ENERGY ASSESSMENT OF TAN 8 WIND ENERGY STRATEGIC SEARCH AREAS

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EXECUTIVE SUMMARY

The Commission

The Welsh Development Agency ("WDA") has commissioned Garrad Hassan and Partners ("GH") to carry out a technical feasibility study of the seven proposed wind energy Strategic Search Areas ("SSAs"). The work does not seek to pre-empt detailed on-the-ground studies that would typically be undertaken by wind farm developers when assessing sites. Rather, it provides an informed view on the broad capacity limits of the areas, and the headline common factors which are likely to influence these limits. The terms of reference did not include any input by GH into the definition of the SSA areas, or any assessment of planning matters such as landscape capacity. Grid access has been considered by others and is not part of this report.

Methodology

A Geographical Information System ("GIS") was used to generate constraint plans for each SSA for a Base Case and for a number of Constraint Cases. Because constraints such as environmentally sensitive areas were considered in the derivation of the SSAs, they did not for the most part impinge materially on the SSAs. The exception to this was the effect of dispersed dwellings, which were an additional consideration in the study, and which did limit available area within the SSAs.

Turbines were placed in remaining unconstrained areas, based on a first-pass judgement. GH modelled the wind resource for each SSA using a wind flow program. This wind speed data in turn formed an input to specialist wind farm design software, employed to refine wind farm layouts imported from the GIS, and to calculate energy yields.

Results

Results are presented for a so-called "Base Case" and for a number of "Constraint Cases." Separate consideration is also given to the implications of siting wind turbines within mature forestry.

The base case is a starting point for subsequent reductions in capacity and energy when additional constraints are applied. The Constraint Cases indicate the nature of two identified categories of constraint which are likely to limit development opportunities, particularly for large wind farms. These are: noise levels from large wind farms; and National Air Traffic Service ("NATS") concerns. Forestry Commission ("FC") land is well represented in the SSAs, and an extra case, on available capacity, was also performed for an FC Park area, Afan Park.

Capacity and energy results for the base case and constraint cases are presented in Table 1 below. The energy results assume significant tree felling in afforested areas to maximise energy capture. An expected value (50% probability of exceedance) and a 90% probability of exceedance value is provided.

Separate consideration was given to a case where trees are not felled (except a minimum required for access and construction). The use of afforested areas needs very careful consideration since it will certainly reduce the energy production compared to open terrain and, more importantly, it may increase the fatigue loads experienced on the turbines. Site-specific measurements would be required to confirm that the presence of trees has not induced turbulence levels which are more onerous than those assumed within the international standards to which wind turbines are designed. An indication of the energy cost of nearby mature trees is provided in Table 2, but is subject to significant uncertainty prior to on-site wind measurements.

Case	**Nos. turbines**	**Rated Capacity [MW]**		**Long term annual energy output [TWh/annum]**	
		Total	**FC[1]**	**50% probability of exceedance**	**90% probability of exceedance**
Base Case	1052	2104	902	6.4	4.9
Base Case + Noise	833	1666	766	4.8	3.7
Base Case + Noise + Afan	759	1518	618		
Base Case + NATS	527	1054	634	3.2	2.5
Base Case + NATS + Noise	424	882	548	2.6	2.0
Base Case + NATS + Noise + Afan	350	700	400		

1 Forestry Commission

Table 1 Results for Base Case and Constraint Cases

	Base Case long term annual energy output [TWh]	
	50% probability of exceedance	**90% probability of exceedance**
Felling	6.4	4.9
Minimum Felling	5.7	4.4

Table 2 Energy Cost of Trees

Conclusions

The results show that the SSAs have the technical potential to accommodate the Assembly's target of 800MW. There is technical scope for more than 800MW, especially if NATS considerations are not treated as absolute constraints. However, experience suggests that as projects progress through the planning process, the technical potential is significantly reduced before an acceptable development results. This observation implies that in order to realise a significant proportion of the technical potential, either planning restrictions in the SSAs would have to be less onerous than those experienced elsewhere, or areas outside the current SSAs would be required.

Some 57% of modelled turbine locations are within afforested areas, and an additional amount are close enough to trees to be affected by them. Siting turbines within mature forestry reduces energy output but also, more seriously, raises some issues on turbine fatigue loads which may significantly reduce the size of developments which can be realised. If trees are not felled, a more detailed evaluation of the large scale use of afforested areas for wind farms is needed

CONTENTS

1 INTRODUCTION

1.1 Study context

The Welsh Assembly (the "Assembly") has set a target of 4 TWh/annum to be produced by renewable energy by 2010 as part of the wider UK national target of generating 10 % of electricity consumption from renewable sources by 2010 [1]. Figures presented by the Assembly for May 2004 estimate the total annual electrical output from renewable installations in Wales as 1.18 TWh [1], with an additional 0.7 TWh of new additional production approved. These figures imply a doubling of current output if the 4 TWh/annum target is to be met. Specifically for onshore wind, the Assembly considers that a further 800MW of installed capacity will be required by 2010 [1].

In light of the need for new renewable energy installations, the Assembly is currently updating its renewable energy planning advice. National planning policy advice on renewable energy is detailed in the Technical Advice Note ("TAN") Number 8: "Renewable Energy". Through modifications to this TAN, the Assembly aims to provide positively for this increase in renewable energy.

As part of this process, the Welsh Assembly Planning Division commissioned work to assess, at a strategic level, the potential for wind energy development in Wales. The consultants, Arup, produced a "decision support tool" which was essentially a collation of relevant information, data, techniques and research, in order to document and clarify relevant issues relating to wind farm development in Wales. The work [2] culminated in identification of seven separate areas, shown below in Figure 1.1, capable of accommodating large scale (>25 MW) wind farms. These seven areas were adopted in a draft version of TAN 8 as "Strategic Search Areas" ("SSAs"), and have been subject to wide consultation.

