RENEWABLE ENERGY AND ITS IMPACT ON RURAL DEVELOPMENT AND SUSTAINABILITY IN THE UK

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EXECUTIVE SUMMARY

Project Aims and Objectives

The aim of the study was to identify and quantify social and economic benefits from Renewable Energy (RE) through a number of case studies and to extrapolate the findings to the wider industry. Taking account of changes in the support structures and markets for RE and possible effects of new Renewable Energy Technologies (RETs), the study estimates the effect that RE could make to rural development by 2010 based on meeting current Government targets.

Background

Environmental benefits provide the main rationale for public support of renewable energy generation. However, a further perceived advantage of RE generation is that, unlike conventional energy production, they might possibly contribute to the rural community both economically and socially.

Previous research, commissioned by the DTI looked at the potential contribution to rural diversification (K/PL/00107/REP and K/PL/00108/REP). These studies highlighted the limitations of scale and job creation potential of many RETs and the fact that the changing nature of rural communities make larger scale developments unlikely. However, in the context of very sparsely populated rural areas with few employment opportunities beyond extensive farming and forestry, small numbers of new jobs could have a significant impact on these communities.

A key factor in determining the contribution RE can make to rural development is the scale and mix of component technologies. This is dependent on its ability to compete with conventionally generated electricity. At a local level, there are also issues of planning consent and community benefits that are key to development.

The main instrument of Government policy for the development of renewable energy systems in the UK up to 2000 was the Non-Fossil Fuel Obligation (NFFO). This guaranteed a price/kWh significantly greater than the electricity pool price, and stratified in such a way as to provide greatest support for the most innovative technologies. Since 2001 the Renewables Obligation (RO) has replaced the NFFO. Electricity suppliers are now compelled to supply 10% of their electricity from renewable sources. Failure to do so will result in penalties which are distributed between the suppliers that do meet their RET targets, offering a higher price for RE generators. In addition to these changes in support structure, the New Electricity Trading Arrangement, NETA, which has replaced the Electricity Pool (EP) has driven down the market price for electricity and is a further obstacle to new and developing technologies.

In this changing economic environment, the rural development benefits of renewable should be tested.

Summary of Methodology Adopted

Twelve case studies were carried out, representing technologies which are likely to (a) impact on rural development, (b) play a significant role in RE generation into the future and (c) are commercially active. In consultation with DTI, a sample was chosen to give a range of technology, size and date of installation: this comprised five wind farms, three small-scale hydro plants and four biomass plants.

For each case study, data were gathered through face-to-face interviews with plant operators or managers and with plant operatives and stakeholders using e-mail or telephone interviews. Data collected included quantitative information on project details, capital and income flows for construction and operation, and employment. Qualitative information was collected on constraints to development, attitudes to RE, community engagement and linkages with other rural industries eg tourism.

This approach was used to isolate the economic impacts associated with the development of renewable energy sources, identify the workforce involved and account for their expenditure behaviour within the local area. This accounts for the flow of additional income into and out of the local area, both direct and indirect. The former is based on those individuals employed directly in the construction, maintenance and operation of the renewable energy facility, while the latter deals with indirect benefits to other sectors such as tourism and hospitality.

A Keynsian local economic multiplier model was used to measure the impact of local expenditure and economic injection into a region associated with investment in renewable energy sources. The size of the local multiplier depends directly on the proportion of income spent locally or, inversely, on the proportion of income at each round of spending which leaks out of the local stream into savings, taxation, reduced transfer payments, or import purchases. The size of the multiplier, therefore, tends to vary directly with the size of the local area, since import leakage's decline as the size of the area increases. Two measures of economic change are estimated in this study: the impact of RE facilities on (a) employment, and (b) output in a local economy. For each of these measures of change, two types of economic multiplier are estimated: a Type 1 multiplier and a Type 2 multiplier.

To understand how multipliers are calculated, and the distinction between Type1 and Type 2 multipliers, it is essential to distinguish between direct, indirect, and induced effects in a local economy. Direct effects are the employment (or output) change occurring in the economic agent that is the subject of investigation: the RE facility. Indirect effects are employment (or output) occurring in industries in the local area in the backward linkage supplying the RE facility. Induced effects result from households spending in the local area some of the additional income they receive as a result of employment in the RE facility plus additional household spending from people employed in other industries in the local area supplying the RE facility.

Thematic analysis was used to assess qualitative data to assess the relationship between RE and the communities in which it is located. This included cross-cutting themes such as community engagement, employment opportunities and the perception of renewable energy as well as specific themes such as access to cheaper energy, sponsorship of local activities, capacity building and linkages with tourism.

Desk research was used to consider the potential role of new and developing technologies in the future and their likely impact on rural development. Together with the primary research findings, this was then used to make an assessment of the overall impact of RETs on rural development in 2010 if Government targets were met.

Conclusions

Local output multipliers for wind energy are extremely low (1.00 to 1.09) in all three cases for which it can be calculated but are larger for hydropower (1.13 to 1.25). Those associated with biomass renewable energy plants are larger still (1.16 to 1.61). It would be dangerous, however, to draw firm conclusions of the relative magnitude of local output of wind, hydro, or biomass multipliers. The case studies here are a small sample of the number of renewable energy plants in each of these categories.

The magnitude of local output multipliers is also affected by the location of the renewable energy plant relative to supplying industries. Biomass plants require fuels that often have a cost and need to be transported while the energy inputs for wind and hydro are supplied free by nature and are "in-situ".

Biomass input may also be an external product of some other production system eg poultry litter or straw. A more accurate measure of the output multiplier for this type of biomass energy would be to measure the additional output in the local economy from using the by-product for energy production rather than disposing of it in some other way. Thus, if the output (sale) of poultry litter is excluded, then the output (value) of local businesses as a result of the biomass energy facilities falls substantially.

However, as biomass energy output expands, it is likely that this will be based on other biomass material eg willow. The Type 1 multiplier impact of using short rotation coppice (SRC) as an RE input might be significant if it was grown on land which produced no other output. If SRC displaces cereal crops, both employment and revenue to farms would be lower from willow biomass production compared to cereal production. Thus SRC biomass production that displaces agricultural cropping will detract rather than add to indirect and induced multiplier effects in the rural economy.

The concept of thresholds for rural development to accrue is not helpful. Wind and hydro schemes are inherently small-scale and generate community benefits rather than substantive employment or income generation. The rural development benefits of biomass energy are based on the income generation and employment effects of a processing plant. The purchase and transport of fuel stock dissipates the benefits to a wider rural economy.

The rural development impact of meeting the Government's 10% RE generation target by 2010 was assessed using the DTI's projected growth in the various RE technologies. An allowance was also made for those RETs that did not impact on rural areas on any growth that was not rurally based eg co-firing of biomass. The gross economic impact is estimated to be a contribution to output of £743m into the rural economy and 2465 full time jobs.

In community terms, RE is almost entirely positive, bringing employment, support to hard-pressed farm communities through land rents, clean industries and funds for local projects. There appeared to be few problems of resistance to these developments once established, although the planning process blocks many. Changes to the latter and a gathering enthusiasm at regional level for RETs offers an opportunity for more co-ordinated and rational development. Linkages with tourism and other rural industry are very limited and a more proactive approach needs to be taken at the planning stage.

Expansion of renewables, in particular further development of onshore wind, hydro and energy crop biomass, which are all linked to rural areas, is potentially positive for rural communities but there is still a major educational gap. This needs to be addressed in a co-ordinated way by involvement of all key stakeholders (trade associations, Government and its Agencies).

Contents

LIST OF FIGURES

LIST OF TABLES

Acknowledgements:

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1 INTRODUCTION

In January 2002 the DTI New & Renewable Energy programme commissioned ADAS Consulting Ltd and the University of Newcastle upon Tyne to research the impact of Renewable Energy (RE) on Rural Development. This builds on earlier studies looking at the impacts of RE on rural economies by Ecotec[1], ESD[2] and the University of Bangor[3] in the mid-nineties.

1.1 Background

The main stimulus for the development of renewable energy in the UK up to 2000 was the Non-Fossil Fuel Obligation (NFFO) through which the government awarded contracts guaranteeing a premium price for electricity generated from non-fossil fuel sources for 15 years. NFFO aimed to provide a level playing field in which developing (and thus expensive technologies) could compete with coal, oil and gas. Successive rounds of NFFO aimed to reduce the scale of the premium, ultimately to the point at which fossil and non-fossil fuel sources achieved price parity. This approach was successfully demonstrated with wind energy systems.

From 1995 NFFO tranches offered contracts specifically for energy crop power stations. Unfortunately, significant local planning objections and/or difficulties in raising finance have seen the demise of most of the planned plants. Since 2001 the Renewables Obligation (RO) has replaced the NFFO. Electricity suppliers are now compelled to supply 10% of their electricity from renewable sources. Failure to do so will result in penalties of £0.03 per kWh, which when combined with the baseline electricity generating price of £0.02 per kWh for fossil-derived fuels suggests that a maximum price of approximately £0.05 per kWh could be paid for renewable energy. Wind and hydro schemes are viable at this rate. However, because the penalties would be distributed between the suppliers that do meet their RET targets, and because there is a deficit in the RE needed for the entire industry to meet its targets, the current value of renewable energy is much higher than the £0.05 per kWh level. Wind and hydro schemes are viable at this rate.

There is no banding of this payment and it is likely that a proliferation of wind and hydro energy projects will be seen, since these are the lowest-cost RE technology available. The ability of other RETs to develop is curtailed under the RO is curtailed since they cannot compete at the £0.05 per kWh level, particularly where large capital investment is needed up front. The future development of biomass, wave, tidal barrier, PV, geothermal and hydrogen/fuel cells will be significantly influenced by grant availability. Without such assistance, they are unlikely to feature in the blend of RETs in the next twenty years.

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1 Ecotec (1995). The Potential Contribution of Renewable Energy Schemes to Rural Diversification – General Review (ETSU K/PL/00107/REP).

2 ESD Ltd. (1995). A Preliminary Study of the Potential Contribution of Renewable Energy to Rural Diversification (ETSU K/PL/0108/REP).

3 Dulas Engineering Ltd. and University of Bangor. 1995. The Mynydd Y Cemmaes Windfarm Impact Study – Economic Impact (ETSU W/13/00300/REP/2E)

1 RENEWABLE ENERGY TECHNOLOGIES

Three Renewable Energy Technologies (RETs) have been selected for this study; wind, hydropower and biomass. These are particularly relevant to rural areas and have both a track record and scope to develop further. There are considerable differences between these types of renewable energy technology in terms of age of technology, infrastructure requirement and scale, which are important to consider alongside their contribution to rural development.

1.1 Wind Power

Wind power is derived from the harnessing of moving air to rotate turbine blades whose motion can be converted to electricity. Wind turbines can be deployed singly or in clusters (wind farms). As with other resources, such as mineral reserves, wind can only be exploited where it occurs. In geographical and commercial terms, this points towards areas having high wind speeds. Most wind power RET development has therefore occurred in exposed western areas of the UK.

The first UK wind farm was commissioned at Delabole in Cornwall in November 1991 with 10 turbines totalling 4MW in capacity. There are now 80 operational wind farms across the country with a total capacity in the region of 550MW. This represents only 0.4% of total UK electricity supplies. Nevertheless, in the past year the number of on-shore wind farm projects receiving planning consent has accelerated. These include large-scale projects in Wales: Denbigh Moors (25 turbines), Cefn Croes (39 turbines), Myndd Clogau (17 turbines) and Scotland: Cairn Uish (28 turbines). Two offshore schemes have also been granted consent at North Hoyle, Rhyl (30 turbines) and Scroby Sands, Gt. Yarmouth (39 turbines). There are many more projects in the planning stage including some proposals in Scotland that could individually generate between 240 – 450MW (Eaglesham Moor, near Glasgow, Stornoway on the Isle of Lewis and Black Law, south Lanarkshire). There have been significant technological advances in turbine design with output from single machines usually rated at 1.5MW compared to the 400kW of the earliest models. These advances also increase the prospects for development of commercially viable projects in less windy locations.

In evidence to the Government's energy review the British Wind Energy Association (BWEA) calculates that the contribution of wind energy to UK electricity supply could increase to at least 8% by 2010 and as much as 15% by 2020. The Government's policy on pricing of electricity generated from RE sources will clearly influence the scale of development, but the main obstacle to achieving this rate of growth appears to be the planning system. This view was endorsed by the House of Commons Environmental Audit Committee and Cabinet Office Performance and Innovation Unit (PIU, 2002). Despite these constraints, the BWEA believes that whilst it has taken 11 years to commission the first 1,000 wind turbines in the UK, the next 1,000 will be operational in only two years if the current momentum is maintained.

The planning authorities that determine applications for wind farm projects make their decisions in the context of their local development plans and Government Planning Guidance (PPG22). For the most part, development plans have restrictive, criteria based policies and in the case of landscapes designated to be of special value (National Parks and AONB's) these can provide a considerable barrier to commercial development. The latter often coincide with the highest, most exposed and therefore windiest locations.

PPG 22 is under review and planning guidance at the regional level is now emerging which is more likely to contain technology specific targets for renewable energy generation. This may include identification of strategic areas of suitable resource on proposal maps; with an expectation that planning authorities adopt policies having a presumption in favour of renewable energy developments where certain circumstances apply. The BWEA[4] has produced advice on the targets that could realistically be adopted for each region.

1.2 Hydropower

Hydro power has been used in industry for centuries. Like wind power, it is often located in areas of high environmental value and is subject to strict conditions at planning stage. The British Hydropower Association, which represents the sector, is critical of the obstacles to development presented by regulation through the Environment Agency[5].

Hydropower in the UK is mainly represented by large-scale storage or dam-based sites, built in the first part of the last century. While these continue to be most significant in terms of energy generation, environmental and planning constraints mean that most growth in hydropower is in small-scale (less than 5Mwe) schemes. These include schemes based on existing dams and lochs and run-of-river projects.

In 2000, hydropower generation in the UK was estimated at 1450 MW from large-scale hydro schemes and 73 MW from small-scale hydro projects with an additional 2,488 MW of pumped storage capacity[6]. In 2000, small-scale hydro contributed only 0.6% of total UK renewable energy generation[7] and large-scale hydro contributed 14.0%.

Research suggests that there is a further 200-600 MW of exploitable hydropower projects in the UK[8] and a large number of potential sites are currently under consideration. The scope for this Renewable Energy Technology (RET) is limited by the ability to develop suitable sites economically.

1.3 Biomass

The term biomass covers all cellulose-based feedstocks including agricultural and forestry crops and residues, animal litter wastes and by-products. Burning wood is the oldest form of energy production. It is only very recently that other fuels have supplanted wood as the world's principal fuel. Indeed, in many regions wood-burning technology has remained the sole source of energy generation with little or no technological improvements.

In the UK, the generation of energy from biomass is diverse in scale and technology. Boilers running on wastes (commonly wood waste and forestry residues) as well as wood logs are common. These vary in scale from a few kW to many tens of MW. Biomass energy plant usually fall into one of three categories; combustion, gasification or pyrolysis.

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[4] BWEA website.

[5] BHA. September 1999. The Demise of Small Scale Hydropower in England and Wales due to Over Regulation by the Environment Agency. Memorandum to the House of Commons Select Committee on Environment, Transport and Regional Affairs

[6] BHA, 2002. Personal Communication.

[7] Digest of United Kingdom Energy Statistics, 2000.

[8] Innogy Hydro. Harnessing the Natural Power of Water.

