SCOTLAND'S RENEWABLE RESOURCE 2001 – EXECUTIVE SUMMARY

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CONTENTS

		Page
1	**BACKGROUND**	**1**
1	**STUDY FRAMEWORK**	**1**
1	**RESULTS**	**1**
1	**EFFECT OF CONSTRAINTS**	**2**
2	**KEY CONCLUSIONS**	**4**

1 BACKGROUND

In view of new policy measures on renewable energy, “Scotland’s Renewable Resource 2001” was commissioned by the Scottish Executive to inform policy development. It updates previous work undertaken for Scotland and the UK in assessing the resource potential for renewable energy, and draws on experience gained in the intervening period.

For each renewable energy technology considered, the study examined the implications for development patterns and costs of a range of deployment scenarios. The scenarios were based on previous development and published policy, and differed in the extent to which development was constrained by technical, planning-related and social parameters.

Given that planning policy and other locational drivers are evolving, and that development is market-based, results should *not* be viewed as predictions. Neither should they be viewed as prescriptive for future development. The results show the likely effects of applying a range of restrictions to development, and quantify the overall size of the resource and its indicative cost. It is a factual backdrop for all those with an interest in the future growth of renewable energy in Scotland, and is intended as an aid for future decision-making.

The study involved extensive research, consultation and proprietary analysis. This Executive Summary provides a very brief summary of some key results. Interested parties are recommended to consult the full report in order to obtain a better understanding of both the methods employed and the wide-ranging policy and technology contexts.

2 STUDY FRAMEWORK

Key tasks in the study were to:

- Estimate resource size and costs for the years 2010 and 2025.
- Assign resource estimates to geographic areas (local authority areas, where possible).
- Produce cost-energy curves for each technology, for each of ScottishPower’s and Scottish and Southern’s network areas.

Generalised costs were estimated for 2010 and 2025 in today’s prices. Costs for some of the less mature marine technologies are more speculative and assume reductions through “learning by doing”. Network upgrade costs were excluded and are considered in the Network Study Group report [NRG Front Plc, Scottish Power. 2001. “Impact of Renewable Generation on the Electrical Transmission Network in Scotland.”]. Modelling employed simplified financial parameters, including set discount rates of 8 and 15%. In reality, commercial projects are financed on variable terms, using balance sheet and/or external finance and a range of payback periods and returns.

Only the resource predicted by the models to be available at less than 7 p/kWh was considered. This was a pre-defined study parameter, set to encompass technologies judged capable of being technically and financially viable within a 10 year timescale.

3 RESULTS

The potential for electricity generation for each technology was estimated for a single “Base case” and varying numbers of “Sensitivity” cases. Constraints were modelled where data availability and information allowed. In interpreting the results it should be borne in mind that the final results reflect the availability of data and key underlying assumptions, both of which differed between technologies. Volume I of the full report describes these issues in detail.

In view of its anticipated importance in meeting near-term targets, onshore wind was modelled in the greatest detail. Onshore wind is a mature technology and there is extensive operational experience from which to draw in modelling constraints on its development.

The "Base Case" results for each technology are shown in Table 3.1. To put these results in context, about 390,000 GWh were supplied to customers in the UK last year, and the total UK installed capacity is 79 GW.

Technology	Capacity (GW)	Energy (GWh)
Onshore wind	11.50	45,000
Offshore wind	25.00	82,000
Wave	14.00	45,700
Small hydro	0.30	1,000
Tidal stream	7.50	33,500
Landfill Gas	0.07	555
Forestry Residues	0.09	700
Energy Crops	0.14	1,100
Agricultural Wastes	0.40	3,500
Municipal Solid Waste (MSW)	0.10	900
TOTAL	**59.10**	**213,955**

Table 3.1 Base case results

The following points should be noted when interpreting the above results:

- All technologies were constrained by some technical and environmental considerations, although the nature of these constraints differed between technologies.
- Onshore wind is the only technology to be constrained by consideration of a socially acceptable limit, which draws on experience in Denmark.
- Generally, the resource remains the same for 2010 and 2025. The exception to this in the modelling is tidal stream, which assumes technical limitations to exploitation of the full resource up to 2010 (the total resource up to 2025 is presented above).
- The estimate for the forestry biomass resource only considered residues. Given downturns in the timber market, and the cost of harvesting in some more remote locations, there may be potential for utilising the whole tree for electricity generation. Any estimates of such potential for the current study were considered to be too speculative.
- The resource for energy crops is extrapolated from the potential inherent in soil and climatic conditions to cultivate energy crops, and makes assumptions on the possible conversion from existing land uses. There are not, at present, any crops grown for electricity generation in Scotland.

4 EFFECT OF CONSTRAINTS

A range of constraints were considered and applied, as appropriate, to technologies in the "Base Case" and/or in sensitivity analyses. Geographically defined constraints were modelled by being removed from the area available for development. Capacity limits were applied as a cap by area, retaining the cheapest projects in each area. Some of the main constraints considered are described below.