The Welsh Development Agency ("WDA") has, in the present study, commissioned Garrad Hassan and Partners ("GH") to carry out a more detailed technical feasibility study of the generating potential of the seven SSAs. The work does not seek to pre-empt detailed on-the-ground studies that would typically be undertaken by wind farm developers when assessing the sites. Rather, it provides an informed view of the broad capacity limits of the areas, and the headline, common factors which are likely to influence these limits. GH expects a significant reduction as part of the detailed planning process. The terms of reference did not include any input by GH into the definition of the SSA areas, or any assessment of planning matters such as landscape capacity. Grid access has been considered by others and is not part of this report. Therefore the SSAs defined in [2] were the starting point of this study.

1.2 Study approach

In reviewing the potential capacity of the SSAs, GH has undertaken a largely technical analysis using up-to-date, and available data on planning constraints, and by employing sensible wind farm design criteria. A Base Case is established and the resource devised from it is refined by considering some additional planning constraints in "Constraint Cases".

Constraint data were imported into a Geographical Information System ("GIS"), filtered and where necessary processed, in order to generate constraint plans of each SSA and for each of the Base Case and Constraint Cases. The remaining unconstrained areas comprised the outer boundaries for theoretical wind farm development, within which turbines were placed with a view to maximising energy capture.

GH modelled each SSA using the WAsP wind flow program [3] initiated with 1km^2 NOABL [4] wind speed estimates. WAsP takes an "initiation" point wind speed, and contour terrain data, to model wind flow over the terrain. For this analysis wind speed data were output at 100m resolution. These wind speed data in turn formed an input to specialist wind farm design software[1], employed here to refine wind farm layouts imported from the GIS, and to calculate energy yields.

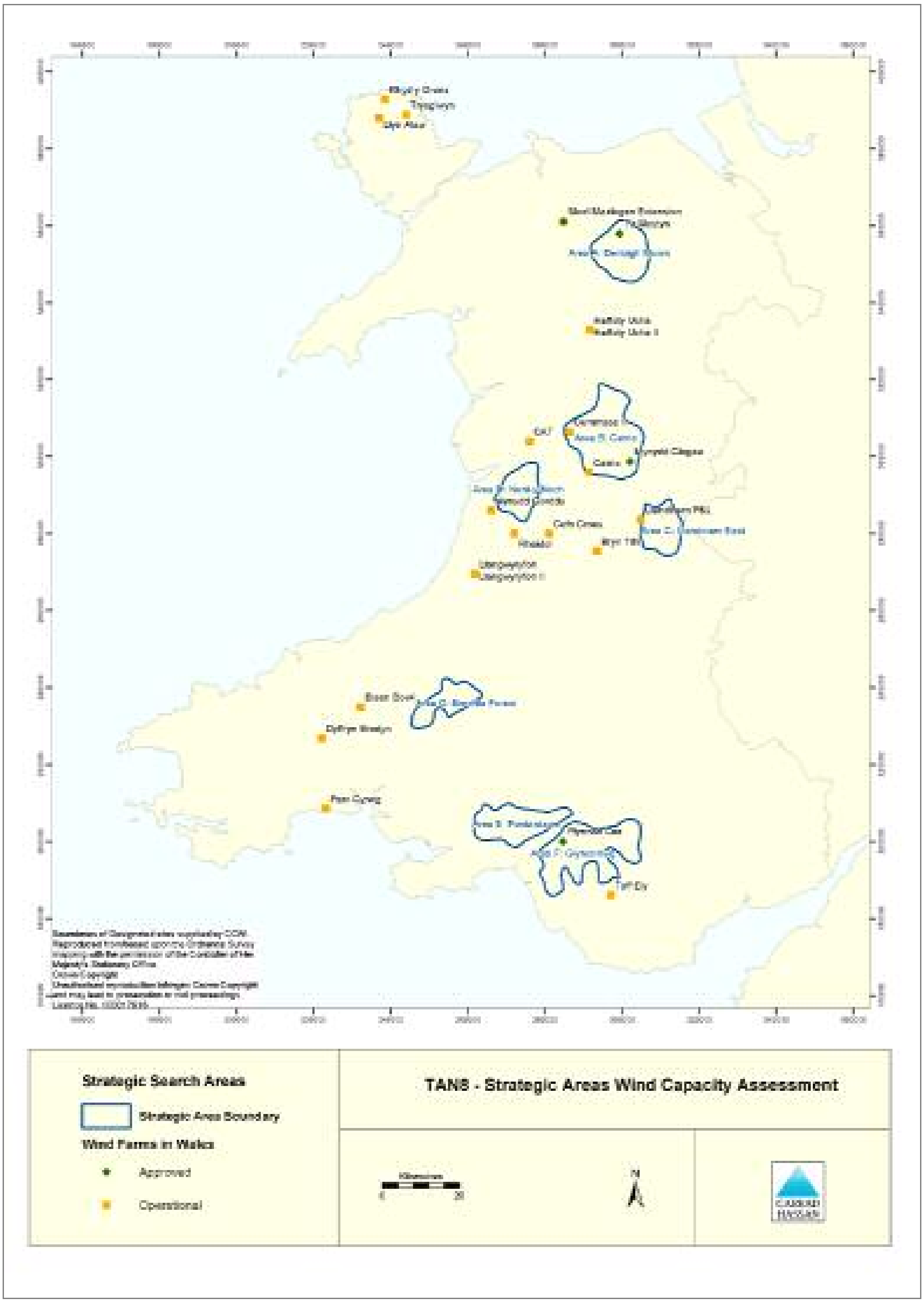

Figure 1.1 The seven Strategic Search Areas

[1] In this case GH's *WindFarmer* package

1.3 Report structure

The remainder of this report is structured as follows:

Section 2 – Analysis methodology
The main aspects of the energy and constraint analysis are presented including the methodology and assumptions used. More detailed information about the methods used can be found in Appendices A to D.

Section 3 – Results
The results of the energy calculations are presented, including energy output graphs and detailed results tables.

Section 4 – Conclusions
The main points and recommendations arising from the analysis are listed.

Appendix A
Additional information regarding the individual constraints used in the GIS analysis is provided.