Simple combustion systems are by far the most common form of biomass RET. Conversion to electricity with this technology has particularly low conversion efficiencies (c. 20–35%). On the other hand, the technology is reliable and proven and therefore appropriate for immediate uptake and exploitation.

Gasification involves the conversion of the biomass into a combustible gas through initial combustion under reduced oxygen atmosphere and temperatures of 800–1,300°C. The resultant producer gas consists of CO, H_2 and CH_4 as the main combustible components. The producer gas can be used as a substitute fuel in oil-fired furnaces or boilers or in engines (diesel, gas turbines).[9]

Gasification technologies for biomass are based on existing systems for coal and, whilst relatively new and unproven, offer significant gains in efficiency for electricity generation at the 1–30 MWe scale. A technical option, which is receiving widespread interest in the UK, is the co-combustion and co-gasification of coal/wood mixtures (consisting of 20% w/w wood) in existing coal-fired stations. However, the major limitations to biomass co-firing are that a) biomass is difficult to pulverise in the manner used for coal in advanced systems and b) the propensity of biomass to produce fouling gases and slagging limit enthusiasm of industry for uptake.

Pyrolysis is the thermal degradation of biomass in the absence of oxygen. A resultant liquid biofuel (bio-crude) with a high bulk density can then be used for firing boilers with relatively high efficiency (35–50%). Pyrolysis systems are still at the developmental stage and the two biomass-fuelled pyrolysis systems proposed under NFFO for the UK (at Carlisle developed by Border Biofuels and Thetford by Econergy) have both failed due to the developer's inability to secure warranties for turnkey operation[10].

Generally, renewables result in zero or much less CO_2 emitted per GJ of energy generated. Most potential for CO_2 mitigation is shown by biomass and energy crops grown over the long term in a sustainable manner, even though CO_2 release (per GJ energy generated) is highest (Table 1). Their benefit lies in the fact that re-growing vegetation will re-absorb any CO_2 released during combustion. Sustainable energy cropping on short rotations offers in the long term a more efficient strategy for CO_2 mitigation than carbon storage in vegetation, because the latter would saturate in time (maximum tree growth rates decline after 10–60 years).

Table 1: Carbon emissions from some primary energy sources (IPCC, 1995).

Fuel	**kg(C)/GJ**
Wood	26.1–29.9
Peat	30.0
Coal	23.9—25.8
Crude oil	19.0–21.4
Natural gas	13.6–15.4

Replacement of fossil fuels with biomass and energy crops is close to carbon neutrality because any CO_2 emitted is re-absorbed during the photosynthesis of successor crops that

[9] Nordin and Kjellstrom, 1996).

[10]Project Development Manger’s personal communication

have replaced those which were harvested or have re-grown. Increased awareness of the potential of energy crops has come in response to the requirements for CO_2 abatement and other environmental considerations, increased global demand and regional land use issues. Whilst renewables and biomass systems for large-scale energy generation often are relatively expensive, most renewable systems in industrialised countries are seeing a 10–15% reduction in costs of production year on year.

In the UK, an area of 125,000 ha of energy crops is proposed by 2006[11] and both Short Rotation Coppice (SRC) and Miscanthus are eligible for planting grants in addition to "set-aside" annual payments. It is proposed that the resultant biomass (c. 1.5Gt per yr.) will be used in conventional combustion systems for the generation of electricity, in combined heat and power (CHP) units, or in gasification/pyrolysis systems. The scale of conversion will range from 50kWe to 50 MWe. There are opportunities for co-firing fossil fuel powered plants and also combined heat and power (CHP) generation.

Post-NFFO, there are a number of support schemes to encourage biomass energy generation. Energy crops (SRC or miscanthus) receive establishment grants of between £920/ha and £1600/ha. These grants require evidence of an end-user, but letters of intent are sufficient at the planting stage. In many instances crop has been planted before the functioning power station is constructed. Subsequent failure of the power station development has left farmers with a crop but no market.

Once of the biggest uncertainties for large-scale biomass projects (and the major consideration when raising finance for such schemes) is the infrastructure of biomass supply and associated logistics. Security of supply in a timely fashion for high quality material must be obtained and this becomes increasingly difficult as the scale of the power unit increases. Banks will expect to see large contingent reserves of biomass and an absence of competing markets for that biomass before supporting a scheme.

The UK government acknowledges the particular problem posed by biomass supply (unique in all renewables technologies; wave, wind, tide and solar energy are all free at the point of source) and additionally supports the set-up of fuel producer groups. The level playing field offered by the Renewable Obligation does not however account for either the high costs of emergent technologies like biomass nor the need to purchase the primary feedstock. Therefore, the government through DTI and the lottery-financed New Opportunities Fund is also contributing to the capital costs of new build projects. It is anticipated that these three schemes will be sufficient to encourage new bio-energy schemes.

Simultaneously, Planning Guidance 22 (PG22) is being revised in order to enable more rapid assessment of biomass unit planning applications and stimulate a spirit that accounts more fully for the positive environmental impacts of renewables generation generally. Comments on PG22 already given for wind apply equally to proposed biomass systems.

[11] DTI, 1999

2 CASE STUDIES

Twelve case studies (based on a range of project age, scale, geographical location and rurality) were selected for this study. These were agreed with the client and the managing companies approached to secure co-operation. At this stage, one company (Garnedd Power Co Ltd., Gwynedd) was unable to take part due to unavailability of key staff. A replacement site in Wales was agreed with Innogy Hydro (Cwm Croesor).

This chapter provides a short profile for each of the twelve participating sites and Table 2 summarises the projects. It should be noted that since the onset of this study, the flagship biomass energy project in the UK – the 8 MWe Project Arbre owned by First Renewables Ltd – has gone into receivership and now may never generate electricity. Although initial interviews with Arbre staff were arranged, the demise of the company has terminated this component of the RE review. A replacement site was agreed with Fibrowatt (Fibrothetford), another poultry litter plant.

Table 2: Case Study Sites

	Technology	Start date	Capacity MW DNC	Location
Wind				
Harlock Hill		1997	1.49	Cumbria
Deli nr. Delabole		1991	1.72	Cornwall
Lambrigg Windfarm		2000	2.53	Cumbria
Hagshaw Hill Windfarm		1995	4.06	Lanarkshire
Carno Windfarm		1997	6.32	Powys
Hydro				
Glen Tarbert	Run-of-river	2001	0.83	Inverness-shire
Cwm Croesor	Dam-based	1999	0.5	Gwynedd
Garbhaig,	Loch-based	1993	1.0	Rosshire
Biomass				
Thetford Biomass Power Station	Poultry litter	1998	38.50	Norfolk
Eye Biomass Power Station	Poultry litter	1992	12.69	Suffolk
Westfield Biomass Power Station	Poultry litter	2000	9.80	Fife
Elean Power Station	Straw	2000	31.00	Cambridgeshire

Taking the failure of the flagship Arbre project into account, it was decided that the study should look at smaller scale biomass operations. Although these are limited in number and scale, preliminary discussions with Talbotts Ltd, who manufacture biomass and wood waste-to-energy systems equipment designed to combust a variety of waste/renewable material for the generation of thermal energy. A case study was not forthcoming and after discussion with DTI New & Renewable Energy programme, it was agreed that the best option was to look at the inputs and outputs from farm energy crops and use these to infer the likely multipliers for SRC biomass. This involved consultation with 3 SRC growers and analysis of the Arbre operation.

2.1 Wind

2.1.1 Delabole, Cornwall

The project was commissioned in 1991 under a NFFO I contract. Approval for the development was granted by the Government following "call in" of the planning application. It has 10 x 400kW turbines and was developed and continues to be operated by a small company, Windelectric Ltd, based at the site. A major visitor centre, the Gaia Energy Centre, was developed, alongside the wind farm in 2001. It has exhibitions and demonstrations on all forms of renewable energy, together with a lecture theatre, classrooms, café and shop. The Centre is operated by a charity and has attracted significant regional development funding.

2.1.2 Harlock Hill, Cumbria

The project was developed by the Wind Company (Sweden) and commissioned in 1997 under a NFFO 3 contract. It has 5 x 500kW turbines. Ownership has subsequently passed to the Baywind Energy Co-operative, which now operates the site. The Co-op is the only one of its kind in the UK. It has a Board of Directors and over 1300 shareholders, with a large proportion of these from the immediate locality. Shareholders receive a return based upon the income from electricity sales and the level of their individual investment. The Co-op has also established an Energy Conservation Trust, which allocates a proportion of the revenue to local good causes.

2.1.3 Hagshaw Hill, Douglas, South Lanarkshire

Ecogen developed the site in 1995 under a SRO 1 contract and did not attract significant controversy at the planning stage. The site is now operated by Scottish Power and has 26 turbines with a total output of 15.6MW. Maintenance of this Windfarm (and others owned by Scottish Power) is currently contracted out to Ingenco, a company specialising in this work and based in Wales. Scottish Power has established a Hagshaw Hill Community Windfarm Trust, which distributes grants to community and environmental projects in the locality.

2.1.4 Lambrigg, Cumbria

The site has 5 x 1.3MW turbines producing a combined output of 6.5MW. It was developed and is operated by National Wind Power under a NFFO 4 contract and was commissioned in 2000. Consent for the scheme was granted by the local planning authority despite some objections from neighbouring authorities, including the Lake District and Yorkshire Dales National Parks. National Wind Power has established a local Community Fund, which is distributed via the local Parish Council.

2.1.5 Carno, Powys

This scheme operated by National Wind Power was the second largest wind farm in Europe at the time of its construction in 1995. It has 56 × 600kW turbines and the site extends over 600ha. This site also has a Community Fund, which distributes £20k per annum to local community projects.

2.2 Hydropower

2.2.1 Garbhaig, Wester Ross

This project is a hydro electric storage scheme, located south of Loch Maree, above Victoria Falls on A832 in Wester Ross. Output is 896kW. Construction started in 1988 and the plant was then operational for a short period before refurbishment and completion in 1993. It comprises a 2.5m weir/inlet on Loch Garbhaig with an underground pipeline (1500m) to a turbine house (30ft x 15 x 15) immediately above Victoria Falls where water is returned to river.

NFFO did not apply in Scotland and the equivalent was the Scottish Renewable Order. Prior to SRO there were transitional contracts (1991 – 98) and Garbhaig qualified under this.

2.2.2 Cwm Croesor, Gwynedd

This small-scale hydro project is a 500kW run-of-river scheme, located in Snowdonia National Park. It was commissioned in 1999 with support from NFFO 4. It is based on a redundant 19th century scheme and was rebuilt for National Power plc by Dulas Ltd of Machynlleth. It has a gross head of 262 m with a 250 l/s design flow and employs a single jet 1000-rpm Pelton turbine, which was manufactured in the UK. It is noteworthy that construction materials had to be flown in by helicopter owing to the environmentally sensitive location and poor access to the site.

Innogy Hydro (part of National Power) manages the scheme at Dolgarrog, Conwy, N. Wales. This involves regular site visits by an operator from Dolgarrog.

2.2.3 Glen Tarbert, Argyll

This small-scale hydro project is an 840kW run-of-river scheme, located in a very remote area near Fort William. It was commissioned in 2001 with support from the SRO. The scheme uses water flows in local burns and required neither dam construction nor reservoirs.

The scheme is managed remotely by Innogy Hydro (part of National Power) at Dolgarrog, Conway, North Wales. A local contractor carries out routine maintenance.

2.3 Biomass

2.3.1 Eye Power Station, Suffolk

The project was commissioned in 1992 under a NFFO I contract and was the world's first commercial generating plant using poultry litter as fuel. A Danish company built the 12.7MW plant for Fibrowatt Ltd. under a turnkey contract. It uses a single, conventional boiler system and grate, specifically designed to combust poultry litter and other biomass fuels. The project cost £20m and has generated over 30 full-time jobs locally plus many more local jobs in supporting businesses. It is situated in one of the UK's largest poultry growing areas and offers an outlet for the potentially polluting litter. The Station Manager runs a Local Liaison Committee and offers sponsorship for local events.

2.3.2 Thetford Power Station, Norfolk

This site was commissioned in 1998 under a NFFO 3 and has a capacity of 38.5MW. It is Fibrowatt's third and largest poultry litter plant in the UK. It uses a single, conventional boiler system and grate, specifically designed to combust poultry litter and other biomass fuels. The project cost £70m and has generated over 30 full-time jobs locally plus many more local jobs in supporting businesses. It takes litter from around the country as well as locally. The Station Manager runs a Local Liaison Committee and offers sponsorship for local events.

2.3.3 Westfield Biomass plant, Fife

The Westfield Biomass plant is operated by Energy Power Resources Ltd and generates electricity from combustion of poultry litter. The £22m project generates 10 MWe (net electrical output) using bubbling fluidised bed technology. Annual biomass use is 110,000 tonnes. The main furnace temperature is 850°C and a condensing steam turbine receives steam at 460°C/60bar. The alternator generates at 11 kV, which is stepped up to 33 kV before export to the grid. The electricity is sold under SRO1 and the plant has been generating since 2000.

2.3.4 Elean Power Station, Ely

The Elean Biomass plant is operated by Energy Power Resources Ltd and generates electricity from combustion of cereal straw. The £60 million project generates 36 MWe (net electrical output) using vibrating grate combustion technology. Annual biomass use is 200,000 tonnes. The electricity is sold under NFFO3 and the plant has been generating since 2001. The project has generated over 30 full-time jobs plus additional local jobs in supporting businesses.

3 RETs AND RURAL DEVELOPMENT

The context for this study is that initiatives to promote rural development have been seen as a means of supporting farming while achieving environmental and social policy goals. The rationale for supporting rural development was outlined in the 1999 PIU report Rural Economies[12] and the vision developed in the DEFRA Rural White Paper.

The research was designed to collect data on investment, income flows and employment at operator level but also to capture information from companies upstream and downstream. The ability of any industry to impact on a rural economy relies on its relative scale and its linkages with other key sectors of the local economy eg agriculture, tourism, business services. A 30-mile radius of the plant was used to define "local" in terms of income flows, employment etc to give a consistent analysis. Findings suggest however that this qualification may need to be revised for more isolated rural sites.

The research also considered non-trading benefits in terms of environment and community. These are less tangible but key to sustainability and support from local planners and agencies. It was not a primary objective of this study to ascertain how popular or otherwise RE schemes are in their own communities. However, acceptance of the RE technologies by local people is a major planning issue as raised in K/PL/00108/REP.

3.1 The Survey

All twelve sites have been researched and face to face interviews undertaken with plant owners and/or managers. Employees and stakeholders were nominated and asked to complete a questionnaire by post, email or by telephone interview. This chapter summarises the qualitative and quantitative responses to the consultation exercise as it relates to economic impact.

[12] PIU (1999). *Rural Economies*. Policy and Innovation Unit of the Cabinet Office.

3.2 Wind

Lambrigg Wind Farm, Cumbria © National Wind Power Ltd

The main points can be summarised as follows:

Most of the capital cost involved in the development of wind farms is for the supply of turbines and associated plant. The companies that manufacture the turbines and associated plant and equipment have, to date, almost exclusively been from overseas. Local firms have benefited from the construction of infrastructure and electrical installation work but this has been a relatively small component of total capital expenditure Landowners can receive significant rental income from wind farms and can be a much more attractive and secure form of diversification than other available options. Wind farms have low operational costs and labour requirements once commissioned; a large share of the maintenance work is carried out via the turbine supplier Taking proposals through the planning appeals procedure is costly and uncertain and can act a significant constraint on new development Independent research suggests that any local concerns or hostility towards the environmental impacts of wind farm proposals evaporates once they are operational Wind farm projects increase public awareness and generate more positive attitudes towards environmental and energy conservation issues With some notable exceptions, there has been little development of on – site facilities and

services either to generate or respond to public interest in wind farm projects

The companies which operate wind farms invariably devote a proportion of revenue to local community projects

3.3 Hydropower

Croesor Hydro Works, Gwynedd © Innogy Hydro

The main points can be summarised as follows:

Small-scale hydro has a high capital cost per kW relative to conventional energy generation. Even though the fuel is free, support measures such Renewables Obligation are needed to make small hydro schemes economically viable.