- **Environmental and Cultural Designations:** National environmental and cultural designations considered cover some 45 % of the land area of Scotland. A selection of local environmental designations considered removed an additional 15 % of land area from that modelled as available for development. Some sea areas are also designated – notably in the Moray and Solway Firths, and parts of the nearshore in the Western Isles.
- **Low Flying Areas:** The MoD has indicated that it would not generally favour wind farms in certain low flying areas (LFA's), two of which are in Scotland. LFA's 20T (in Southern Scotland) and 14T (in Highland) together occupy some 26 % of Scotland in the analysis.
- **Grid:** Local transmission system limitations were taken from modelling undertaken by ScottishPower (SP) and Scottish and Southern Energy (SSE). Also, North-South transmission bottlenecks tend to shift generation from SSEs to SPs area, the implications of which were broadly considered for onshore wind only.
- **Social:** Social constraints were modelled by applying a set capacity limit per local authority area (for onshore wind only), which was derived from experience in Denmark.
- **Marine Navigational Risk:** areas experiencing a high volume of routine marine traffic were treated as a constraint for the marine technologies.

The following key effects of constraints were found:

LFAs and Environmental Designations

- The total area constrained in the model by both LFAs and environmental designations totalled nearly 70 % of onshore Scotland. Onshore environmental designations and MoD low flying areas principally affect onshore wind. Because they cover large parts of Scotland, and because the onshore wind resource is widespread, with large areas of comparable cost (excluding grid upgrade costs), these areas have a strong influence on project location.
- There are marked differences between local authority areas in the effects of constraints. For instance, LFA 20T covers some 94% of Dumfries and Galloway. The only area remaining – the Stranraer Peninsula – is subject to radar-related constraints (radar constraints were not modelled).
- For onshore wind, progressive removal of LFAs and environmental designations increases the cost of exploiting the resource, although the effect is relatively minor in SSE's area. The effect is more marked in ScottishPower's area where there are fewer high wind speed areas and available land is more severely limited.

Local transmission constraints

- Local transmission system constraints limit the onshore wind resource to 3.1-3.4 GW depending on the scenario considered. This means that network modifications or upgrades would be required to accommodate additional capacity. The corresponding figures for offshore wind and wave are 2.5 GW and 0.3 GW respectively. For tidal stream to 2010, local transmission constraints limit the resource to 0.4 GW and in 2025, to 0.6 GW.

Shift of Generation to SP's Area

- If LFA, environmental designations and local transmission constraints were all considered to limit development, the model shows just 1.8 GW of onshore wind available in ScottishPower's area, some of which is "bunched" in one or two areas. This does not consider other constraints such as radar, which would reduce this figure even further. The conclusion is that it is the cumulative effect of a number of constraints which could limit development of onshore wind for the near- and medium-term market.