Appendix B
The inputs used for the Base Case energy analysis and the methodology and assumptions applied are described.

Appendix C
The modelling assumptions and methodology used in the noise constraint analysis are set out.

Appendix D
The modelling assumptions and methodology used in the tree constraint analysis are described.

Appendix E
The turbine layout maps and constraints for each SSA and sensitivity are provided.

2 METHODOLOGY

This section describes the methodology for the Base Case, Constraint Cases and for the separate consideration for wind farms within mature trees. It also explains the basis of an uncertainty analysis computed for the energy predictions. Further details can be found in Appendices A to D.

2.1 Base Case

The rationale for developing an initial Base Case layout was to determine a reference case for feasible maximum capacity of each SSA.

2.1.1 GIS analysis

Areas considered to be unavailable for development in the Base Case are listed in Table 2.1 below. A detailed description, including references for datasets and buffer zone assumptions, is presented in Appendix A.

Category of constraint	Datasets
Practical / Technical	Residential areas, steep slopes, inland water, roads and railways
Military / Aviation	Air defence radar, safeguarded civil aerodromes, met office wind profiling radar, MOD tactical training areas, military technical[2] sites
Environmental	SSSIs, Ramsar sites, SPAs, SACs, Biosphere areas, Biogenetic areas, Heritage Coasts, National Parks, Country Parks, NNRs, AONBs, LNRs, Scheduled Ancient Monuments, National Trails and Coastal Paths, WHSs, IBAs, RSPB Reserves

Table 2.1 Base Case Constraints

The majority of constraints listed in Table 2.1 were considered in the original identification of the SSAs [2], and hence do not materially impact on the land available within the SSAs. GH's precise definition of constraints – buffer zones or degree of slope, for example – do depart from the original SSA assumptions to a significant degree. The main material difference in the present study is the addition of buffers for dispersed dwellings which was omitted from the previous study. It forms the main locational driver for turbine placement within each SSA.

Inspection of the OS maps and digital postcode data suggests that there are a number of dwellings within the SSAs. The data did not allow differentiation between residential and other properties, but it is reasonable to assume that a subsection will comprise noise-sensitive properties – that is, they will be subject to planning conditions relating to permissible turbine-generated sound levels at the houses.

[2] Various military sites such as storage installations.

As part of the constraints analysis, all residential, business and public postal addresses in Wales were subject to a 700 m buffer to ensure adequate separation from turbine locations. Part of the reason for including this buffer zone is to mitigate any noise effects experienced at properties from operating wind turbines. Typically noise levels from medium-sized single UK wind farm sites would be sufficiently low at a distance of 700 m to meet planning guidance.

2.1.2 Turbine assumptions

A typical 2 MW wind turbine with an 80 m hub height and 80 m rotor diameter was chosen as a typical onshore turbine specification for use in relatively complex terrain, up to the year 2010.

2.1.3 Turbine layout design

Based on GH's experience of planning wind farm layouts in a number of different terrain types, layout designs for each area were generated with the aim of maximising energy output within the given constraints. The following factors were taken into consideration when siting the turbines:

- Wind exposure;
- Prevailing wind direction predominantly South Westerly;
- Avoidance of local obstacles such as small rivers and pathways;
- A minimum turbine spacing of 6 rotor diameters in the prevailing wind direction and 4 rotor diameters in the perpendicular direction.

2.1.4 Energy production

Wind flow modelling at the assumed hub height of 80 m was undertaken for each SSA using WAsP [3]. The modelling was initiated using wind speed estimates taken from the NOABL wind speed database [4]. The results from the wind flow modelling were then input into GH *WindFarmer* to model the wake effects of the turbines, giving the predicted energy output of each individual turbine. A more detailed description of the procedure is presented in Appendix B, where maps of the predicted wind speeds are shown.

2.1.5 Capacity factor iteration

The capacity factor of a wind turbine is a measure of the energy output of a turbine compared to the output that the turbine would produce if it was operating continuously at maximum rated power. Windier locations have higher capacity factors. Predicted capacity factor can be used as a way of screening wind farm layouts to eliminate low-yield turbines.

A refinement of the Base Case layout was undertaken to eliminate the less productive, lower wind speed turbines. A capacity factor of less then 30 % was set as a pragmatic cut-off value, given the wind speed characteristics, the type of turbine, and the specified hub height. It should be noted that for the same turbine location and hub height, different turbine types will exhibit slightly different capacity factors.

2.2 Constraint analyses

The following sections describe the Constraint Cases on the Base Case.

2.2.1 Noise emission

The basic buffer zone approach is described in Section 2.1.1 above. A slightly more sophisticated approach was taken to noise analysis in order to define a Noise Constraint Case.

Planning limits are usually set with reference to normal background noise, which would be measured as a function of wind speed. Thus it is not possible to undertake a definitive assessment of noise until detailed background noise measurements have been made at nearby residences. Such an approach is clearly outside the scope of this study. GH have therefore made the assumption that a wind farm development is likely to meet the relevant planning guidance provided predicted noise levels at dwellings are less than 40 dB(A) at a reference wind speed of 8 m/s at 10 m height [5]. The noise calculations were based on a noise source power of 105 dB(A) for the "normal" turbine and 101 dB(A) for the "quieter" turbine at this condition with an assumption of no tones.

The Base Case has some atypically large developments, and the 700m buffer is not sufficient to maintain a level of 40dB(A) at all the properties shown. Because the purpose of this exercise is to elucidate theoretical upper limits to development, it was considered sensible to undertake a constraint study that approximated the maximum size of development for a 40dB(A) absolute limit. In the event, if smaller wind farms are developed, noise is expected to be less of a constraint than indicated here.

To undertake noise calculations for large wind farms for many layout iterations is a computationally onerous task. The buffer zone in the Base Case is a first approximation, which is then refined in this constraint by undertaking noise predictions for the resultant layout design.