Once established, the ongoing input for operation and maintenance is low and this is often done remotely from another area or region. This can make it difficult to demonstrate economic and social benefits locally.

Small-scale hydro has limited environmental impacts (on fish populations, drainage effect of pipelines) but due to the strict planning conditions, this is more than compensated for by positive mitigation eg river corridor for wildlife. In context, RE has local impacts while conventional energy (fossil fuels) has global impacts

Social impact of small-scale hydro is based on jobs sustained/income stream into the local economy (land rents, local contractors, use of accommodation), in-kind benefits (provision of access and fencing) and community funding programmes (£5-10k per MW) often set up by energy companies.

Hydro is often located in remote areas where the local economy is based on agriculture & tourism – both low wage – and can have a significant impact. There is often an associated high environmental value in these areas and this can make planning a major issue. However, small-scale hydro is generally much preferred in terms of environmental impact by local stakeholders eg National Parks, to more visible development such as wind farms or large-scale hydro.

Like other RE projects, hydro schemes increase public awareness and generate more positive attitudes towards environmental and energy conservation issues

Visitors are encouraged to visit sites but this tends to focus on more urban-based projects where staff are based and numbers justify the input.

3.4 Biomass

Eye Power Station, Suffolk © Fibrowpower Ltd

The main points can be summarised as follows:

Bio-energy crop schemes have generally required farmers to initiate cropping before the power station has been built. So far, this leap of faith has not been good judgement since biomass stations at Swindon, Carlisle, Newbridge-on-Wye, Thetford and most recently the Arbre plant at Eggborough have all failed to be built or commissioned. This is a significant problem for future plants, and an ongoing problem for farmers already committed to the crop.

Revenue to farmers for the energy crops is generally low, particularly given the risks and opportunity costs of perennial cropping. A standing crop of coppice may reduce by 50% the effective farmland value. Grant aid has to date been insufficient to stimulate massive cropping programmes.

Planning issues, concerns over supply logistics and the lag phase between commissioning and energy crop supply all pose serious limitations on the feasibility and “bankability” of major bio-energy schemes. Smaller, embedded schemes may be more appropriate but have not previously found favour with DTI due to perceived lower efficiencies of supply and generation.

The plants using poultry litter have successfully used a proven technology to generate power and have also made use of an available by-product from agriculture. There is an additional environmental benefit from using this potential pollutant in areas of concentrated poultry farming and NVZ areas. However, these plants may be forced to invest heavily in cleaning technology if the process is deemed to fall within the EU Waste Incineration Directive.

The Renewables Obligation is not considered sufficient or secure enough for lenders to support new-build for this technology, which has a high investment cost and has to pay for its fuel. It is argued that it cannot compete with conventional established technologies until it has had time to build infrastructure, track-record etc

Local rural impact of these schemes is high since they require locally produced biomass. Indeed the capital cost of the building phase of a biomass plant is a small proportion of the total project’s costs.

The bulk of the capital cost involved in the development of biomass systems is for the supply of furnace, boiler, gasifier and turbines. Most of this is sourced from mainland Europe with little direct benefit to UK plc. Local firms have benefited from the construction of infrastructure and electrical installation work but this has been a relatively small component of total capital expenditure

Biomass systems have high operational costs and labour requirements once commissioned; a large share of the maintenance work is carried out via the turbine supplier but there are significant impacts on local direct and indirect employment

The scale of generation of RE from biomass is more substantial than most other technologies. In this respect, it should have the greatest potential to contribute to Government targets. However, a catalogue of failed projects threatens to undermine large-scale projects.

Planning consent remains a major issue but the evidence is that any local concerns or hostility towards the environmental impacts of biomass system proposals evaporates once they are operational and can be reduced at planning stage by early involvement and consultation with all stake-holders

biomass projects increase public awareness and generate more positive attitudes towards environmental and energy conservation issues

The companies which operate biomass projects invariably devote a proportion of revenue to local community projects

4 MULTIPLIER ANALYSIS

An economic multiplier summarises the total impact or effect in a region that might be expected from a development project and its operation, such as a renewable energy (RE) facility. The regional economic impact of a facility can be assessed by constructing either (a) a Keynesian local economic multiplier model, or (b) an input-output (I-O) model.

National I-O tables are produced regularly, but there are no local I-O tables. Considerable effort would be required to construct accurate local I-O tables, which detail linkages between all industries within a spatial area and across spatial boundaries (see Willis, 1987). The excessive data demands of an I-O table are avoided in this study by collecting a more restricted set of data on output and employment related to the RE facility itself, and constructing Keynesian economic multiplier estimates. More assumptions need to be made in the construction of Keynesian economic multiplier models than in the use of local I-O tables, and these are outlined later in this section.

The economic change as a result of a RE facility can be measured in several ways. In this section two economic change measures are estimated: the impact of RE facilities on (a) employment, and (b) output in a local economy. For each of these measures of change, two types of economic multiplier are estimated: a Type 1 multiplier and a Type 2 multiplier.

To understand how multipliers are calculated, and the distinction between Type1 and Type 2 multipliers, it is essential to distinguish between direct, indirect, and induced effects in a local economy. *Direct effects* are the employment (or output) change occurring in the economic agent that is the subject of investigation: the RE facility. *Indirect effects* are employment (or output) occurring in businesses in the local area supplying the RE facility. *Induced effects* result from households spending in the local area some of the additional income they receive as a result of employment in the RE facility plus additional household spending from people employed in other industries in the local area supplying the RE facility.

An employment multiplier measures the total number of jobs that will be created in the local area as a result of the RE facility. The employment multiplier for a local economy is defined as the ratio of the employment in the RE facility plus employment change in other local industries as a consequence of supplying the RE facility, to the employment in the RE facility: $K_E = \Delta(E_{RE} + E_L) / \Delta E_{RE.}$ This is a Type 1 employment multiplier, based upon direct and indirect employment change. Where K_E is the employment multiplier, E_{RE} is the employment in the RE facility and E_L is the employment elsewhere in the local economy.

A Type 2 (sometimes referred to as a Type 3) employment multiplier equals (direct + indirect + induced effects) divided by direct effects. A Type 2 employment multiplier thus includes the effect of increased employment in backward linked industries supplying the RE facility, as well as the employment effects of induced consumption. Output multipliers are calculated in an analogous manner.

The size of the local multiplier depends directly on the proportion of income spent locally or, inversely, on the proportion of income at each round of spending which leaks out of the local stream into savings, taxation, reduced transfer payments, or import purchases. The size of the multiplier, therefore, tends to vary directly with the size of the local area, since import leakage declines as the size of the area increases.

For each case study we have used this approach to isolate the economic impacts associated with the development of renewable energy sources. We have interviewed companies to identify the workforce involved in the new developments and account for their expenditure behaviour within the local area. This accounts for the flow of additional income into and out of the local area. We have also collected detailed information on income and expenditures of those individuals who have gained employment as a result of the development.

This information examines both direct and indirect sources of income. The former concentrates on those individuals employed directly in the construction, maintenance and operation of the renewable energy facility, while the latter deals with indirect benefits to other sectors such as tourism and hospitality. Much of this information has been gathered through questionnaire surveys of relevant individuals and local businesses. The sampling frame was determined following the selection of case study sites. At this point, appropriate sectors to target were agreed for the information gathering exercise.

4.1 Data

Data to construct the Keynesian employment and output multipliers comprised two sources:

- information from RE firms on payments to locally based factors of production, and also information on the initial capital injection to set up the RE facility
- information from employees on their expenditure (by type and spatial area) and savings

The analysis is separated into two elements:

- the impact of the initial capital injection required to build the RE facility on the local economy (which is temporary); and
- the impact of the continuing revenue stream from the sale of electricity from the RE facility on the local economy (which is permanent, but subject to fluctuations in the NETA contract electricity price).

4.2 Analysis: initial capital injection

The survey of RE site owners obtained information on the initial capital injection to develop the facility. The impact of the initial capital injection on the local area was quite small. For wind-turbines, the manufacture and erection of the turbines was undertaken by companies outside the local area (actually, outside the UK). Non-local companies also undertook grid connection, switch-room and cabling. Local expenditure was limited to local construction firms laying foundations and roads.

Table 4.1 reveals that, for wind-power, the percentage of local capital expenditure to total capital expenditure was extremely small. Thus labour to construct was essentially employed by an outside contractor, based locally at the RE site during this phase.

Hydropower also created few local jobs during the construction of the facility. A larger percentage of local to total expenditure was reported for two of the sites. Approximately half of this local expenditure in each case was attributable to land purchase and professional services respectively, and not to the purchase of local machinery and other material inputs.

The largest impact on the local economy came from the construction of biomass power plants. This mainly arose because of the size of these plants, and the fact that they are located closer to urban areas with large populations and firms able to supply construction equipment to develop the site. The actual mechanical equipment for the biomass plant was built overseas and imported into the UK.

Table 4.1: Impact of initial capital injection to build renewable energy facility - average values of all the case study sites

Technology	Total cost (£000)	Local expenditure (£000)	Percentage of local expenditure to total cost	Number of job years
Wind	9,520	495	5	15
Hydro	1,080	133	12	3
Biomass	56,667	5,767	10	459

4.3 Analysis: continuing revenue flows

Information on continuing revenue and local expenditure of the RE firms is summarised in Table 4.2. It is immediately apparent that little continuing employment is attributable to wind and hydro RE facilities. Moreover of the employment generated only around 50% is located in the local area of the wind and hydro RE facilities (defined as <30 miles from the RE site). Biomass energy production, by contrast, generates many more local jobs. This due to the scale of electricity production from the biomass plants; since (electricity) output per local job is also higher for biomass than for hydro (so that there are relatively fewer local jobs per unit of energy production from biomass compared to hydro).

Table 4.2: Summary data of the local economy benefits of each RE facility (£ thousands) - average values of all the case study sites

		Wind	Hydro	Biomass
Local Jobs	PT	2	2	1
	FT	0	0	25
Total Jobs	PT	2	6	1
	FT	0	0	28
Rent		27	5	0
Business rates		30	3	80
Community payments		9	2	2
Inputs from local firms		105	19	2,358
Income from electricity sales*		962	100	9,775
Grants LECs		0	5	0
Grants: ROCs		0	49	0
Total income		962	154	9,850

* Revenues can vary with actual wind conditions and with turbine breakdowns
N/R = not recorded on the questionnaire. NA = not applicable
** Same revenue recorded for each year, but with note to effect that the revenue varied from year to year!
*** This facility was commissioned in 2001.

Table 4.4: Output multiplier estimates for the RE facilities (£ thousands) - average values for all case study facilities.

	Wind	**Hydro**	**Biomass**	**Biomass excluding agricultural input**
Local Wages	26.1	7.5	426	
Output in other businesses in local area	95.6	21	2360	885
Total output	961.8	100	9775	
Basic Type 1 Output Multiplier	1.19	1.19	1.38	1.10
Basic Type 2 Output Multiplier	1.20	1.18	1.40	1.12

Falling electricity prices have resulted in a decline in revenue for the case study sites. A decline in electricity revenue may affect income flow into the local economy in the future. For the present multiplier calculation, the 2001/2002 revenue stream is used.

4.4 Output multiplier estimates

The estimates in Table 4.2 for the flow of revenue due to the output of the RE facility into the local economy as a result of the RE facility can now be used to derive the output multiplier effect of the RE facility. They show the first round on inter-industry transactions from the RE facility. Again some assumptions are required about the land rent, business rates and community payment money flows. We assume that community payments accrue as outputs to community activities, along with purchases from local firms and service providers. However, we assume that business rates are not hypothecated as expenditure in the local area. Land rent is regarded as a payment for a fixed factor of production and will be treated as income to the landowner and included with other household income (wages) in estimating Type 2 multipliers.

No information was available on the subsequent transactions between sectors in the local economy in which these renewable energy facilities are located. However, if we assume the same output of products in other local firms as the local output (expenditure) to total revenue of the RE facility, then Type 1 output multipliers of the magnitude reported in Table 4.3 are derived.

There are discrepancies in the recorded data for the total amount of output purchased from local firms, and the sum of this output when it was collected by disaggregated industrial category (machinery and equipment; chemicals; transport, storage, and communications; electricity, gas and water; financial and business services; agricultural; construction; and others). Where this occurs, the higher of the two recorded local purchase values is used to estimate the Type 1 output multiplier.

It would be dangerous to draw any firm conclusions of the relative magnitude of local output of wind, hydro, or biomass multipliers. The case studies here are a small sample of the number of renewable energy plants in each of these categories. The magnitude of local output multipliers is also affected by the location of the renewable energy plant relative to supplying industries. Biomass plants require more input (biomass) than wind or hydro whose energy inputs is supplied free by nature.

Some biomass material is a necessary external product of the production of some other good. Poultry litter is a necessary part of the production of chicken meat and eggs, whilst straw is a necessary part of cereal production. If energy output was to expand, it is unlikely that this rise would be satisfied by increasing the output of chickens and eggs, or cereal, but rather from an increase in the output of some other biomass material (eg willow).

A more accurate measure of the output multiplier, for that type of biomass energy that is dependent upon the by-products of other industries, would be to measure the additional output in the local economy from using the by-product for energy production rather than disposing of it in some other way. Thus, if the output (sale) of poultry litter is excluded, since the production of poultry litter does not depend upon its purchase by the biomass energy plants, then the output (value) of local businesses as a result of the biomass energy facilities falls substantially. As a consequence, the Type 1 output multiplier estimates are reduced significantly for the biomass energy plants, as Table 4.4 reveals. As a result of the exclusion of poultry litter as a local output, the Type 1 multiplier estimates for biomass energy plants are of the same order of magnitude as those for wind and hydro renewable energy plants. [Note: with poultry litter excluded, a significant element of the economic multiplier derives from local transport of poultry litter to the biomass plant. However, if transport was required to dispose of poultry litter in some other way, then the *additional* economic multiplier effect from transport attributable to the RE plant would be zero].

4.5 Local employment multiplier estimates

The local employment multiplier measures the total change in local employment resulting from the employment at the renewable energy facility. Type 1 employment multipliers are obtained by dividing the direct and indirect employment by the direct employment in the RE facility.

Indirect employment was estimated by calculating output-employment coefficients for are each broad industrial sector. These show the amount of output per employee in each industry. Thus if the RE facility purchases £X worth of input from a supplying industry it is possible to estimate how many jobs in the supplying industry this annual purchase sustains.

The output-employment coefficients were derived from the Input-Output Supply Use Table (2000) and employee jobs by industry (2002). The I-O SUTs provide a picture of the flow of products and services in the economy for a single year. These tables provide a single framework showing the relationships between components of gross value added (GVA), industry inputs and outputs, product supply and demand, and the composition of uses and resources across institutional sectors, within the National Accounts framework. The UK Input-Output (I-O) Analytical Tables are derived from the annual (I-O) Supply and Use Tables (SUTs).