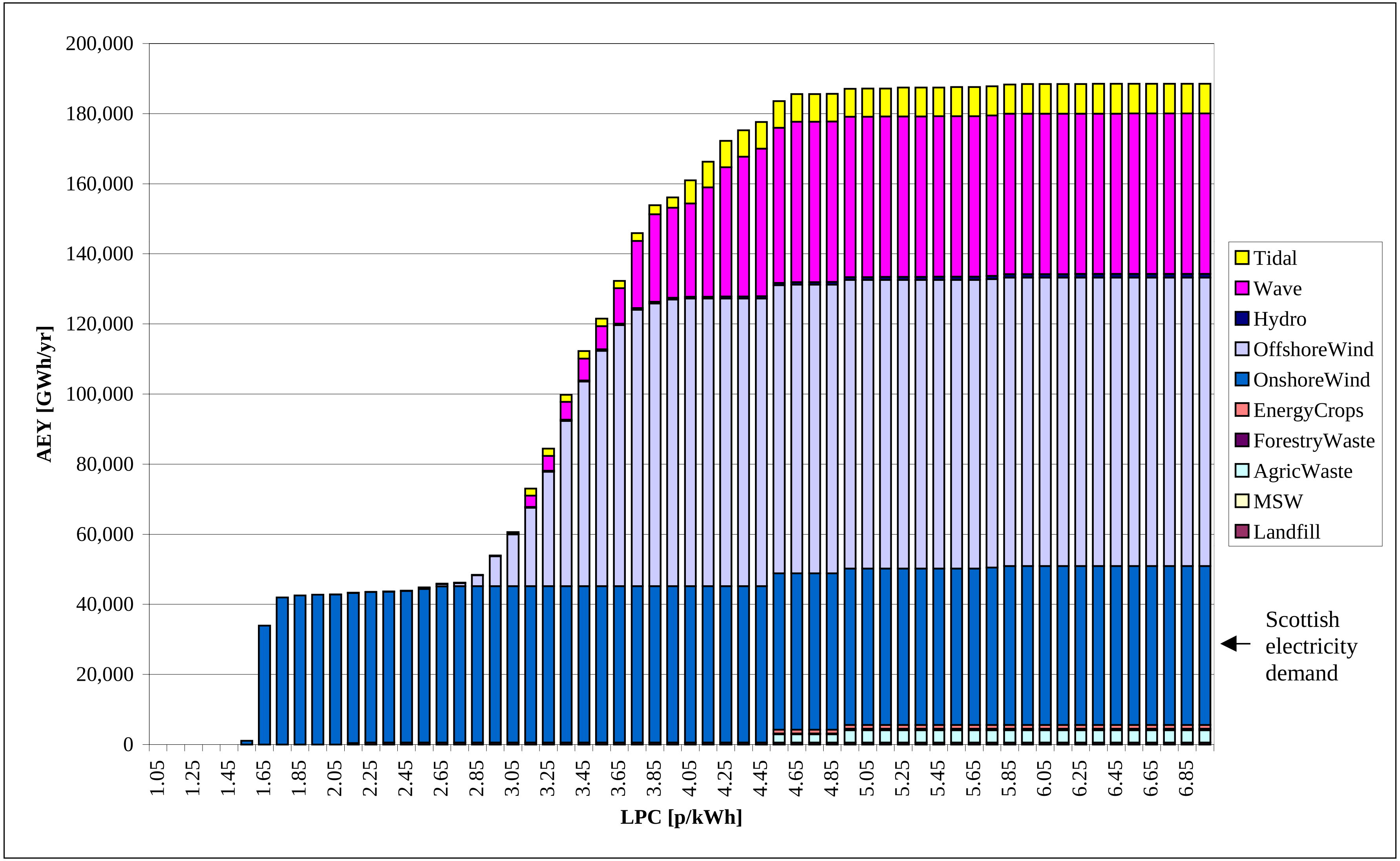
Marine Navigational Risk

- These areas limit wave and tidal technologies (the effect on onshore wind was relatively minor). For wave, while the overall resource remains significant, marine traffic could limit the availability of "optimal" sites. All of the longer-term resource for tidal stream is centred on the Pentland Firth, which experiences large volumes of marine traffic – the impact this would have on exploitation of the resource requires further investigation.

5 KEY CONCLUSIONS

A stacked cost-energy curve for the Base Case scenarios modelled is shown overleaf. It shows costs for 2010 at 8% discount rate. Key conclusions are as follows:

- **Onshore wind**: the resource is widespread and is the cheapest of the renewable energy technologies considered, with the "available" 11.5 GW modelled at under 3 p/kWh *in 2010 at 8% discount rate, and excluding certain network costs*, and under 4 p/kWh at a 15 % discount rate. On the basis of cost, it can be expected to contribute to the bulk of near-term government targets. This 11.5 GW is modelled in just under 2% of the area of Scotland. Analysis shows that while any one constraint may not compromise policy targets, their *cumulative* effect is significant.
- **Marine technologies** (offshore wind, wave, tidal): the resource is very large – a total of 46.5 GW were modelled at under 5-6 p/kWh in 2010 at 8% discount rate (and about 1.5 p/kWh higher at 15%). The grid on the West and the North coast is a severe limitation to exploitation – local network constraints limit the total available to around 7 % of the total without network reinforcement . Constraints to development are less well understood for these technologies, as are costs. More work needs to be undertaken to understand and avoid unnecessary conflicts. Demonstration schemes are required to improve cost estimates for wave and tidal.
- **Small hydro**: also a relatively small resource, and mostly in SSE's area. Costs are more widely spread than for other technologies and were modelled at up to 7 p/kWh. Nonetheless there are rural development benefits to be gained from exploitation. Environmental and regulatory pressures could restrict development of the resource identified.
- **Landfill Gas**: also a relatively small resource, but cost-competitive in the near-term with modelled costs all under 3 p/kWh. There is a strong environmental rationale for its exploitation and can provide baseload output.
- **Biomass** (forestry residues, energy crops, agricultural wastes): individual resources are relatively small, but could be increased by expanding and combining fuel sources. The modelled resource totalled 0.63 GW, but due to the lack of data, not all potential sources were considered. Opportunities for energy crop cultivation hinge on the relative economics of alternative land use options. There are economic benefits, particularly in the forestry and agricultural sectors, to be gained from biomass exploitation, and it can provide baseload output.
- **MSW**: again, a relatively small resource with the potential very much contingent on waste management policy developed at the Waste Strategy Area level. For both biomass and energy-from-waste, new gasification and pyrolysis technologies promise improved efficiencies, greater flexibility and (of relevance to MSW) lower environmental mitigation costs.



Stacked cost energy curve, 2010, 8% discount rate