Since turbine manufacturers can offer different types of turbine with a different maximum noise output, it is possible to model different scenarios to determine the most suitable turbine noise profile and layout. Reducing the maximum permissible noise output of a turbine also reduces power output. In this constraint, GH used its *WindFarmer* program to produce noise contours for the Base Case turbine type, and for a quieter (and lower yield) turbine. For the latter case, turbines were removed until each property met the 40dB(A) limit. This approach incorporates an element of conservatism as not all properties are in reality expected to be residences.

Figure 2.1 illustrates, for Area E, the noise contours and turbine layouts for the Base Case and its Noise Constraint Case. The top map in Figure 2.1 shows the Base Case layout and 40dB(A) contour plot for the highest yielding turbine of its type. The bottom map shows a predicted 40dB(A)-compliant layout and contour plot, assuming the quieter turbine type.

Predictions of noise propagation were made in accordance with the ISO 9613 standard [6]. While GH considers that this is a reasonable assumption if the sites were to be progressed some amendments to the layouts would be expected in the light of actual background noise measurements.

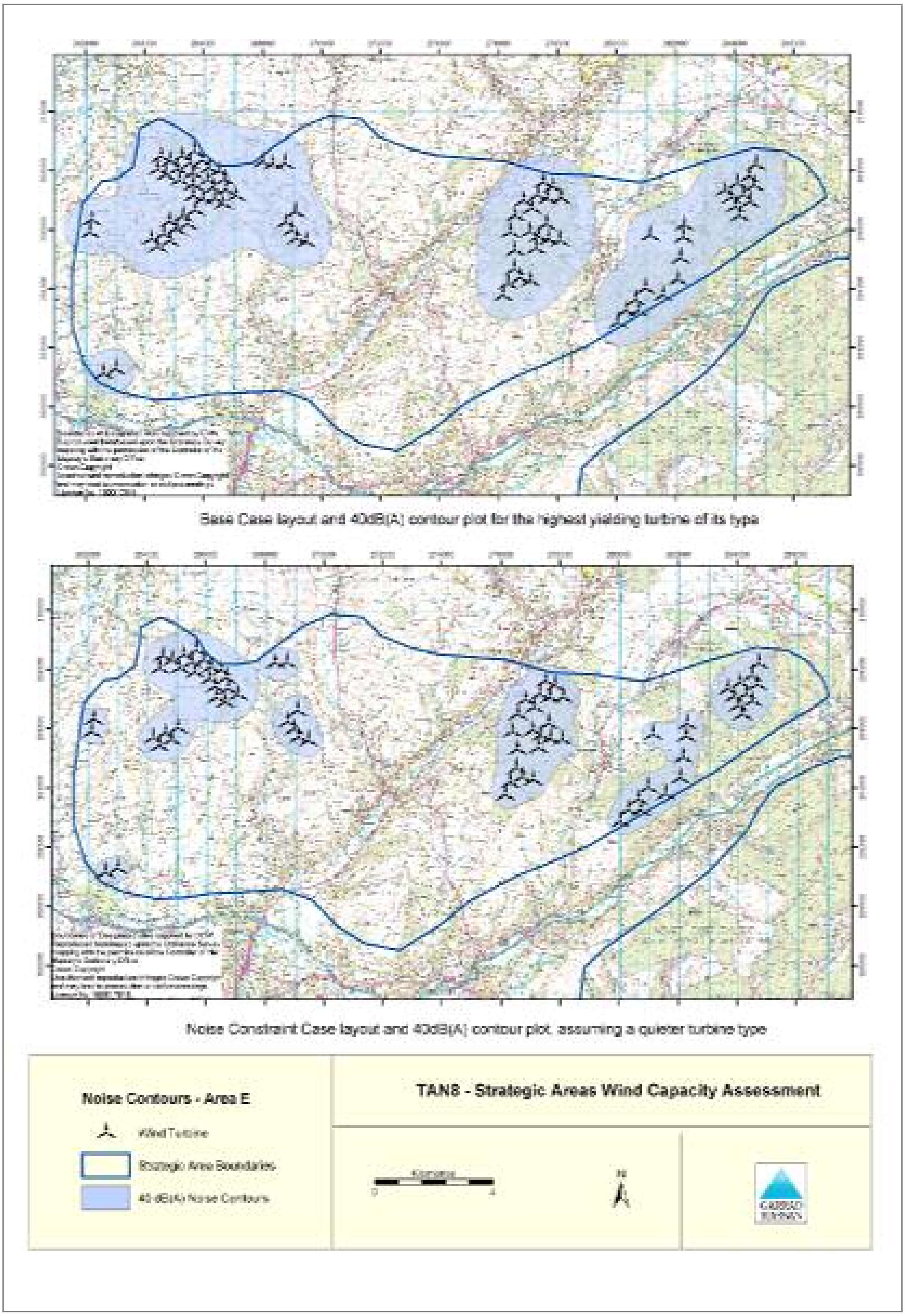

Figure 2.1 Noise constraint example, Area E

2.2.2 NATS

The Base Case includes a buffer for safeguarded airports, which does not have a major effect on the area available in SSAs. However, the National Air Traffic Service ("NATS") has also published data on the potential for interference with a variety of air traffic navigation aids. Since NATS treat each development on a case by case basis, this dataset was not included in the Base Case. However, given the potential for objections, it was deemed appropriate to assess the potential impact of these restrictions as a constraint.

Information on possible interference is provided by NATS on two levels: (1) areas where development is likely to interfere with NATS operations, and (2) areas where there is a potential to cause interference. As a worst case scenario, both levels were excluded in the NATS Constraint Case. The energy calculations do not differ from the base case i.e. energy yield differences to the base case are simply due to the exclusion of turbines falling within NATS areas.

2.2.3 Afan Park

In the course of the study, FC indicated that a park in Area F – Afan Park – was a potential constraint, and asked for the effect of its exclusion to be considered.

2.2.4 Combined cases

The effect of noise from large wind farms is estimated for both the Base Case and NATs-constrained layouts. The new noise-constrained layouts are then further reduced for consideration of Afan Park. For time and budget reasons, only capacity results are presented for the Afan Park cases.