Employment by industry was derived from Office of National Statistics (2002) data, which records employee jobs, by industry (Standard Industrial Classification 1992) in the UK. Seasonally adjusted figures for all persons in employment in Spring 2002 were adopted.

The output of local industries supplying the RE facility was divided by the employment coefficient to calculate the number of indirect jobs attributable to the RE facility. The results are shown in Table 4.4. Two local employment multipliers are calculated, in recognition that wind and hydropower can result in part-time job creation outside the local area for engineers and financial service personnel maintaining the facility. Thus K1 expresses local jobs in relation to jobs in the RE facility where these workers live locally. K2 expresses local jobs in relation to all jobs in the RE facility irrespective of where the RE workers live.

The largest employment multipliers are those associated with biomass RE facilities. The multiplier estimates in Table 4.4 for biomass assume that no agricultural jobs depend upon purchases from the agricultural sector, since the fuel is a by-product of another agricultural activity (eg chicken and egg production, or cereal growing). Extremely low employment multipliers are associated with hydropower production.

4.6 Indirect and Induced Multiplier estimates

Multipliers that estimate the indirect (output and employment in other industries supplying the RE industry) plus induced (purchases by local households as a result of wages) effects are termed Type 2 multipliers. Type 2 multipliers require information on the wages paid by the RE facility and wages to labour in firms supplying the RE facility with products and services; plus the expenditure pattern of these workers.

In the absence of extremely detailed income and expenditure figures (eg along the lines of the Family Expenditure data, with supplementary information on the local of household expenditure), some assumptions have to be made about imports, savings, and taxation rates to which employees of the local RE facilities and other workers in the local economy are subjected.

To estimate the multiplier effect of household expenditure from enhanced income due the RE facility, we need to derive values for

c = marginal propensity to consume;
t_d = direct tax and National Insurance contributions;
u = percentage decline in transfer payments (eg unemployment and social security payments);
m = proportion of spending on goods imported into the region; and
t_i = indirect tax rate.

Information on employee income and expenditure covers only a limited number of individuals, from the different RE sites. Some are directors in the RE companies, and other are managers, and are therefore not representative of the technical, skilled and unskilled workers, and administrative and clerical staff associated with RE facilities, and other businesses in the areas of these RE projects. Indeed, two directors had extremely high rates for marginal propensity to save (MPS) of 50% and 25%, implying that their marginal propensity to consume (c) is 0.5 and 0.75 respectively.

The small number of workers sampled meant that it would be unreliable to apply the characteristics of those workers associated and sampled from each RE plant, to that particular RE plant. Hence, information from all 9 employees for which requisite financial information was available was generalised to all the RE plants. Moreover, these workers might not be characteristic of workers in industries supplying the RE facility.

The average gross income of the employee sample was £38,544. 86% of this income was attributable to the RE facility. The survey of employees can be used to derive values for c, t_d, u, m, and t_i.

The induced multiplier calculates the multiplier impact of a marginal increase in wages from the RE facility. Spending and saving data of employees reveals an average propensity to save (APS) of 0.10, and conversely an average propensity to consume (APC) of 0.90. This is slightly higher than the MPS figure, which can be calculated from Family Expenditure Survey (FES) data. FES data for 2000-2001 indicates an APS of 8% for all households [ie (savings + pension contributions) divided by disposable income]. However, Table 4.2 reveals that the RE facilities generated a lot of part-time (PT) local employment. Thus the impact of these RE facilities can be regarded as contributing marginal income to each household. Marginal income (eg from a part-time jog in RE, which is additional to the main household income source) will by definition be subject to higher MPS than intra-marginal income (ie main household income from employment outside the RE facility). Thus the induced multiplier impact of RE facilities will be less than would otherwise occur if these facilities had provided full-time jobs. Thus, given APC is approximately 0.90, it might be reasonable to assume that the marginal propensity to consume (MPC) c = 0.85 (ie MPS = 0.15).

By analogous reasoning, direct taxation is likely to be high (ie 22% or 40%), with marginal increases in income, although for some individuals the increase in income attributable to the RE facility will exclude them from additional national insurance (NI) contributions. From the employee data we estimated, using tax and national insurance bands for the tax year 2002/03, that each employee will pay £9,577 in direct taxes to the government, giving a value for t_d of 0.248. This reduces the net wage spending attributable to the RE facility by each employee within the county to £17,598.

An estimate for *u* (change in transfer payments) requires information on changes in unemployment and social security payments as a result of employment in the RE facility. Current unemployment levels are low, and evidence from the survey of employers and employees indicates that they had alternative employment income in addition to that derived from the RE facilities, which are the subject of this study. Thus we can assume u to be zero.

Indirect taxation is difficult to estimate because different consumer goods are subject to different levels of indirect taxation. Employee information recorded their expenditure by various classes on goods: those not subject to indirect tax (eg mortgage or rent, council tax, travel, and food, newspapers and children's clothing), those not subject to full VAT (eg domestic heating), and goods subject to both VAT and excise duty (eg petrol and alcohol). Energy consumption (electricity and gas) has a VAT of 5%. Excise duties on alcohol, tobacco, and petrol, are much higher than the standard VAT rate of 17.5%. The amount of indirect taxation a household pays on its marginal income from employment attributable to the RE facility will depend upon the expenditure of this marginal income. On average 61.1% of disposable income was spent the categories listed in question C4 of the employees' questionnaire. We therefore assume that the remainder (38.9%) was spent on goods subject to VAT at the standard rate.

Of the expenditure reported in question C4, 48.4% was on goods not subject to indirect tax; 5.2% on goods subject to 5% VAT; and 7.5% on goods subject to VAT and excise duty (for which an indirect tax rate of 60% was assumed). We estimated that the indirect tax incurred was £3,351, giving a figure for $t_i = 0.087$. Of course, marginal income is likely to be devoted proportionately more to consumer goods attracting VAT and excise duty, compared with intra-marginal expenditure on basic foods, and mortgage or rent payments. Hence, the figure for $t_d = 0.087$ may be an under-estimate.

Employees estimated that they spent 70.6% of their income within the county surrounding the RE plant. However, since RE facilities are situated in remote rural areas, imports are likely to be high (this has been shown in a number of previous local I-O and Keynesian multiplier studies). Consumer durable goods, gas and electricity, etc, and many food items might be distributed locally, but are unlikely to be produced locally. However, remoteness might increase dependence upon local personal services such as hairdressers. Thus, the value of m might be around 0.80 for wind and hydro plants that are located in remote rural areas. Biomass plants situated in more populated areas, with major towns located within 30 miles, are likely to have a lower import coefficient. Hence for employees in biomass plants, the value for m was assumed to be 0.7.

Table 4.4 documents the amount of wages out of total revenue from the RE's electricity sales, which are paid locally. This varies substantially between areas in which the RE facilities are located.

These values for c, t_d, u, m, and t_i were used to estimate the proportion of wages that were spent locally, from the wage payments paid locally by the RE firm and reported for question B7 (1) in the questionnaire to RE operators. In a small number of cases a value for B7(1) was not reported, although a response to question C1 (a, b and c) indicated that the RE facility employed local workers. In this situation the response to question C1, listing the number of local workers employed to maintain and operate the RE facility, was used. The wage rate for these workers was assumed to be £30,000 per year for a full-time worker (pro rata for part-time workers).

Type 2 multiplier estimates for output and employment effects are reported in Table 4.6, along with Type 1 output and employment multipliers for comparative purposes.

Studies investigating employment multipliers of a project or policy in rural areas are based upon workers employed on the project or site in question. Usually all employment is based at the site. This was the case for all but one of the biomass plants. However, for wind and hydro plants a considerable proportion of employment associated with the plant is not located locally. The Type 2 employment multiplier effects in Table 4.6 are estimated in relation to the total number of workers associated with each plant, and not in relation to locally based employment associated with each plant. Adopting the latter perspective would have resulted in higher employment multiplier estimates.

Table 4.6 reveals that including induced effects generally adds little to the size of the output multipliers. However, the inclusion of induced effects also adds more to the size of employment multipliers for all types of renewable energy: wind, hydro and biomass plants. Note that Type 2 employment multiplier impacts vary between sites, depending upon the level of local wages paid relative to induced employment in other local firms.

Employment multipliers tend to be higher than output multipliers in rural areas (see Hubbard, 1982). This is the case here for most sites except hydro sites. The Type 1 and Type 2 employment multipliers for wind and hydro are lower than employment multipliers for rural areas estimated for other types of activities such as Development Commission advance factories and recreation activities. However, the employment multiplier impact of biomass plants is considerable, but this is probably partly a function of the fact that they are located in more populated areas.

4.7 Agriculture and biomass

All of the biomass RE facilities included in this study comprise the combustion of an agricultural by-product: poultry litter or straw. However, some RE biomass facilities burn wood products and wood derivatives. Would such a RE biomass facility have a greater multiplier effect, and a greater impact on rural development, than those burning poultry litter?

It has been assumed, on the evidence of the Arbre project, that a wood-burning RE facility, of similar size to the poultry litter plants in terms of electricity output (10 MW per year), would also have an equivalent number of people directly employed at the RE facility itself (about 40 staff). In terms of its impact on rural development, the issue therefore revolves around

- the difference in labour requirements in the fuel supply industry (agriculture)
- the multiplier effects of these changes.

A typical wood-burning biomass plant might have 60% of its input from short rotation coppice (SRC). This backward linkage would require 2,000 to 3,000 hectares of willow coppice within a 40-km radius of the RE facility [the 40% input remainder to the RE facility might come from forest residue]. Such a wood-burning RE facility would certainly have a greater Type 1 multiplier impact that a poultry litter burning plant. Since poultry litter RE plant burns a by-product, there is no additional employment in agriculture as a consequence of this type of RE biomass.

The Type 1 multiplier impact of using short rotation coppice (SRC) as an RE input might be significant if it was grown on land which produced no other output. However, we have assumed that the SRC would displace cereal crops because:

- the draft Mid-Term Review of the CAP indicates that set-aside cannot be cropped, so biomass would need to compete with cereals [without Integrated Arable Crop Support (IACS)]; and

- those currently growing SRC tend to set aside more than the minimum 10% of cropped land, and so biomass effectively displaces crops. Thus the question becomes: what is the *net* multiplier effect between cereal production and SRC production.

Both employment and revenue to farms would be lower from SRC willow biomass production compared to cereal production. The only case where employment and revenue from output would increase in farms supplying RE facilities would be if SRC biomass was grown on set-aside land which would otherwise have been fallow. Many farmers currently crop set aside with industrial crops such as High Ureic Acid Rape (HEAR), which has a larger labour input than SRC of willow, and in future are likely to exploit other opportunities such as biodiesel and bioethanol.

The multiplier effect of agriculture varies according to the type of agriculture. Garrod and Willis (1999)[13] estimated Type 1 output and employment multipliers for agriculture, for West Lancashire (mainly horticulture, cereals and other root crops), of 1.45 and 1.50 respectively,

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[13] G.D. Garrod and K.G. Willis (1999). *The Economic Impact of Agriculture and Horticulture in West Lancashire District*. Report to the Lancashire Area West Training and Enterprise Council (LAWTEC) Rural Action Group. Department of Agricultural Economics and Food Marketing, Newcastle University.

using the 1996 national Input-Output Table disaggregated to West Lancashire. There are no multiplier estimates for SRC of willow in England but they are likely to be smaller than cereal and root crop economic multipliers because they require less inputs and labour over the rotation cycle. A study of biodiesel by Sheffield Hallam University[14] considered a number of research papers and used an employment multiplier of 1.4 for SRC. Thus SRC biomass production that displaces agricultural cropping will detract rather than add to indirect and induced multiplier effects in the rural economy. SRC biomass production would add to rural economic multipliers only if it were grown on set-aside land that was not cropped.

Table 4.5: Employment multiplier estimates for the RE facilities

	Wind	Hydro	Biomass
Direct local employment in RE facility	1.20	0.83	25.50
Total employment in RE facility;	1.86	3.00	28.25
Indirect employment in other local industries attributable to inputs purchased by the RE facility;	0.26	0.16	13.21
Local type 1 employment multiplier, K_1, calculated in relation to local employment in RE facility	1.16	1.18	1.48
Local type 2 employment multiplier, K_2, calculated in relation to total employment in RE facility	1.15	1.05	1.42

Table 4.6: Output multiplier estimates for the RE facilities (£ thousands)

	Wind	Hydro	Biomass *
Basic Type 1 Output Multiplier	1.19	1.19	1.10
Basic Type 2 Output Multiplier	1.20	1.20	1.12
Type1 Employment Multiplier K2	1.15	1.05	1.42
Type 2 Employment Multiplier	1.32	1.08	1.72

* Excludes agricultural employment
⁺ Induced multiplier only: lack of information prevented estimation of indirect multiplier.

[14] N D Mortimer, P Cormack, M A Elsayed and R E Horne (2002). *Evaluation of the Comparative Energy, Environmental and Socio-economic Costs and Benefits of Biodiesel.* Report for Defra. Resources Research Unit, School of Environment and Development, Sheffield Hallam University.

5 EXTRAPOLATION OF RESULTS

Objective 3 in the TOR required the research to "… identify any specific circumstances for the case studies which mean that the results will not be widely replicable and estimate the effect this might have." Case studies were selected to demonstrate the potential or actual economic impacts in a range of circumstances, rather than reflecting the current or future industry. For this reason it is necessary to consider to what extent results can be extrapolated to the wider industry. This is considered separately for each of the three RETs covered by the case studies

5.1 Wind

The technology used by the wind farms varied only by its age and the number of turbines. All sites are unmanned and the greatest variable is the rurality of the local economy and the ownership of the site. In summary, smaller scale operations are more likely to generate wider benefits for rural development through independent or community ownership and the greater propensity of such owners to develop linkages with other sectors eg tourism. Large-scale wind farms are more likely to be owned by a power company with the specific purpose of generation. Planning constraints dictate that these are more likely to be situated in remote areas where the scope for tourism-related development is less.

With five case studies, wind generation has been well covered and the results should be widely applicable.

5.2 Hydro

Small-scale hydro schemes in rural areas can utilise a variety of water resources; the three case studies represented dam, loch and run-of-river projects. Like wind power, many of the suitable sites will be remote and therefore limited in terms of their ability to attract (or repel) visitors. As with wind, hydro is also limited in terms of ongoing income and employment generation.

5.3 Biomass

Power generation from biomass is a very different technology to wind and small hydro. It has the capacity to generate large amounts of energy and create significant employment and economic activity. The four case studies chosen deliberately focused on this large-scale generation but the results are not encouraging. The Arbre project was put into liquidation during the course of the study and the other plants have found it difficult under the new competitive trading arrangements (NETA). NFFO supported schemes have the benefit of a given price but the Renewables Obligation does not offer security to a technology which has a high requirement for capital at the start and substantial ongoing costs for operation and maintenance.

The Fibrowatt plant at Thetford replaced the Arbre case study. This is based on poultry litter, as are two other case studies (Eye and Westfield). While this gives us good knowledge of this specific biomass technology, we are constrained in using the results more widely for a number of reasons:

The UK poultry litter resource for RE is now largely tied up with the four existing plants

Other sources of by-product biomass could be used (eg forest residue, farm and food waste, organic waste and separated green municipal waste) but there is no commercial case for new-build plant due to limited support under RO and a long list of failed ventures. This is compounded by the possibility of animal-derived materials coming under the Waste Incineration Directive.

Biomass crops grown by farmers (on set-aside land) require the cropping programme to be scheduled ahead of plant commissioning. Again, previous failures will make farmers very wary of making such commitments.

