grid connection are sufficient to explain the lack of UK industry above the 10kW barrier.

Government must support this key market of for renewables at 10-100kW

No matter the potential size of the tree, in a mature forest the sapling will die, unless the canopy is opened to let in the light.

11.1 Funding Requirements

It is a brave person that predicts the effect of price changes within any market. However, an estimate of the necessary funding is extremely useful when assessing potential policy. The following table is compiled using the best estimates available to us through our knowledge of the market and technology. More research is needed to confirm these figures.

	Estimate	Electricity Industry support (per year)	Governmental funding (per year)
Simple Net~metering** up to 100kW	Conservative	£300k	Nil
	Optimistic	£2million	Nil
Net~metering** with extended limit for wave-power (500kW)	Conservative	£500k	Nil
	Optimistic	£3million	Nil
As above, with grants to support community purchase	Conservative	£800k	£200k
	Optimistic	£4million	£1million

Estimate of additional funding from electricity supplier and government sources

**Net metering is a system found extensively in the USA where the electricity meter is made to go forward when electricity is consumed and backward as electricity is supplied.

The maximum level of support to establish an embryonic UK industry is a very small percentage (0.5%) of the funding generated through the Renewable Obligation. (£billion/year)

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11.1.1 Employment

Although the key impetus for this funding is to build a foundation upon which to build a UK renewable industry, it is interesting to give an idea of the direct benefit of this support to UK employment. With the provisos given above, the following table suggests levels of turnover and employment that could be created from this support within 5 and 10 years.

	Estimate	Industry turnover	Employment
Simple Net-metering up to 100kW	Conservative	£2million	50
	Optimistic	£9 million	200
Net-metering extended limit for wave-power (500kW)	Conservative	£3 million	70
	Optimistic	£12 million	300
As above, with grants to support community purchase	Conservative	£5 million	130
	Optimistic	£20 million	500
Long term (10 year) (8-30% of UK market)	Conservative	£50 million	1200
	Optimistic	£200 million	4500

Estimate of turnover and employment (see text for details)

11.2 Potential Policy Mechanisms

11.2.1 "Free of Cost" Support

Some policy changes are quite possible with very little funding. For example, removing the institutional barrier presented by the electricity industry to grid connection would only require minor changes to legislation & procedures and clear planning guidelines should be part of normal government work.

However, market support needs funding. The Renewable Obligation effectively creates a charge on the electricity consumer to support renewable energy. As has been shown, this policy will fail to support smaller generators and the rollout of new technology into initial field operation. It is therefore sensible to change this policy to provide support.

11.2.2 Price Support

From the information available, we suggest that a minimum price support of 7p/kWh between 1kW and 100kW would remove much of the distortion in the electricity market and provide intra-company funding for early rollout of technology into the field.

However even at this level, there may be new technology with considerable technological challenge which requires higher levels of support, or where the 100kW limit would be too low. Current wave schemes are around 500kW so this may be reason to extend price support up to this level. For technology with high potential returns but higher costs than average, additional support it

may be necessary.

Controlling Risk to Government

It would be unreasonable to propose price support mechanisms that allow unlimited burden on the taxpayer. The simplest mechanism to ensure a limit is to provide a limited budget and then fund projects either on first come first served or through some form of selection to try and "target winners". The problem of this approach is that it creates a lottery for the developer, further increasing what is already a high risk. At this point in time and in this market, this strategy would be counterproductive.

Another approach is to limit funding by linking it to requirements that are naturally capped. An obvious example of this is net-metering, where the maximum output capacity is limited to

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the maximum consumption. The number of renewable energy sites that are viable is limited, so net-metering provides a simple capping mechanism. Also, as the cost of net-metering is borne by the electricity supply companies, the risk to government is minimal.

Finally, providing grants where there is a natural limit can control risk. For example, grants to small communities in regions of high deprivation are clearly limited by the number of these communities with suitable sites for renewable energy.

Net-Metering

Net-metering is a simple price support mechanism. The meter goes forward for consumption and backward for supply. Normally, supply can only be offset against consumption so that in any year excess supply is free to the grid. Net-metering is an obvious candidate to provide market support for smaller systems. With an increase in unit price of around 10% due to the ROC, the price support could be close to 8p/kWh. From the consumers viewpoint, the price for electricity produced should be close to the price for consumption. It is arguable that the value of electricity for embedded generation should be higher because it does not suffer from transmission losses.

Community Net-Metering

The UK needs to support the market from 10 to 100kW or even as high as 500kW for wave power. Given an average household consumption of around 400W, and output from renewables of 30% of maximum, on average, these installations could power 8 (10kW) to 80 (100kW) houses or 400 houses for wave systems. Although many could be sold to farms and small businesses, there is clearly a case to allow the pooling of consumption to enable smaller communities to benefit.

Given that the Highlands and Islands is the area with the largest resource and would be a key market for renewables both for technological and social reasons, lack of large industry makes community net-metering an essential part of the strategy to build a UK renewable industry.

Guaranteed Purchase of ROCs

As outlined above, the price for ROCs given to smaller systems (<3 MW or <1% of market) will collapse if supply exceeds demand. In fact, even if supply is always less than demand, the mere possibility that a developer could create large generating capacity before projects breakeven would prevent smaller systems from securing funding from financial institutions.

The Renewable Obligation must be changed to provide guaranteed purchase of ROCs from smaller generators (i.e. smaller than 37MW), otherwise this will create a further disincentive to new technology.