2.3 Trees

A significant number of the modelled turbine locations fall within or adjacent to forestry. All surfaces impede and disturb the flow of wind over them. This effect, within the "atmospheric boundary layer", is more pronounced for rough surfaces. Trees have a more substantial and hence detrimental effect on wind flow in the context of wind turbines, than, say, rough pasture. The wind speed at hub height is therefore lower over forestry than over rough pasture. The increased surface roughness also causes more turbulent flow, which increases the fatigue loads on the turbines. The consequences of siting wind turbines in trees are that the energy production is lower and less predictable, and that the design life of the turbines is reduced, compared with turbines on open sites.

Loading imposed on wind turbines sited in proximity to trees is an important consideration. Wind turbines are designed to international standards which use generic descriptions of the turbulence in the wind, and for the variation of wind speed with height. If a turbine is sited within mature trees with a low turbine hub height, conditions at the site are likely to be more onerous than those assumed in the design of the wind turbines. This can be serious. Mitigation is therefore necessary, either by use of higher hub heights, or by felling trees, or both.

If trees within or in proximity to a wind farm are not felled, the effects require careful consideration. This task includes on-site wind measurements, preferably at hub height, and negotiation with turbine manufacturers on warranties. It is beyond the scope of this study to quantify accurately the effect of trees on energy or design life, or to set out any selective felling strategies – these areas are subject to ongoing assessment and are very much influenced by site-specific factors.

The tree constraint simply informs the broad scale of potential compromise between energy and tree felling. In this report the effect of trees on energy production was estimated by considering the separate influence of the trees as surface roughness and a reduction in effective hub height, and obstacles to the wind flow, which collectively reduce the wind speed at each turbine. For the analysis, GH assumed that all areas of forestry as shown on the OS 1:50,000 plan within each strategic area would remain, with the exception of an area of clear fell of 50 m radius around each turbine, and of roads to each turbine. This is an absolute minimum fell radius – requirements vary by turbine model. A typical example of the 50 m fell radius and access roads is shown in Figure 2.2 below. A typical recommendation is to fell up to 50 times the tree height from each turbine, which would maximise energy production and remove all concerns about design life from the perspective of tree-related issues.

The effect of the trees on the design life was not considered in this constraint analysis. For the turbines located within forestry, GH considers that the assumed tree felling is the minimum required for the operation of the turbine. The 50 m buffer zone of clear fell will have little effect on the turbulence issues associated with the presence of trees and hence it is still expected be a significant issue and would need to be investigated at the time of any development. As a rule of thumb, GH considers that the bottom of the rotor should be at least the height of the trees away from the top of the trees. In the analysis presented here, GH has assumed turbines with rotor diameters of 80 m and hub heights of 80 m.. The trees for all areas have been assumed to be 20m in height, which is typical for mature conifer plantations; hence the minimum clearance specified above is assumed to be achieved in all cases. It must be stressed that detailed site-specific measurements would be required to confirm that the assumed hub heights are acceptable within trees. There remains a significant risk that the measurements would indicate that at least some turbine locations are non-compliant with the relevant design assumptions.