However, as already discussed small-scale plants for generation of power or heat are likely to progress in the short term. It is important to cover this in the research and it is recommended that another 1-2 case studies are included for this purpose.

6 THRESHOLDS FOR RURAL DEVELOPMENT

The TOR require that consideration is given to the threshold scale at which any given RET will have an impact on rural development. This is a difficult issue which balances the concept that small is beautiful and sustainable against that which dictates that economic development requires a critical mass to stimulate a local economy.

The three RETs studied in the project are considered in turn.

6.1 Wind energy

The opportunities for economic development in rural areas in relation to wind generated RE are rather minimal and perceived to have a marginal impact on the local economy. This is largely related to the inherent scale of employment associated post-construction with even larger sites generating only a few FTEs. Very large developments are still likely to face planning constraints but clustering of wind development may create sufficient critical mass to justify more locally based jobs in maintenance and services. There is certainly now sufficient critical mass and confidence in the industry to justify the Vestas Company establishing a turbine manufacturing plant in Campbelltown, a deeply rural part of Scotland. This plant will be strategically placed to supply turbines for schemes in Scotland, Wales (eg North Hoyle) Ireland and other parts of the UK. The rental income to individual landowners from wind farm sites can also be considerable and offer a secure and lucrative form of farm diversification.

The main environmental issues associated with wind RE projects centre around the visual impacts on landscape about which public opinion can become polarised. However, projects do generate community benefits through community funds provided by generators, community ownership and possible reduced cost or security of energy supply.

It is not considered appropriate to set a threshold scale for wind RE as the benefits are mainly community based, which is not scale sensitive.

6.2 Hydro power

The impact of small-scale Hydro RE on rural economic, environmental and social and community development was seen to be very small. However, these can be significant on a small-scale economy in very remote areas where existing mature industries such as farming, fishing and mining are in decline.

As with wind, the key benefits are community based (part-time local employment and land rental income) and are not scale sensitive. Again, applying a threshold for rural development impact is not appropriate for this technology.

6.3 Biomass

The biomass plants researched in this study operated on a much larger scale than ether wind or hydro schemes. They require considerable investment in infrastructure (combustion plant) and generate a significant number of local jobs (20-34). The secondary cash and employment impacts on other local companies were substantial.

Despite this, the biomass plants are struggling to compete under NETA and without the price security offered by NFFO. Project Arbre went into liquidation during the research period despite scale while some smaller scale ventures have survived. The key difference is the capital-intensive nature of biomass RE and the need for bank support for larger projects.

In a less demanding energy market, scale would be limited by the need to source feedstock fuel from within a realistic geographical catchment. The need to haul such (often bulky and sometimes odorous) materials dictates that plant location is rural and planners may limit that plant scale.

6.4 Conclusions

The concept of thresholds for rural development to accrue is not helpful. Wind and hydro schemes are inherently small-scale and generate community benefits rather than substantive employment or income generation. The rural development benefits of biomass energy are based on the income generation and employment effects of a processing plant. The purchase and transport of fuel stock dissipates the benefits to a wider rural economy.

The imperative for further development of these technologies is economic sustainability. This requires an established technology, a suitable infrastructure and a commercial track record. While this has arguably been achieved for wind and hydro, biomass has yet to gain critical mass and economies of scale as an industry. The Arbre experience may lead to increased focus on smaller scale CHP development and larger scale co-firing. Neither is likely to have the potential rural development impacts of moderate scale, dedicated biomass plant.

Rural development impacts may depend more crucially on the ownership of RE schemes and their engagement with local communities.

7 MAXIMISING RURAL DEVELOPMENT

The field research has highlighted the extent and range of impacts that a number of actual projects had on local rural development. Using the case studies and wider analysis, this chapter considers how public policy might support RETs in order to maximise the rural development effect. This is considered in terms of the three key pillars of sustainable rural development, namely economy, environment and community and is summarised in Table 8.1 with benefits coded as positive ▭ , neutral (or limited) ▭ or negative ▭ .

Table 8.1: Relationships between RE and Rural Development

ECONOMIC	ENVIRONMENTAL	COMMUNITY
Short term ***increase in employment opportunities locally during plant construction but often high reliance on overseas and non-local specialist engineers***	***Negligible or no direct impact*** on the local environment. Indirect benefits include use of potential pollutant waste materials and maintaining farmers on the land	***Population increase during site / plant construction leads to a temporary increase in local cash flow***
Longer term ***increased demand opportunities for local service sector development*** to meet plant/site servicing needs	***Actual or perceived negative environmental impact of RETs often dissipates*** when plant and site up and running	***Increased self respect for individuals through employment and association with green technology***
Would reduce local household bills ***if energy generated could be procured locally***	***Reduced need for nuclear and conventional energy generation – this benefit is felt at a wider national level, rather than locally***	***Social and community support and development fund*** is often provided for use by the local population
Increased skilled and managerial job opportunities when plant is up and running – benefit not necessarily located in the same locality or region though	***Negative impact during construction phase and potentially beyond (hydro in sensitive catchments)***	***Uneven (positive) impact on rural communities generally***, in terms of geographical location
Increased opportunities for diversification of the local (largely service) economy where ownership is local	***Stimulates wider public interest in sustainable and community based solutions to energy generation and waste disposal***	Can ***help increase informal educational opportunities locally***

7.1 Economic development

There are 3 distinct phases of economic activity associated with development of RETs. Each of these (site construction, plant operation and related development in other sectors) might impact on the local economy. Most of the equipment and much of the expertise used is currently are imported from abroad, where use of the technology is more widespread. One exception to this is combustion technology used with the poultry litter plants, although again there was a high reliance on overseas labour. A wind turbine manufacturing plant has also been established in Scotland, no doubt in anticipation of a significant growth in the number of commissioned sites.

An earlier investigation of the relationship between RE and rural development by Hislop and Whitby (1995) suggested that while RE sites may be constructed using support services procured from urban areas initially, their existence in rural areas can ultimately help stimulate (bespoke) service sector expansion in rural areas. Some rural or market town based firms have indeed become established[15]. Opportunities for servicing and maintaining wind farms and turbines are nevertheless, still limited and the norm is for largely non-local, machinery suppliers typically provide plant maintenance and servicing. What is more, the task itself takes relatively little time and uses very few human resources.

It is clear that there is considerable overlap in the location requirements of wind and hydro plants; both are naturally suited to locations on or near the West Coast or in remote areas. In terms of biomass, plant location should be closely linked to the fuel source eg intensive poultry industry for litter plants. This offers opportunities for clustering and a geographical focus for promotion and development of this technology and associated industry. This approach is consistent with the Regional Development Agency (RDA) focus to cluster development in other industrial sectors as a mechanism for economic development.

7.1.1 Suggested Action:

Stimulate the location of site and plant machinery manufacture and servicing in the same geographical location as the RET plant. In this way it would be possible to concentrate industry development in a geographical cluster or concentration and may help retain more economic benefits from RET developments in the same local area or region. There may also be a need to support skills development and training of the local workforce to underpin development of specialist manufacture and service provision.

Explore the potential for and feasibility of clustering RE developments in appropriate locations – there is considerable overlap between wind and hydro. This should be developed through the RDA's in association with national and regional developers. RDA's are already pursuing cluster development and most include RE as an objective in their Regional Economic Strategies.

These biomass plants are important to economic development in rural areas because of their ultimate dependence on and use of locally procured farm waste (or energy crops) as the principal input to their RE process. Essentially, this helps keep local farmers farming, which was seen as a positive impact, and the local availability of appropriate quantities of suitable inputs was a key reason behind the establishment of the site in this location. In particular, biomass plants appeared to rely on a local cluster of farms to provide the quantity of material needed; this has wider benefits for specialist supply and service companies in the area.

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[15] One example is the small market town of Hexham, Northumberland where two firms, AMEC Border Wind and E-Connect are located. The two firms had their origins as commercial spin – offs from the Newcastle University based Northumbria Energy Workshop. AMEC Border Wind develops and manages wind farm sites whilst E-Connect are consultant electrical engineers providing innovative solutions to grid integration for all forms of RE. The latter firm also exports its expertise and now employees around 40 staff.

7.1.2 Suggested Action Points:

Promote the biomass option for gate-fee materials and waste products where disposal by other means may be environmentally difficult or expensive. Encourage the use of waste from farms (and potentially domestic sources) as inputs to biomass RE generation as a way to promote more local linkages between input suppliers to RE plants.

Resist the attempt to categorise waste material such as poultry litter as a waste under the Waste Incineration Directive, which would add additional costs to reduce emissions of CO_2, acid and dust. Defra and the EA are supportive.

Findings suggest that RE (biomass) can help stimulate diversification and extension of rural economies in such a way that the returns may be used in and for the development of the RE industry locally as well as other engineering based work. In relation to rural economic development and biomass RE, one employee suggested: "*…In the longer term, skills have been developed that can be utilised in maintenance and upgrading areas…. Furthermore, skills that have been established can be used in other areas of engineering…"*

7.1.3 Suggested Action Point:

The provision of engineering training opportunities locally would help ensure local skilled labour provision and may help attract other RE and engineering companies to an area where it is known that there is a pool of appropriately skilled / trained labour available.

7.2 Community development

Local ownership of industry often has a capacity building effect and this is supported by evidence from the case studies. While only one site was community owned (wind), two were privately owned and a hydro RE stakeholder explained that the site would become the property of the local National Park when after it had been operating for 25 years. In all these cases, there was evidence of actual or anticipated investment in growth or diversified activity.

7.2.1 Suggested Action:

Embedding an RE plant in a local area through community ownership has wider social and economic benefits and helps promote public awareness of sustainable development. It may also reduce public resistance to an RE plant prior to construction. The form of ownership should be regarded as a material consideration in the assessment of an application for planning permission.

If energy from rural RE plants was directly available to local people, there may be significant economic benefit for the community. Previous work addressing the role of RE in rural development (see Hislop and Whitby 1995) suggested that smaller scale RE sites are more likely to be able to help shortfalls in energy supply without needing an upgrade of existing power lines. The continuity of energy supply in more remote rural areas may attract investors who perceive a risk associated with a possible break in power supply from the national grid. Recent storm events have highlighted the fragility of energy supply linkages between the national grid and remote rural areas and this may well increase investors' perceived risk of (re-) locating in such locations.

7.2.2 Suggested Action Point:

Explore the feasibility and cost effectiveness of embedded RE generation in rural areas. The constraint currently is the cost of connecting to the grid and the unreliability of single-source RE generation. Marketing a reliable supply of RE to domestic and industrial customers in the same locale could offer direct cost savings and might also stimulate the local economy through improved security of energy supply.

Support local energy initiatives where schemes are developed for local use. Initiatives at the Centre for Alternative Technology (CAT) have demonstrated the benefits and support for such an approach.

The major RE generation companies invariably offer a local social and community development fund to help secure community support and promote the technology. Stakeholders saw this as one of the most important ways in which RE can underpin rural social and community development.

7.2.3 Suggested Action Points:

Encourage plant owners to provide support for the local, for example through provision of a community development fund through the conditions attached to planning consents or separate legal agreements. These conditions/agreements should prescribe suitable management arrangements for the administration of the funds to secure an appropriate level of community control over or involvement in grant application decisions and so benefit projects that have the highest local priority, for example schools, community groups and youth facilities. Reporting of successful funded projects is also likely to stimulate awareness of RE and its contribution to the local area and may help reduce resistance to RE locally.

A further social and community development benefit associated with RE generators was the provision of informal education and information provision for schools and local people. In a number of cases, RE operators provided guided tours for interested groups and individuals and conducted visits to schools. Such initiatives reinforce local commitment to individual RE projects and support for national policies to expand renewable energy generation.

7.2.4 Suggested Action Points:

Encourage site operators to build on the existing provision of information packs and other interpretative material and to exploit more fully the opportunities provided by their company websites and the DTI database. It may be appropriate for companies to collaborate more closely in this field and establish a national network of sites that are willing to participate in promotion of RE through site visits for specialist interest groups, schools and the general public at home and abroad. Links should be built with the regional network of TIC's and other information centres to promote and publicise such opportunities, particularly in areas where RE clusters are (being) developed.

Biomass RE in particular has a tangible impact on rural social and community development locally through job creation and it's associated social benefits of increased confidence and self esteem amongst the local population.

7.2.5 Suggested Action Point:

Encourage the employment of local people in new biomass RE generation sites / plants. The scale of these plants is such that job creation is inherently local but the technology required mainly skilled and semi-skilled workers. Links with schools and training schemes could encourage maximum integration of socially disadvantaged groups.

7.3 Environment

The planning system is widely regarded as having unduly stifled the growth in RE capacity and is the main reason for the slow progress made to date towards the Government's generation targets. This situation appears to be changing, as evidenced by recent decisions concerning wind farms, not least in Wales and Scotland, but the planning process still remains more reactive than proactive. The technologies most likely to raise strategic planning issues are wind farms, major biomass generators and hydropower. Pressure for development will inevitably focus upon remote and relatively undisturbed open countryside. The planning system should therefore be the key driver in facilitating RE development in a balanced way which satisfies global, national and local requirements for sustainable energy generation but protects our most sensitive environments. This more positive role may be stimulated by the impending review of PPG 22, which currently provides an insufficiently clear interpretation of the Government's energy policy, and the radical changes to the development plan system to be introduced in 2003 under the Planning and Compensation Act.

Under the new planning regime RPG will be replaced by Regional Spatial Strategies (RSS). These are expected to set regional and technology specific targets for RE generation. The BWEA have produced advice on the targets that could realistically be adopted for each region These targets may be amplified in the RSS by the definition in diagrammatic form of broad geographical areas of search eg Strategic Wind Resource Areas (SWRA). Decisions on most RE projects will continue to be made by District or Unitary Councils, as the local planning authorities. These authorities will find it difficult to reconcile the complexity of global, national and local issues without clear strategic guidance. For example, Tynedale Council in Northumberland is typical. It has recently published an Issues Report in connection with the review of its Local Plan which states that "*In light of the ... Government's considerable support for the development of the renewable energy industry, it is now considered appropriate for the Local Plan to agree with the renewables industry, specific sites which could be allocated in the Local Plan for wind energy developments. It is considered that such sites should be well related to the SWRA's which will eventually be identified…."*.

Local Plans are to be replaced by Local Development Frameworks, which should provide greater flexibility. A set of documents (rather than a single plan) will include a statement of core policies, which will be criteria-based and non site-specific. This could outline an overall strategy for RE generation and set out the broad principles against which RE proposals would be assessed. The core policies are expected to be supplemented by a Proposal Map, which should identify sites for particular developments, as well as Area Action Plans for key areas of change, to be produced as and when required. It would seem eminently appropriate that all rural planning authorities should give high priority, for a specific Area Action Plan for RE. Failure to produce the necessary lead via the planning system will inevitably result in a costly and time-consuming sequence of public inquiries over individual development proposals.

7.3.1 Suggested Action Point:

Government Regional Offices and Regional Chambers (representing local planning authorities) should ensure that the present RPG, or replacement RSS documents contain technology-specific regional targets for delivery of the Government's RE policies. The RPG/RSS should also provide Local Planning Authorities with clear guidance about the location requirements of RE developments and how in broad geographical terms they can best be accommodated, region wide, with least impact on the environment and communities. In addition, RPG/RSS should be closely integrated with the RE component of the RDA's Regional Economic Strategies (see above) so that a coherent and positive lead is given to developers and generators in the renewables industry.