11.2.3 Grants for Purchase

As the main cost of renewable energy is the capital purchase of equipment, support through grants provides funding at the most necessary point. However, if this route is chosen, grants should represent only a proportion of capital cost as this ensures that applications are chosen for commercial viability. For example grants of 20-30% would attract 3 to 5 times as much external

funding. As many good sites are in rural areas which also suffer higher deprivation, it would be possible limit the uptake to areas of deprivation and still support a significant market.

11.2.4 Securing Funds for Policy

Net-metering is the simplest mechanisms to support smaller renewables. But, perversely the Renewable Obligation provides perhaps the best mechanism to correct the problems it creates by providing a source of funding for this market. Two potential mechanisms are:

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1. Increasing the value of ROCs from small scale generators to twice their nominal value for the first 100k equivalent output. This would provide a market price of around 7p/kWH (Assuming that there is also a guaranteed purchase of ROCs.)
2. Allocation of part of the buy-out fund towards support for smaller systems, community grants or new-technology. Based on our estimates, the maximum value this fund needs to be is £10million per year. This could easily be achieved by allocating a proportion of the buyout fund to this purpose. (At 1% shortfall from RO%, £10million would be secured from 10% of the buyout fund.)

11.2.5 Planning

In order to reduce unnecessary project risks, it is essential to provide clear planning guidelines and procedures. This report has argued that renewable energy and particularly smaller systems, should be seen as a complementary activity to agriculture and as such planning control in this area should be relaxed.

11.2.6 Other Support

This report does not consider other forms of support to the industry such as a university research centre such as CREST, a wave power test centre, support for industrial clustering etc. as these should be covered extensively elsewhere. However, it is important that these other forms of support continue.

12 Conclusion

There is no insurmountable reason why the UK should be failing to develop its renewable industry and the Danish experience shows that this sector could provide significant economic benefits to the UK. Therefore as the government has said, we shall seek to see *"UK securing at least its relative GDP share of business opportunities stemming from Kyoto mechanisms by 2010"*.

Although present policy provides both direct price support in the market and funding for Research & Development, it leaves a gap in funding at a key stage in development before new technology reaches commercialisation. The unusually high level of entrepreneurial risk in renewable energy and the lack of an indigenous industry to fund this stage in development, means that this gap in funding has become an insurmountable barrier.

Without changing government policy it is extremely unlikely that UK industry will achieve anywhere near our relative GDP share. Achieving this target requires significant changes to policy and a shift in attitude to start treating renewable energy as strategic economic industrial sector.

No matter the potential size of the tree, in a mature forest the sapling will die, unless the canopy is opened to let in the light.

The experience of the Danish wind industry shows that support for smaller renewable systems enables the development of new technology and creates a pool of tried and tested designs and key personnel which formed the foundation of their present industry.

Unfortunately, the UK must accept that it is unlikely to develop an indigenous large wind turbine industry in the near future, as foreign competition is now too strong within the field. However, there is still considerable economic potential in small and medium turbines both in the UK and worldwide, there are other technologies such as wave-power, tidal, etc. that await exploitation. Even in large wind, technology never stands still and it is quite possible that given a strong indigenous wind industry, the UK would be able to capitalise on new developments to break into this market.

It is therefore a strategic imperative that the UK has commercially viable indigenous companies operating in the renewable industry so that there is the experience and personnel to fully capitalise on new technology.

It is therefore strongly recommended that the government provide market support for renewable equipment in the size range 10kW to 100kW (and wave to an appropriate level) either through doubling the value of the Renewable Obligation Certificates for generation in this range or through individual and community net-metering.

The Highlands and Islands is a key area for the uptake of this technology and these communities

could benefit from smaller renewables systems. It is therefore suggested that funding is provided to these communities in the form of capital grants to assist purchase of renewable energy generation.

The Renewable Obligation will fail to support new technology unless the government provides guaranteed purchase of ROCs for generators below around 37MW. In addition government must act to remove institutional barriers within the electricity industry preventing smaller systems from connecting to the grid. Finally government must reduce the lottery created by uncertainty in the planning process.

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13 Appendix 1 Specific Proposals

- 1) Introduce net-metering and community net-metering for general renewables up to 100KW and Wave Power up to the appropriate level for this technology.
- 2) Act to remove the institutional barriers of the electricity industry. Connection for generation must be as simple and inexpensive and connection for consumption.

Change the Renewable Obligation order to provide guaranteed purchase of ROCs from smaller generators.

Change the Renewable Obligation order to allocate part of the buyout fund to provide a new source of funding.

Use the above funding to provide capital grants to rural communities particularly in the Highlands and Islands for the purchase of renewable energy equipment.

- 6) Amend the Utilities Act to allow the inclusion of auto-generation particularly for island community energy schemes.
- 7) Provide other supporting measures such as industrial test centres, support for start-up companies, support for near market R&D etc.
- 8) Review the potential economic opportunity of non-electricity generating renewable energy such as solar, wood burning and where appropriate act to support these industrial sectors.
- 9) Review present R&D funding to ensure that it is directed toward UK industry and if necessary act to stimulate the growth of commercial companies in areas of potential economic benefit.
- 10) Create a Planning framework to support renewables and introduce clear guidelines.
- 11) Provide money to educate the public on the potential benefits of renewable energy and energy reduction.
- 12) More research is necessary to clarify some of the issues highlighted in this report.