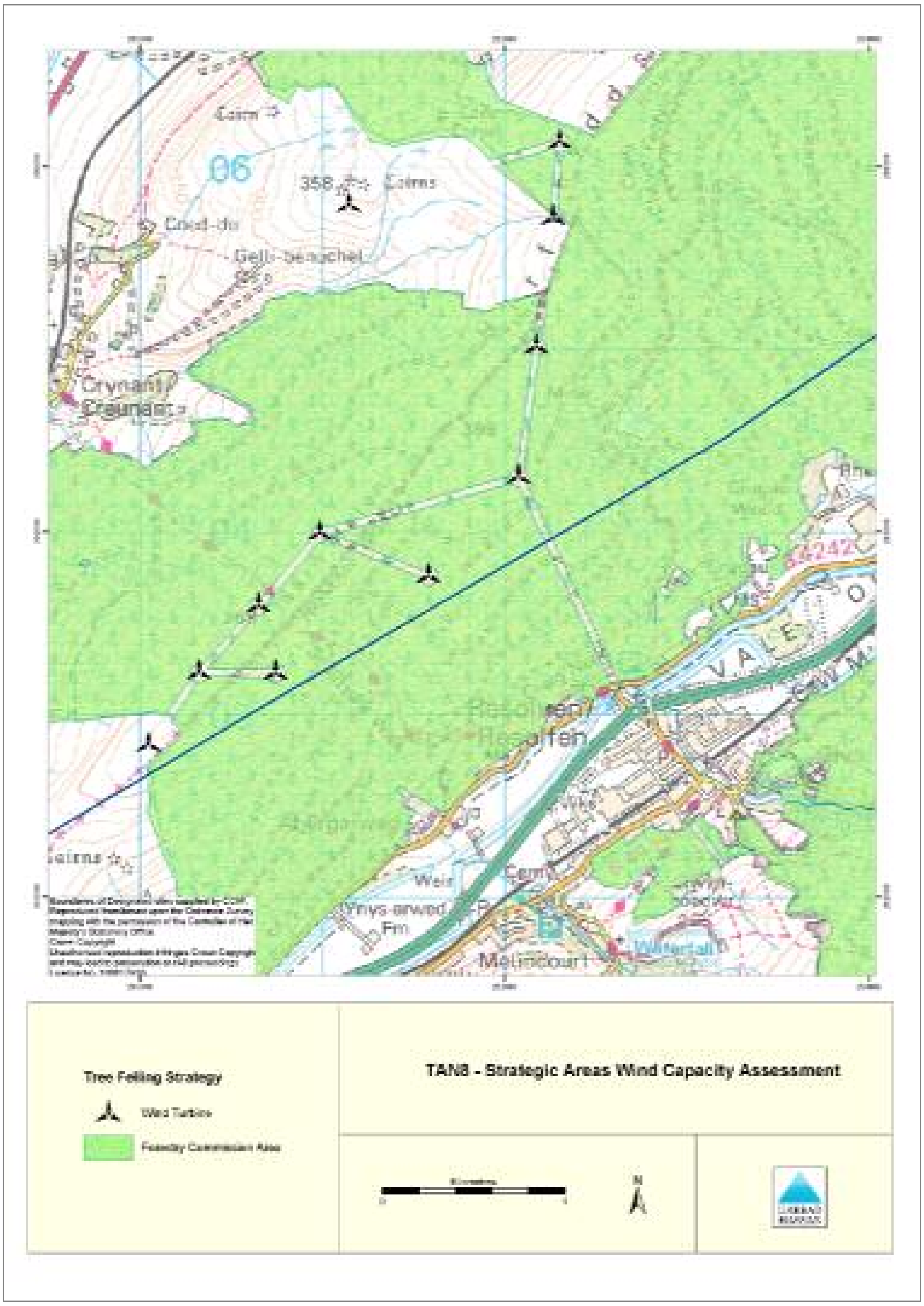

Figure 2.2 Typical example of 50 m fell radius and access roads

2.4 Energy uncertainty

Considerable caution should be exercised in the interpretation of the energy predictions described above. They represent the long-term mean, 50% exceedance level, for the annual energy production of the SSAs. This value is the best estimate of the long-term mean value to be expected from each area. There is therefore a 50% chance that, even when taken over very long periods, the mean energy production will be less than the value given.

Given the scale of the SSAs and the nature of the analysis at this stage, GH considers that it is not possible to quantify formally the uncertainty in these energy predictions. However GH has made a pragmatic estimate of the uncertainty, in order to indicate the broad magnitude of the likely uncertainty in the predictions.

The main sources of uncertainty in the energy predictions described above, apart form uncertainties resulting from the risk of not obtaining planning permission, are considered to be uncertainty in the:

- predicted long-term mean site wind speed based on NOABL;
- wind flow modelling across the site;
- wake modelling and other more detailed assumptions in the analysis.

An approximate quantification of these uncertainties is detailed in Appendix B. Energy results for the Constraint Cases are presented in Section 3 for 50% and 90% exceedance levels. The latter is the annual energy output over a ten year period that is expected to be exceeded 90% of the time – the so-called "P90". It is stressed that these are indicative numbers intended only to highlight the magnitude of uncertainty, prior to availability of measured on-site data.

3 RESULTS

The results are presented as follows:

The Base Case adopts the constraints set out in Table 2.1. The Noise Constraint Cases introduces appropriate maximum noise levels as described in Section 2. The NATS Constraint Case removes any NATS sensitive areas.

Constraint case results
Table 3.1 presents, for each Constraint Case, the total number of turbines and installed capacity. Predicted annual energy output for 50% and 90% exceedance levels is also provided for all but the Afan Park cases. As a sensitivity, Table 3.2 presents an iteration on capacity results which examines the effect of removing any remaining isolated turbines.

Comparison of individual SSA capacity and energy results
Figure 3.1 presents the installed capacity of the proposed layout designs for each SSA and Figure 3.2 shows the calculated annual energy output of these areas. Table 3.3 gives a more detailed breakdown of the Constraint Case energy results calculated for each SSA.

Energy production in mature forest
Table 3.4 shows the energy cost of trees.

Individual SSA turbine layouts including constraints
Maps for each SSA for all sensitivities are reproduced in Appendix E.

3.1 Constraint Case results

Case	Nos. turbines	Rated Capacity [MW]		Long term annual energy output [TWh/annum]	
		Total	FC	50% probability of exceedance	90% probability of exceedance
Base Case	1052	2104	902	6.4	4.9
Base Case + Noise	833	1666	766	4.8	3.7
Base Case + Noise + Afan	759	1518	618		
Base Case + NATS	527	1054	634	3.2	2.5
Base Case + NATS + Noise	458	916	572	2.6	2.0
Base Case + NATS + Noise + Afan	350	700	424		

Table 3.1 Combined results for the seven SSAs – Constraint Cases

Case	Nos. turbines	Rated Capacity [MW]		Rated Capacity after [MW]	
		Total	FC	Total	FC
Base Case	1052	2104	902	2066	880
Base Case + Noise	833	1666	766	1624	746
Base Case + Noise + Afan	759	1518	618	1478	600
Base Case + NATS	527	1054	634	1014	612
Base Case + NATS + Noise	458	916	572	882	552
Base Case + NATS + Noise + Afan	350	700	424	668	410