Under the new development plan system, Local Planning Authorities should give a high priority to the preparation of a specific Action Area Plan for RE generation that translates strategic planning guidance into location-specific planning policies. The Plans will need to be subject to the usual consultation procedures but Authorities might use this opportunity to consider imaginative ways of engaging the public in a dialogue about the best ways of meeting the Governments RE targets at the local level.

In relation to rural development, local ownership of land on which small-scale hydro is sited ensures that much of the economic benefit flows through the local economy since rental income is largely spent locally. Some National Park Authorities are known to want to encourage hydro on less environmentally sensitive sites but fail to engage effectively with local landowners. On the other hand developers often pursue more sensitive sites on behalf of landowners but in the process fall foul of environmental agencies and the planning system. This is unfortunate in that RE can help landowners remain viable and also generate resources for maintaining and improving the local environment.

7.3.2 Suggested Action Points:

Encourage local landowners to lease land to environmentally responsible hydro developers or to pursue projects on their own behalf alongside specialist supply providers. This will require a multi-agency approach, particularly in the early discussion of development ideas prior to the formal submission of proposals for planning consent. The provision of incentives eg capital grants, specialist support and advice may also be required.

Seek to establish better communications between central government who promote RE, national environmental agencies eg EA and local agencies such as National Park Authorities. There is scope for sustainable development of a larger number of sites but these will only be realised if a joined-up approach is taken.

7.4 RE generation and rural tourism

The research has revealed only modest levels of public interest in RE sites and plants. Visits to biomass and wind RE sites were generally *ad hoc*, unless substantive educational / information provision was made at the site. The best illustration of the latter is the Gaia Energy Centre, which is co-located with the Delabole wind farm in Cornwall. The capital cost of this facility exceeded £4m and came to fruition because of the successful application of a wide variety of European, national and regional funding sources. The Centre is operated by a charitable trust. It has impressive, interactive exhibits on all forms of renewable energy as well as extensive conference/teaching facilities and a café. It became fully operational in

2002, is forecast to attract over 100,000 visitors per annum, and employs 16 full time and 6 part time staff (far in excess of the original wind farm site). The impacts of this development on the local rural economy are therefore considerable.

Small-scale hydro sites do not attract the same degree of interest, as they are mostly located in remote areas with the infrastructure discreetly integrated into the landscape. Visitors are often co-incidental hill walkers in the same location, although the hill tracks developed as part of an HE scheme could improve the range of access routes available to walkers. Other elements of the HE plant could provide a focus of interest eg salmon ladders, the powerhouse or lake and to this extent benefit the local economy through increased tourism. The general impression gained, however, is that without substantial investment in visitor centre type facilities, the benefits would be very modest.

Wind turbines leave a much stronger visual impression with passers by, even at long distances, and this can lead to casual visits to wind farm sites in the absence of information provision or parking. It appears that individuals with a particular or specialist interest in RE or engineering also visit and explore the wind turbines. There has been considerable concern expressed by opponents of wind energy schemes about the depressing effect that the cumulative development of wind farm sites will have on tourism. Nevertheless, a number of research studies[16] conducted into public opinion before and after the development of sites indicates that the public quickly become accustomed to their presence and more generally supportive It appears, moreover, that small numbers of turbines can have an artistic, elegant, even magical quality for some people and it may be worth exploring the feasibility of using such concepts to promote and increase acceptance of wind turbines in more remote areas.

In contrast with wind RE, employees at the biomass RE plants explained that people visit the site because they are intrigued by the generation process. They have hosted visits by foreign dignitaries (government and industry) who are keen to develop similar plants in their countries, and who have visited the biomass plants to learn about their development and operation. More generally, people seem keen to learn about RE generation processes and activities and a number of individuals and local groups (eg primarily schools) have visited the sites to gather information about this.

In conclusion, therefore, responses to the question of how and whether tourist interest could and should be developed in relation to RE sites varied widely. At one end of the spectrum is the Delabole example where the enthusiasm and commitment to RE has resulted in the development of a major tourist attraction. Other wind and biomass stakeholders, by contrast, specifically suggested that it was inappropriate to develop tourism around an RE site. For example, landowners are not always enthusiastic about public access and there may be concerns over public liability. One employee stressed the importance of the scale and type of ownership of the plant in terms of deciding whether they should also provide visitor attractions: "*As a small privately owned company there are financial restraints. We can only allow a limited number of visits without causing disruption in the running of the plant…It is also difficult to find suitable guides. For example, at the moment, we employ retired or semi-retired people who work as and when required…*"

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[16] RBA Research/National Wind Power (2002). *Public Attitudes Towards Wind Power*:

ETSU/DTI (1993). *A Survey of Public Opinion in Cornwall and Devon (1993).* ETSU/DTI and Lambrigg Wind Farm-Public Attitude Survey.

7.4.1 Suggested Action Points:

Encourage RE developers and owners to consider the possible tourist potential of the site at the outset. This may have a bearing on the success or failure of applications for planning consent if there is additional support from tourist and business interests and substantive rural development benefits can be demonstrated.

RDA's and Regional Tourist Boards, in the course of preparing their Regional Economic and Tourism Strategies, should explore the potential for the development within each region of a major visitor centre for the promotion of RE, along the lines of the GAIA model in Cornwall. Co-location with a suitable RE site might be advantageous and links could be made with other RE sites in the area as part of a wider regional strategy of education and tourist development.

RE industry associations should collaborate to promote examples of good and innovative practice in the provision of information and education packages. In this way, standards of provision across RE sectors and sites can be raised and public awareness increased.

Determine the essential / key components of an information and education package and encourage their provision across RE sectors and sites to normalise provision of such information nationally. In this way, potential visitors would know what type of information they can receive at each and every individual RE site across the UK.

In view of the need for landscape preservation, planning consent should only be provided where it is possible to ensure sensitive site development, in line with countryside users' perceptions and feelings about particularly high value landscapes, for example in the National Parks.

Once people are at a site, in most cases, there is generally very little there to entertain them and it is unlikely that people make repeat visits. Respondents implied that it was very much a case of "*once you've seen one wind turbine you've seen them all*". Therefore there is a need to extend the provision of visitor centres at wind RE sites / plants, in the same fashion as the successful visitor centre which is located at a wind RE site in the South West.

8 MARKETS AND SUPPORT STRUCTURES

This section addresses Objective 6 in the TOR, namely, the effect that recent/proposed changes in support structure and energy markets on these industries and what the expected outcome will be in terms of development of RETs. In order to do this a generic discussion of recent, current and future markets and support structures in presented.

8.1 Rationale for supporting RETs

The UK government has adopted a target that 3% of all electricity shall be produced from RETs by the end of 2003 rising to 10% by 2010. These targets are enshrined in the Renewables Order, which has a timeframe until 2027, and the Climate Change Levy. The motivation for these targets is three-fold;

Greenhouse gas (GHG) emissions reduction

Domestic Energy security

Land-based economic diversification

The background to these drivers is discussed in more detail at Annex C.

8.2 RET Support Framework

Recent and current government policy for supporting RETs focus predominantly on electricity generation, with some consideration of heat markets but almost nothing in the transport fuel market.

8.2.1 Renewable Electricity

During the 1980s and 1990s the principle vehicle for promotion of RETs was the Non-Fossil Fuel Obligation (NFFO). The NFFO recognised that the cost of electricity generation from different RETs was variable, depending on the maturity of the market. Consequently, for each type of RET a competitive process allowed potential generators to supply electricity at higher than pool price – with the lowest bids gaining the contract. Contracts offered index-linked electricity contracts for a 15-year period. There were five NFFO rounds and the government's expectation was that successive rounds would see electricity price convergence over time as the NFFO process itself encouraged RET maturity. The early NFFO rounds were very successful in achieving this in certain RET sectors, most notably wind and solar, less so with biomass and energy crop schemes.

This mechanism was replaced under the Utilities Act 2000 by a new procedure, the Renewables Obligation whereby any retailer selling electricity is required to source a percentage of what it sells from renewable resources. The first such Renewables Order (RO) was made in April 2002. For the year ending March 2003 this obligation is set at 3%, rising to 10.4% by 2012. The RO allows for electricity generation from onshore and offshore wind, biomass and clean waste streams, tidal/wave, geothermal and PV.

The RO works through a mechanism, under which electricity suppliers require renewable certificates to cover the statutory level of renewable production, otherwise they must pay a levy of 3p/kWh. Thus, at current prices a combined value of renewable energy generation of 4.5p/kWh might be expected (1.5p/kWh being the value of the electricity component). This is known as the buy-out price. Currently, only onshore wind from good sites and soon offshore sites can be generated profitably at, or below the buy-out price.

Since the RO is not banded, a value of 4.5p/kWh over the duration of the RO (until 2027) would not be sufficient to stimulate other, less mature, RETs. However, these 3p/kWh levies, applied by Ofgem, are recycled to electricity suppliers who manage to achieve compliance. A consequence of this, and of the fact that Renewable Obligation Certificates (ROCs) are in deficit, is that ROCs are trading in the sort term at least at much higher levels than the buy out price. This situation will probably remain so long as ROCs are in deficit. The problem for renewable energy developers, and the banks providing the finance, is that predicting the value of ROCs into the medium and longer term is very difficult.

Further complicating the situation is the New Electricity Trading Arrangement, NETA, which has replaced the Electricity Pool (EP). The EP produced a half-hourly price for electricity determined by the seller's cost of generation. The top bid that satisfied market demand became the pool price for contracts made during that period. Smaller generators (like biomass and wind) were able to make sales contracts by reference to the pool price, which offered secure terms. NETA is far less advantageous to small generators. Bilateral contracts are now normal, such that the purchasing electricity supplier can award long-term contracts to the lowest bidding generator. Intermittent electricity generation, for example from wind, is penalised in these contracts since generation cannot be guaranteed. Bundling together of renewables (ie, wind biomass and hydro) may be a mechanism by which continuity of generation can be achieved which would be reflected in an improved price. However, even if that is achieved the fundamental purpose of NETA is to reduce prices paid for electricity by consumers. This further increases the vulnerability of renewables projects in UK.

One of the key issues for potential renewables generators is whether the value of the RO plus the climate change levy is sufficient to for generation to be economically viable. To provide additional assistance needed to continue the development of RETs other than wind and hydro, the government has a raft of schemes in place:

Bio-Energy Capital Grant Scheme (England and Wales)
Energy crop infrastructure grants
Energy Crop scheme planting grant support
Clear Skies renewables initiative

8.2.2 Renewable Heat

NFFO focus was on electricity generation – the value in stimulating renewable heat production markets was not considered. The reason for this is simple – most of the housing developments in the UK that have arisen in the last 2-300 years have done so against a background of plentiful, relatively inexpensive heat, electricity and more recently gas from fossil reserves. The infrastructure for distributing heat from RETs (essentially biomass-derived heat) is not in place and it would be prohibitively expensive to do so on a large scale. In a marketplace of low cost heat from fossil fuels it is particularly difficult to encourage wide-scale uptake of more expensive RET-based systems. However, NFFO did miss significant smaller scale opportunities for CHP and heat only generation, for example in new-build developments or where industrial heat requirements lend themselves to replacement with RETs. Individually providing minimal impact but collectively with the potential for significant GHG reduction.

Since 2001, government has recognised the opportunities and contribution that can be made from heat provision have been recognised (PIU, 2002). There are now a number of grants available for the modest development of heat and small-scale CHP. For example:

Bio-Energy Capital Grant Scheme - The New opportunities Fund/DTI has recently provided grants of £3 million for small-scale domestic heating system development and additional money for larger scale CHP units. But the major focus is still on electricity production.

Enhanced Capital Allowance Scheme
CHP Quality Assurance Programme
Community Energy Programme
Community Renewables Initiative
Farm Waste Grant Scheme
Community and Household Renewables scheme

Further stimulus for heat of CHP systems comes form the climate change levy (CCL). Currently, taxes applied to electricity and natural gas use are 0.43p/kWh and 0.15p/kWh, respectively. Solid Fuel and LPG are taxed at 1.17p/kg and 0.96/kg, respectively. Exemption certificates are available from Ofgem where the energy use of an industry has a renewables origin. However, under the current electrical market prices it is unlikely that substitution of heat/CHP units for grid-supplied electricity could be defended on economic grounds, except where their use enables waste streams to be utilised that would otherwise carry a disposal cost. In addition, there are a number of technical considerations of heat from RETs. For example, can the intensity or rapid variability of heat achievable from oil and electricity be matched by renewables? Are they sufficiently reliable sources of heat for a business to rely upon?

8.3 Limitations of Support for RETs

Current policy and or legislative limitations to the further development of the Renewables market in the UK include:

Format of RO
Failures of NFFO
Flaws in grant schemes
Focus on next-generation technologies
Planning Process
Climate Change Levy
Limitations on what constitutes a renewable biomass source
Uncertainty of Mid-Term Review of the Common Agricultural policy

All of these issues need to be addressed if RETs are to flourish, as they need to if government GHG abatement targets are to be met. They are considered in more detail in the section below.

8.3.1 Format of the Renewables Obligation

A key problem is the failure to differentiate RETs within the RO, thus expecting PV to compete directly with onshore wind on price. Where sufficient support is in place to enable the technologies to mature, renewable energy sectors are likely to continue to be a significant growth area since they fulfil key aspects of UK Government policy, namely:

Low carbon economy
Fuel security
Farming diversification.

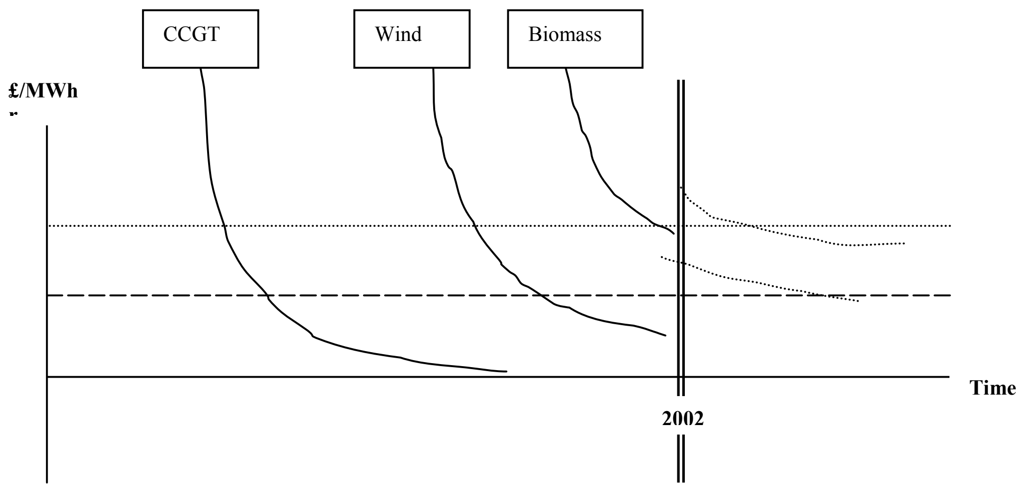
In the next fifty years the likely generation costs from renewables will decline, sometimes to the point (in the case of wind) of achieving direct parity with gas-fired fossil fuel systems. It is accepted (PIU, 2002) that even where parity is not achieved, additional support for renewables will be justified due to the three key areas listed above.