Table 3.2 Combined capacity results – effect of removing isolated turbines

3.2 Comparison of individual SSA Constraint Case results

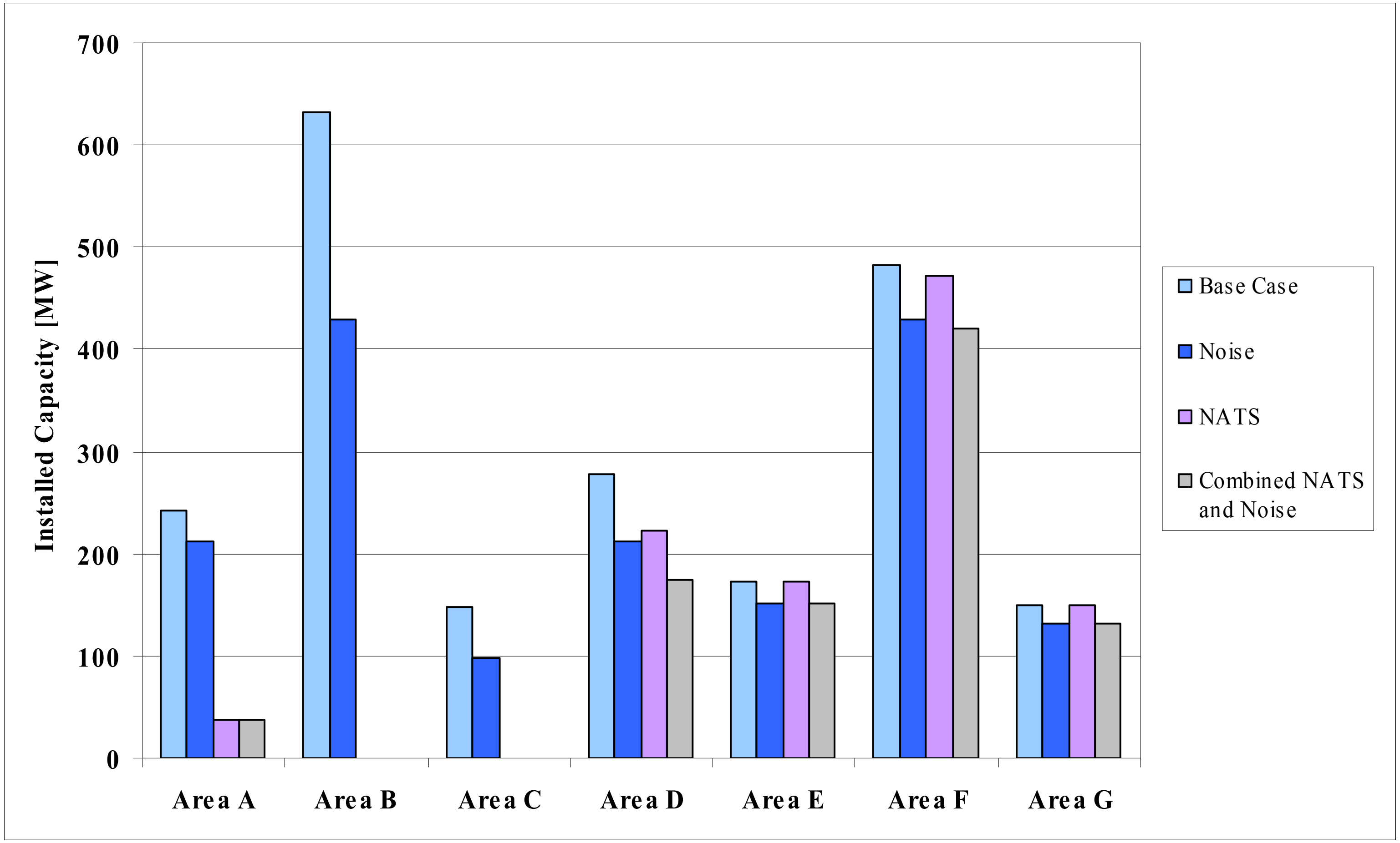

Figure 3.1 Comparison of installed capacity for the SSAs

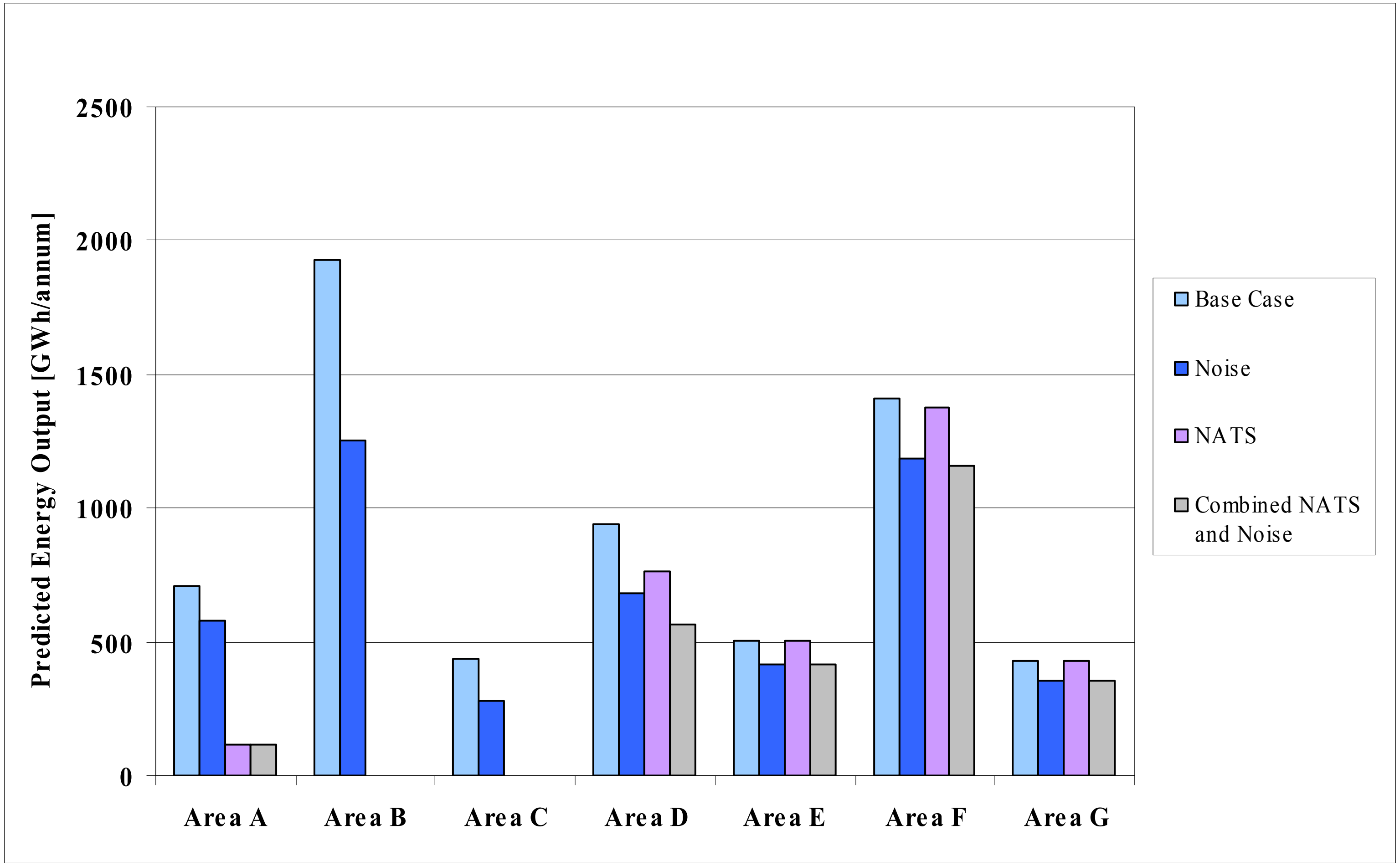

Figure 3.2 Comparison of predicted energy output for the SSAs

Constraint	Number of turbines	Rated capacity [MW]	Predicted output [GWh/annum]	Net capacity factor [%]	Output as a percentage of Base Case energy [%]
Area A					
Base Case	121	242	706	33	100
Base Case + Noise	106	212	582	31	82
Base Case + NATS	19	38	117	35	17
Base Case + NATS + Noise	19	38	117	35	17
Area B					
Base Case	316	632	1928	35	100
Base Case + Noise	215	430	1254	33	65
Base Case + NATS	0	0	0	-	0
Base Case + NATS + Noise	0	0	0	-	0
Area C					
Base Case	74	148	434	33	100
Base Case + Noise	49	98	276	32	64
Base Case + NATS	0	0	0	-	0
Base Case + NATS + Noise	0	0	0	-	0
Area D					
Base Case	139	278	943	39	100
Base Case + Noise	106	212	684	37	73
Base Case + NATS	111	222	760	39	81
Base Case + NATS + Noise	87	174	566	37	60
Area E					
Base Case	86	172	502	33	100
Base Case + Noise	76	152	418	31	83
Base Case + NATS	86	172	502	33	100
Base Case + NATS + Noise	76	152	418	31	83
Area F					
Base Case	241	482	1412	33	100
Base Case + Noise	215	430	1188	32	84
Base Case + NATS	236	472	1378	33	98
Base Case + NATS + Noise	210	420	1155	31	82
Area G					
Base Case	75	150	427	32	100
Base Case + Noise	66	132	354	31	83
Base Case + NATS	75	150	427	32	100
Base Case + NATS + Noise	66	132	354	31	83

Table 3.3 Summary of constraint results for each SSA

3.3 Energy production in mature forest

In Table 3.4 below, “B.C. max” is Base Case energy production where trees are felled to maximise energy production, “B.C. trees” is the energy production when the effect of mature trees is included.

Base Case	Predicted output [GWh/annum]	Net capacity factor [%]	Output as a percentage of max. energy [%]
Area A			
B.C. max	706	33	100
B.C. trees	612	29	87
Area B			
B.C. max	1928	35	100
B.C. trees	1779	32	92
Area C			
B.C. max	434	33	100
B.C. trees	433	33	100
Area D			
B.C. max	943	39	100
B.C. trees	877	36	93
Area E			
B.C. max	502	33	100
B.C. trees	464	31	92
Area F			
B.C. max	1412	33	100
B.C. trees	1158	27	82
Area G			
B.C. max	427	32	100
B.C. trees	376	29	88

Table 3.4 Summary of results for each SSA

3.4 Scenario turbine layouts

See Appendix E

4 CONCLUSIONS

GH understands that access to the electrical grid has been addressed by others and is not considered here. It will, however, be an important constraint.

4.1 Ability of SSAs to meet targets

Identification of the SSAs was also undertaken by others through desk-top study of available planning-related data. The present technical appraisal of the SSA has also been undertaken in the absence of site measurements which will be required for actual development.

Detailed site-based feasibility investigations would include planning-related issues such as visibility, inter-visibility, ornithology, ecology, hydrology, noise and other matters which would need to be considered within the formal Environmental Assessment process. From a technical standpoint, site-based investigations would include on-site wind measurements, ground investigations and access studies for transport of components to site. The initial technical assessments of maximum capacity presented in this report will be revised downwards through the course of these investigations. No allowance for such reduction has been included.

When providing for wind energy through strategic planning of preferred areas, the policy uncertainty of meeting targets can be reduced through progressively detailed study. This means that a preferred area approach which provides greater certainty on meeting targets would tend to encroach on work which would otherwise be the remit of private developers. In the absence of detailed study, risk can be reduced through built-in contingency capacity in the preferred areas.

Results presented here show an initial technical potential of 2104 MW capacity, which corresponds to 2.6 times the Assembly's 800 MW target for onshore wind. When constraints are considered which are particularly relevant to large, or a number of adjacent, wind farms, this potential could be reduced to approximately 916 MW. When the FC Afan Park is also taken into account, the potential reduces even further to 700 MW, which is below the Assembly's target.

It is important to note however that NATS constraints are not absolute. GH understands that there is ongoing separate investigation to provide greater clarity on the extent to which NATS concerns are likely to limit development. A reasonable view on the technical potential of the SSA's is therefore somewhere between the noise-constrained base case and the noise-constrained NATS case with Afan Park, or between 700 – 1518MW.

Energy production figures are predicted to be between 3.2 and 6.4 TWh/annum. However these are subject to considerable uncertainty. These values are likely to be substantially reduced by planning considerations.

GH considers that the results of wind energy potential presented here, together with remaining uncertainties, suggest there is a risk that neither capacity nor energy targets will be met. This risk can be better quantified through further investigation of the SSAs, or flexibility in application of the SSA boundaries or planning policy associated with the SSAs.

4.2 Turbines in forestry

It is noted that 57% of the Base Case turbine locations are within areas of forestry. The installation of wind turbines within forestry raises some serious technical issues which need to be mitigated by the use of tall hub heights or felling strategies or both. If there is a limitation on maximum hub height this will have an important and significant effect. A detailed program of wind speed measurements would be required to confirm the suitability of the forested areas to accept turbines and to define the mitigating measures required. Such measurements are clearly outside the scope of this study. However, if there is little flexibility to undertake extensive felling within the proposed forested areas, the turbines which are proposed within the forested areas must be considered to have a high risk that they would prove to be impractical compared with those located in non-forested areas.

From the perspective of energy capture and wind turbine loading, the felling of trees within proposed wind farm areas is the strongly preferred option.

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