New renewable energy technologies currently contribute less than 1% of global energy demand, and less than 3% of electricity, but collectively have the potential to deliver orders of magnitude more. Current targets are to increase this figure to 10% by 2008-12 with recommendations of an increase to 20% by 2020 in order to accommodate raised awareness of the environmental challenge of GHG emissions, and energy security. The scope for cost reduction is therefore very large. Current costs differ substantially, from 2.5–3.0 p/kWh for onshore wind in good sites, through 5–6 p/kWh for offshore wind, around 8p/kWh for energy crops, to around 70p/kWh for PV.

All energy technologies benefit from learning curve cost erosion – as the technology scales up and industry learns lessons, so the unit cost of generation declines. This phenomenon has been seen with fossil fuels and wind energy, and is predicted for the newer renewables technologies, for example PV and biomass (see Figure 9.1).

Unit cost of production will influence uptake rate and consequently direct and indirect economic impacts of those technologies. As shown in Figure 9.1, the mature biomass industry would have significantly higher generation costs since the energy is not free at the point of source – farmers have to be paid for growing, harvesting and delivering the biomass and also recompensed for the opportunity cost of the land. This cost must be reflected in RO banding if certainty of long term prices for biomass electricity is to be achieved. These guarantees are essential to the long-term viability of biomass systems

Figure 9.1: Learning curves – unit reduction in electricity generation with time



Another major issue is the medium and long-term uncertainty of value of ROCs versus long-term nature of generation projects, causing lack of “bankability” of most projects. ROCs are trading in the sort term at least at much higher levels than the buy out price. This situation will probably remain so long as ROCs are in deficit. The problem for renewable energy developers, and the banks providing the finance, is that predicting the value of ROCs into the medium and longer term is very difficult. Thus it becomes more likely that large utilities that can finance projects on balance sheet will become dominant in the RE market. This will act to suppress small scale and embedded technology advancement.

A further issue is the continued predominant focus on relatively large-scale state of the art generation projects. The focus of NFFO (continued under the Bio-Energy Capital Grant Scheme for biomass projects) was the development of relatively large-scale, state of the art biomass generation systems, utilising either advanced combustion, gasification or pyrolysis technologies. Of those projects that received NFFO awards (a total of 31) only seven have developed to produce electricity. The remainder have failed or are stalled. The reasons for the failure are in many instances due to the scale of generation, including

Planning rejection due to scale of conversion facility
Lack of bankable finance, due to concerns about supply chain logistics
Failure to appoint turnkey operators prepared to take on the warranties and guarantees demanded of them by finance institutes
Technology failure

Restrictions on co-firing are also limiting biomass development, but the risk that if co-firing rules are relaxed, a monopoly of large power producers will take control of market.

8.3.2 Failures of NFFO

A key failure has been the inability to aggregate NFFO contracts. There are many instances where NFFO contracts have been awarded but the scheme has not been developed. Recently developers were granted the option of moving the NFFO contract, which has aided the rehabilitation of some NFFO awards. In at least one case, a development company wished to move one NFFO and aggregate it with another to allow economies of scale but this was not allowed.

8.3.3 Format of NETA

The RO stipulates that the consumer should not pay for renewable energy technologies even though the environmental offset value is palpable. This, combined with the impact of NETA driving down wholesale electricity prices (from 3p/kWh to 1.4p/kWh in two years) results in a disproportionate pressure to reduce costs being applied to the renewable energy generator. Quite simply, this stipulation is contrary to government objectives of increased energy use efficiency and renewable energy adoption.

Bilateral contractual arrangements that require generation continuity are also a limitation. A consequence of NETA is that long-term supply contracts are negotiated bilaterally - between supplier and purchaser - and that the cheapest bid wins. This is seldom any RE technology other than wind. The ability of the ROC to support other technologies is frail, as has been evident.

Aggregation of renewables generation favours large generation companies, as, with the exception of energy crops, renewables are intermittent. This, together with site specific aspects such as local wind regimes, affects load factors and is built into the costs quoted above, and the projected costs summarised below. Renewables that are both intermittent and to some degree unpredictable also impose additional system costs – the system must be able to cope with unpredicted fluctuations in output. Not all intermittent renewables are unpredictable: tidal energy is completely predictable; wave is more predictable than wind; and predictive capacity for wind is improving. The costs to the electricity system of coping with unpredictable intermittence are low whilst the total contribution of the technologies remains >20% (perhaps 0.2/kWh), since fossil fuels will form the storable component of energy generation, and will remain the predominant fuel source.

Failure to reward line owners for RET grid links makes small-scale links very (sometimes prohibitively) expensive. Grid connection costs for renewable energy systems are often prohibitively high, due partly at least because the companies maintaining the lines receive no tax or direct benefit from upgrading the lines for RETs. The introduction of net metering, where energy generated at a site and exported is metered as well as energy imported and the deficit levied as a fee (or revenue) would significantly reduce these line upgrade costs, making small scale generation economically feasible, but has not yet been implemented.

8.3.4 Failure of grant schemes

Generally, too many strings are attached under the rules of grant schemes for them to be considered bankable. There is a real concern that the poor conversion of contracts into power generation that was seen with NFFO will be repeated with the Bio-energy Capital Grant Scheme, since the government retains the right to reclaim the grant should the project not develop in strictly the manner expected – for example if insufficient energy crop is planted. This renders an otherwise significant grant useless in terms of bank assurance that the capital is on the table, and will be a significant deterrent to finance of bioenergy schemes. Taking us once again towards the proposition those large utilities that can work on balance sheet will be the major beneficiaries of this scheme.

The Energy Crops Scheme is considered too bureaucratic ie the process of obtaining funding to plant an energy crop is laborious, containing as is it does environmental and economic assessments and stakeholder consultation. Some improvements may be generated by plans to introduce a scheme to develop bio-energy fuel supply infrastructure. This will support sustainable forest management as well as agriculture by promoting the use of waste-wood products alongside purpose-grown energy crops.

8.3.5 Fundamental problems with continued focus on next-generation technologies

Unproven technology is difficult to finance. Starting from a simple base would enable stepwise progression and give banks more confidence in the underlying technology tranche, as has been demonstrated with wind turbines

In addition, high profile failures incur significant industry set backs. The highest profile bioenergy project to evolve from NFFO was the project Arbre, an 8 MWe CCGT system that was originally to run predominantly on locally grown coppice. A sequence of problems led ultimately the operating company to go into receivership in the autumn of 2002, with 1,700 hectares of coppice in the ground with no market. A less ambitious project based on steam cycle technology, albeit at lower conversion efficiency, would probably have succeeded and enabled subsequent systems to utilise more innovative technologies. The consequence of this failure is that the entire farming community in the UK is now very wary of coppice in general and CCGT in particular. It should be noted that of the seven NFFO projects that are running, five are steam cycle and the remaining two sub-megawatt CHP units. All of the CCGT projects have stalled or failed.

8.3.6 The Planning Process

There is no clear link between national and global sustainability goals and local responsibilities. Between 50-80% of onshore wind and biomass projects fail at planning application stage due to local opposition to the schemes. In some instances this opposition is well founded but in many cases it is 1 or 2 individuals and a badly considered application that cause the projects demise. PPG22 is under review, in order to redress the balance between our global responsibilities and local interests.

8.3.7 Failure of the Climate Change Levy

The CCL could have a major impact on domestic energy use, yet it is levied only to industry. In addition, many intensive energy users have negotiated exemptions and revenue raised is not distributed evenly. Thus manufacturing industries are disproportionately effected whilst heavy industry is exempted. Those industries that attempt waste minimisation often find themselves paying for the tax twice since CCL is applied to recycling technologies.

8.3.8 Limitations on what constitutes a renewable biomass source

Under current legislation only biomass feedstock's that are at least 98% renewable are eligible for ROCs. This dismisses combustion of, for example, cardboard and paper that would otherwise be sent to landfill. Whilst the sentiment at the heart of this legislation is understandable it does reduce the number of potential schemes that can be developed, increases the catchment needed for schemes, ignores an otherwise unutilised waste stream and it also identifies confusion in government thinking since the electricity generated from waste incineration projects is exempt from Climate Change Levy.

8.3.9 Uncertainty of Mid-Term Review of the Common Agricultural policy

Under the Mid Term Reform proposals of the CAP all farms will need to set-aside 10% of their land to long-term fallow and energy crops are to become ineligible for growth on this set-aside. A premium of 45 Euro per hectare is proposed for energy cropping on other land. This would be insufficient to move farmers from growing combinable crops to energy crops since the likely margins of food crops and certainly the flexibility retained offer much more security. If the MTR is retained in its current form there will be no further energy cropping in the UK. This contradicts current Government policy, as highlighted in the recent Strategy for Sustainable Food and Farming document, which reaffirms the Government's commitment to extending the non-food uses of crops, including biomass production for RETs.

8.4 Conclusions

The UK has put in place many initiatives for the development of renewable technologies, some of which – notably onshore wind – are now mature industries that can compete with fossil-derived fuels, particularly where grid connections are costly (ie outlying regions of the UK). A number of policy mechanisms now in place are not working to promote further RETs as smoothly as they should, and modification of these policies, as identified in the report, is needed to increase market uptake.

Wider land use policy and legislation could impede RET uptake still further. For example:

adoption of MTR in its current form would see very little energy crop grown
adoption of the EC Waste Directive pertaining to the combustion of poultry waste would see the cessation of currently the most active area of biomass energy production
cessation of the Renewables Obligation would see all but wind power systems rendered non viable

In the absence of legislation to pass on the true costs of renewable energy adoption to the consumer ie allowing for positive externalities, the impact of the actions listed above would prevent future development of renewable energy.

Options which need considerable further technical work, such as wave and tidal energy, and ways of storing electricity or hydrogen, will probably need longer to become established than those where the main barriers are economic or institutional (eg greater take up of energy efficiency).

Development of some options may be related to the regulatory cycle for the natural monopolies, currently 5 years. Options in this category include significant changes to the design of electricity distribution systems and, related to this, greater take up of small-scale onshore renewables and CHP. Significant development of larger renewable resources in Scotland (onshore and marine) could be influenced by electricity transmission regulation as well.

9 NEW RETs AND RURAL DEVELOPMENT

Looking to 2020, each technology sector for RE has been reviewed briefly in order to determine

a) whether or not significant development potential exists within the horizon

b) if so, is any rural economic benefit likely

c) if so, can that benefit be quantified?

Of all renewable energy technologies biomass has the greatest potential for impact at the rural level. The EUROFORES study[17] calculated that by 2020, 515,000 new jobs might be created throughout Europe in the biomass fuel production chain alone. Although progress to date in the UK has been erratic and beset with problems, this still remains the most likely area for significant rural economic impact. We predict an annual demand of 1 million tonnes of biomass from energy crops by 2010, which would require at least 100,000 hectares of energy crop, with resultant employment multipliers. This demand would consist of three 20 MWe bespoke biomass stations, two co-firing systems (coal fired stations) and a multitude of small-scale heat and CHP units.

Wind energy is likely to be the largest RE growth sector but with little direct relevance to the rural economy. Wave and tidal energy are unlikely to develop significantly and their rural impact would be no more significant than wind systems. PV is likely to develop slowly, heavily subsidised by capital and installation grants, and the installed units are likely to be so dispersed that servicing and installation will be conducted from industry based in urban areas not rural areas. Other technologies (geothermal, fuel cell) are either to expensive to be seen in the future or unlikely to have any rural impact (or both) or simply to far from commercial development to be considered with accuracy.

Source data for this section has been derived from DTI technology route maps[18], the PIU Energy Review (supporting technical annexes), survey of trade associations and EC data.

10.1 Wind power – off-shore

The UK possesses the greatest wind energy potential in Europe (300 TWh/yr.), with capacity to more than meet the UK's current electricity demand, yet lags behind Germany, Denmark and Netherlands in terms of installed capacity. The realistic maximum for wind energy in the electricity mix is 20% (DTI, 2002), about 14 GWe. The UK currently has 0.555 GWe installed capacity for on-shore wind (BWEA, 2003) but zero offshore. Within the EU states there are 80 MWe installed offshore installations in Sweden, Netherlands and Denmark. The first offshore UK site, at Blyth (3.8MWe), is now generating. In the UK 1 – 1.5 GWe are planned by 2010. Future developments will be typified by fewer, larger and more efficient turbines. The EC[19] calculates that every 1MW installed capacity produces 15-19 jobs in manufacturing and construction, with additional (unspecified) jobs created in O&M. Offshore will present a very large new potential for the development of wind energy. The theoretical

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[17] EUFORES (1999). The impact of renewables on employment and economic growth. European Forum for Renewable Energy Sources.

[18] DTI (2002). Sustainable Energy Technology Route Maps (www.dti.gov.uk)

[19] EC (1999). Wind Energy in Europe – The Facts.

value of wind energy offshore of UK is an order of magnitude greater than the onshore energy available.

To-date, off-shore developments have been relatively close to land, thus presenting relatively modest engineering challenges, since turbine structure will be the same as onshore systems, but still a greater construction/installation cost, with perhaps a higher proportion of regional employment over a short timescale during development. Future developments will focus on a blend of inshore and deep-sea installations. It is likely that the installed cost of a deep-sea turbine will be 30% greater than that of an onshore system (PIU, 2002) and much of that will be due to additional labour requirements during installation. However, wind systems generally are expected to achieve a generation cost of 1.5-2.5 p/kWh, and as such this mature technology will not be constrained.

The key to producing low cost electricity from wind will be the ability of developers to use the most suitable sites. Developments in the offshore market will require many new skills from the handling of raw materials in the factory to the management of the system for access and erection. Transmission costs will be higher for deep-sea systems. Transport and logistics will be particular areas of development, building on techniques developed in the oil exploration industry. Indeed many of the workers in offshore wind energy may be displaced from the oil sector. Additional skills in areas such as geology, archaeology and biology may also be required. Maintenance labour inputs will also be higher. These activities are unlikely to lead to direct rural economic impacts, since the majority of workers will be specialist engineers or divers – it is possible that some revenue may be dispersed into the catering industries of rural areas, but on a virtually trivial scale.

10.2 Wave energy and Tidal Barrages

About 1 MW of wave energy systems are deployed worldwide and no tidal barrage systems. Tidal barrage technology has been demonstrated in France and USA. At least five barrages are planned for UK – The Severn, Mersey, Rhyl, Newport Estuaries and Cardiff Bay. 59% of cost would be due to civil engineering phase (DTI, 2002) with some opportunity for local employment. Manufacturing base may be in UK, but unlikely to be local. Barrages would also offer additional communications links and barriers to flooding. Current generation cost equates to 8 p/kWh. Tidal barrages would require significant development periods (up to 14 years for the Severn estuary).

10.3 Geothermal

This will be, at best, a minority contributor to UK RE, even though 8 GWe of capacity are installed worldwide. Most geothermal energy in UK is suited to low grade heat uses (eg district heating) and the location of the geothermal source will perhaps coincide with only a maximum of 50 possible commercially exploitable schemes. Costs of the heat generated, at c. 3.5/kWh, are high.

Rural employment in such schemes might be moderately high, since the installation and maintenance of district heating systems would be relatively labour intense.

10.4 Photo Voltaic (PV)

Although the cost of electricity production from PV will decrease during the next twenty years, it is not expected to become cost-competitive, attaining 10 – 16 p/kWh, a ten fold increase over the most cost effective technologies, by 2020. Consequently, there will be virtually no uptake of the technology and therefore no rural economic impact. The only caveat would be that for some very specific niche applications, in regions not served by grid connection, the effective difference between PV and alternative provision of reliable electricity would be less.

The government – industry forum on PV h as recommended a 50% capital grant for installation of PV on 70,000 domestic roofs, and more recently the DTI's Clear skies initiative, has placed funding for small scale renewables projects for such developments. Uptake of these initiatives in the medium to even long term will be dispersed, and it is difficult to see how even the installation and maintenance sector will make an impact on the rural sector. The largest area for market development in UK in the medium term may be where PV is integrated into building materials (PV Government – Industry Group, 2001). It is unlikely that this would have a rural manufacturing base.

If and when PV becomes cost-effective then the impacts on the rural economy may be significant, since the installation and servicing of the systems will all be sourced locally. Manufacture will be outside the UK.

10.5 Biomass

A number of options are likely to be exploited for energy crops in the next twenty years:

Increased uptake of heat only and CHP units on the small to medium scale (50 kW – 20 MW)
Large-scale co-firing of coal-fired stations
Increased development of bespoke biomass units

Capital grant awards have already been announced for the first category, with similar awards for the third group (totally £66 million) pending. This could easily equate to an additional installed capacity of 75 MWe and 100 MWt, with an annual biomass requirement of one million tonnes. In addition, co-firing of one or two coal-fired systems could double the annual demand. Much of this tonnage will come from domestic and imported forestry residues but at least half will be derived from energy crops (since this is a necessity to achieve grant compliance). One million tonnes would require at least 100,000 hectares of crop. DTI's assumed target for biomass electricity generation systems is 5TWh (equivalent to 1000 MW DNC), suggesting that even greater uptake is possible.

10 RURAL DEVELOPMENT IMPACTS BY 2010

While many commentators question whether the 2010 target of 10% of UK energy from renewables will be met, this study requires us to estimate of the effect that RE could make to rural development if electricity generation from RE meets current Government targets. Given the three dimensions of rural development, it is important that all are considered.

11.1 Environmental impact

Given the level of regulation applied to the industry, it can be assumed that in environmental terms, expansion of the renewable energies will be largely neutral – that is, there will be at least as many benefits as disbenefits.

The one major change that might be expected, is a significant expansion of farmed energy crop for biomass. While there may be some concerns over the impact of large areas of SRC on the landscape, there are indications that it is positive for biodiversity20.

11.2 Community impact

In community terms, RE is almost entirely positive, bringing employment, support to hard-pressed farm communities through land rents, clean industries and funds for local projects (see table 8.1 for a full list of impacts). Expansion of renewables, in particular further development of onshore wind, hydro and energy crop biomass, which are all linked to rural areas, is therefore very positive.

The greatest expansion is likely to be in biomass which impacts on less remote rural areas and which was seen to be very well received in local communities once established. Lessons can no doubt be learned from existing projects about how best to involve local people and ensure that they share in the benefits of expansion of the technology.

11.3 Economic impact

Given the variation in economic impacts between primary research findings in this study, the mix of RETs will be key to the rural impacts delivered. In particular, the expansion of biomass offers opportunities for employment and increased output. Given the reliance on ongoing support, the rural impact assessment will be based on the total generation of relevant RETs in 2010 rather than the incremental increase from the current base.

The technology mix used in this study for 2010 is based on projections by DTI[21] and British Wind Energy Association and is set out in Table 11.1. For the purpose of this study, future rural development impacts are based on the following assumptions:

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[20] Sage R & Tucker K, 1998. Integrated crop management of SRC plantations to maximise crop value, wildlife benefits and other added value opportunities. ETSU B/W2/00400/REP.

Coates A & Say A, 1999. Ecological assessment of SRC. ETSU B/W5/00216/REP1.

Rich, sage, et al, 2000. ARBRE Monitoring - Ecology of SRC plantations. Interim report 2000. ETSU B/U1/00627/00/00.

[21] DTI (2002) Digest of the UK national energy statistics. Capacity and Generation: Renewables. Table 7.4. HMSO: DTI.

(i) there will be no expansion of large-scale hydro (currently 1440 MWe DNC) but there will be some rural development impact from existing plant. As this is not dependent on ongoing Government support and is not relevant to any cost benefit analysis of public support, it has not been estimated in this project.

(ii) the new technologies which are still in the development stage (PV, Geothermal, Fuel cell, Tidal, Wave) will not make a contribution to rural development in this timescale due to lack of generation scale.

(iii) offshore wind contribute to renewable generation (estimated 1260 MWe DNC by 2010) but will not make a significant contribution to rural development as the technology will be driven by major generation companies and based at existing centres of engineering and offshore construction expertise (oil and gas industry).

(iv) Landfill gas and waste incineration are largely urban-based with little impact on rural development and have been ignored for the purpose of this study.

(v) The main rural development benefit will come from expansion of existing RETs considered in this research i.e. onshore wind, small-scale hydro and biomass. However, much depends on the technology used. For example, if biomass energy generation were mainly through co-firing at existing conventional urban-based generation sites, rural impacts would be much reduced. For the purpose of this study, it is assumed that 50% of biomass generation in 2010 comes from co-firing.

(vi) Output and employment multipliers calculated for these RETs in this study are assumed to remain constant, despite greater critical mass and improved infrastructure. In practice, there will be greater returns to uptake and less leakage from the local economy.

11.4 Scaling up rural impacts

The methodology for scaling up the rural development impacts of the three technologies researched in this project is set out below:

(i) estimate the base level of output and employment per unit of energy generation (MW capacity) for each technology

(ii) scale up these factors to the estimated generation level by technology in 2010 (from Table 11.1) allowing for any generation which is not rurally based

(iii) apply the multipliers calculated from the study by technology to give gross output and employment for each

(iv) aggregate the scaled-up output and employment estimates to give an industry level forecast of the total benefit to the rural economy

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DTI (1999). New and Renewable energy: prospects for 21st century. HMSO:DTI.

DTI Renewables Technology Route maps

The calculations are shown in table 11.2 and 11.3 for output and employment respectively. The gross impact is a contribution to output of £743m into the rural economy and 2465 full time jobs.

Table 11.1: Forecast UK renewable energy mix at 2010

Technology band	Current DNC 2001 (MWe)	Predictions of capacity by 2010 (MWe DNC)			Predictions of capacity/capability by 2020/25 (MWe DNC)	
		DTI - TRM	DTI – NRE***	TAs	DTI – NRE**	PIU cost estimate
Wind – on-shore	182		2,000	1500	8 TWh	1.5-2.5
Wind – off-shore	1.6		1260	6500	100 TWh	2-3 p/kWh
Large hydro	1440		1440			
Small-scale hydro	68		138		3 TWh*	2-3
Biomass	133	1000	553		large	2.5-4
PV	2.8		<3	300	37 TWh	10-16
Geothermal	0		<1			-
Fuel cell	0		<1			-
Tidal	0	0?	<1	500		4-5
Wave	0		<1		50 TWh	3-6
Landfill gas and waste incineration	692		2512			
	= 2.5% of electricity					
10% = 7,000 MW dnc			7906			

* small-scale hydro
** exploitable potential, not linked to price of electricity
Note: 1,000 MWe = 1 GWe = 5TWh/yr
Note: UK electricity use currently = 340 TWh/yr., therefore 1GWe installed capacity = 1.5% of current level.
Note: By 2010, electricity demand is expected to reach 370TWh/yr, in which case 1 GWe installed capacity would meet 1.35% of demand
*** extrapolated from percentage figures presented

Table 11.2: Calculation of Contribution to Output from RE at 2010

	2010 MWe DNC	% rural economy	Output per MWe* (£'000)	Total output (£m)	Output multiplier (Type 2)	Total output (£m)
Wind – onshore	2,000	100%	251	503	1.20	604
Small-scale hydro	138	100%	137	19	1.18	22
Biomass	553	50%	378	104	1.12	117
					Total	**743**

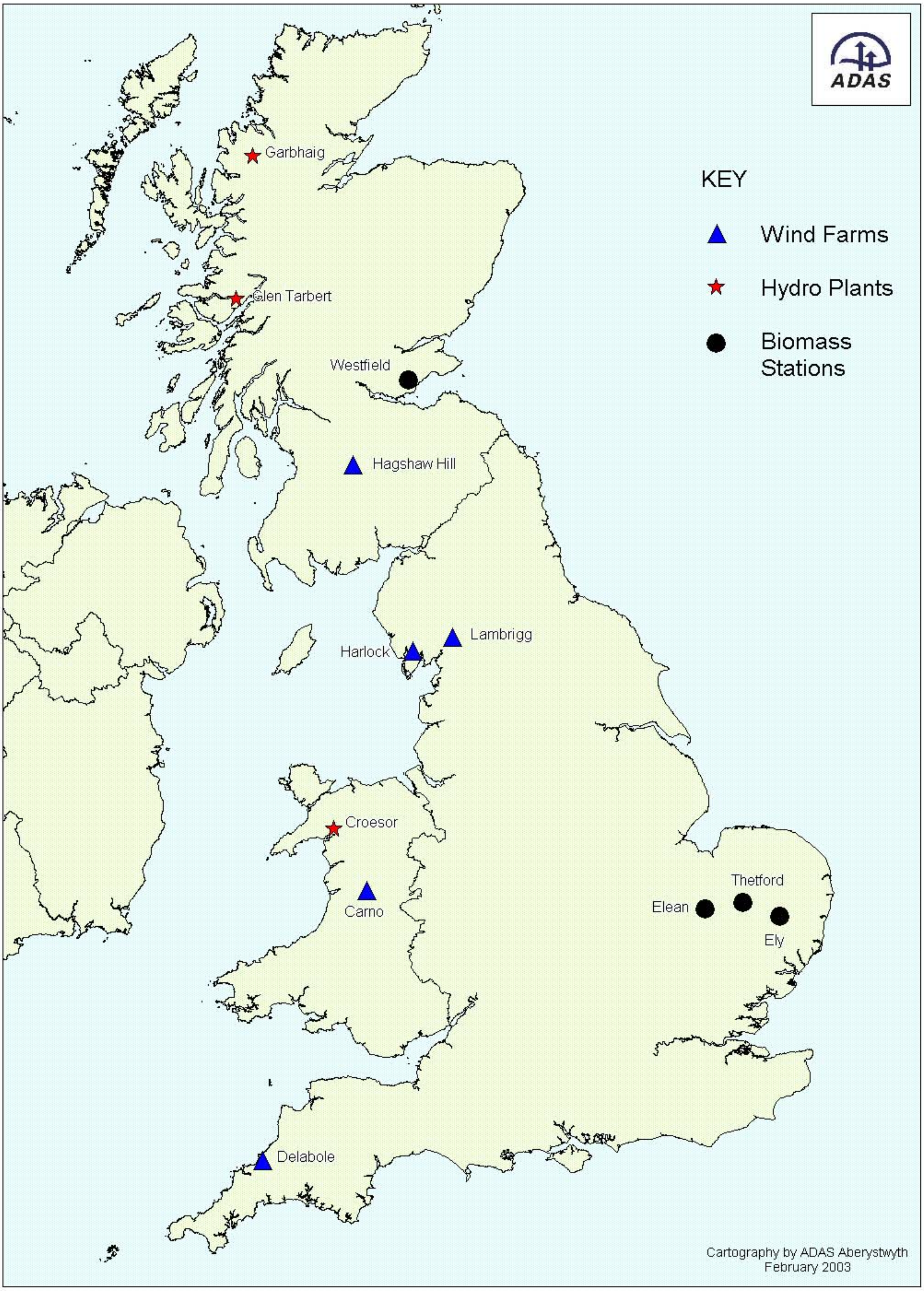
* based on average of researched sites.

Table 11.3: Calculation of Contribution to Employment from RE at 2010

	2010 MWe DNC	% rural economy	Employment per MWe* (£'000)	Total output (£m)	Employment multiplier (Type 2)	Total employment (£m)
Wind – onshore	2,000	100%	0.6	1182	1.32	1560
Small-scale hydro	138	100%	1.3	173	1.08	186
Biomass	553	50%	1.4	397	1.81	719
					Total	**2465**

* based on average of researched sites.

ANNEX B: Case Study Maps



ANNEX C: Government Rationale for RET Support

Greenhouse gas emissions reductions targets

On a global scale, a powerful political stimulus for the development of energy crops came from the Intergovernmental Panel on Climate Change (IPCC, 1992). At the so-called Earth Summit UN conference in Rio de Janeiro 1992, the IPCC called for a global reduction of CO2 emissions levels in 2010 to 1990 levels (the Rio Declaration). Signatories to the Rio agreement implemented energy efficiency and new generation policy measures (with varying degrees of vigour and success). The Rio Declaration was followed by the Kyoto Protocol of 1997, which proposed measures aimed at reducing global greenhouse gas emissions by 6% relative to 1990 levels by the period 2008–2012 and attempted to assign individual targets for reductions for nation states (Kyoto Protocol, 1997). The proposed targets varied between countries, with a few (eg Australia) permitted an increase, but with most required to reduce emissions by 6–8%.

Ratification of the Kyoto Protocol was finally achieved in 2001 at the Seventh Conference of Parties (COP–7) in Marrakech. Although the proposals themselves have been watered down and international consensus impaired by the USA's refusal to ratify the Protocol, this nevertheless represents an important start in the creation of a legally binding framework for the global reduction of greenhouse gas emissions. The Protocol allows for a number of mechanisms for nation states to reduce CO2 emissions: increased energy efficiency, reduced fossil fuel consumption, increased use of renewables resources, carbon and emissions trading, and limited carbon sequestration development. Over eighty countries are signatories to the Kyoto Protocol, including the UK and the EC15.

The EC has established GHG emissions reduction targets, leading to an overall 8% reduction relative to 1990 levels by 2010 – individual member states have their own targets that contribute to this. The UK government has sighed up to a 12% reduction in GHG emissions by 2010, including a 20% cut in CO2 emissions. Whilst it is anticipated that the UK will meet or exceed its GHG emissions targets it is anticipated that a deficit of (currently) 7% between its 2010 electricity generation target exists currently and that this will not be met under existing frameworks.

Energy Security

Since 1970s the UK has been a net exporter of oil and more recently gas. Of all OECD countries only UK and Canada is currently self-sufficient in energy needs. Within the next ten years the UK is predicted to become a net importer of these commodities as north sea oil reserves are depleted and as the growth of the CCGT sector increases stimulated by inexpensive and plentiful European supplies, the relative expense of coal extraction and the lower CO2 emissions from CCGT (compared with coal). This could have a significant impact on domestic fuel security. Although plentiful and inexpensive gas and nuclear electricity is available from Europe and France, respectively, the UK must ensure that it has capacity and diversity to mitigate against:

Fluctuations in world energy prices
Over-reliance on importers (c.f. the Californian Experience)
Unreliable supply sources
Unreliable gas quality
Ceding to much market power

Facility/logistics failure in importing countries
Risks associated with piping gas through transit countries
Reduced UK investment incentives
War and terrorism

Renewables are currently considered an important component of the development of a diverse, indigenous, low carbon solution to energy security. However, a significant caveat is that this security (and environmental benefit) is expected to be delivered with minimal impact on the domestic energy consumer - a caveat that renders many RETs under current support mechanisms unviable.

Rural Diversification

Embedded generation of electricity/CHP, regional generation of all forms of energy and the production of transport fuels from crops could all significantly enhance rural diversification and regeneration. This much was noted in the recent Curry Commission on the Future of Food and Farming. Such diversification would flow in the following forms:

Export of energy into national markets, thus generating local revenue
Offset of energy imports and non-renewable energy
Use of local resources to provide the renewable energy
Use of local infrastructure and manufacturing base

Opportunities for rural diversification come most obviously from biomass and energy crops (including transport fuels) but also significantly from onshore wind, PV and small-scale hydro.