Mid Sussex District Council

Sustainable Energy Study

Final Report - Technical Appendix

AMEC Environment & Infrastructure UK Limited

October 2014

Appendix A
Technical Assessment

A.1 Wind

The amount of energy any single wind turbine can generate is directly related to the speed of the wind it experiences. The first requirement when assessing the potential for use of wind turbines is therefore to consider the annual average wind speed in a given area. DECC's UK wind speed database is based on use of the NOABL model, a wind flow model based on a mass-consistent model method. The NOABL database contains estimates of wind speed at 10 m, 25 m and 45 m above ground level to 1 km grid square resolution assuming ground cover of short grass and no obstacles (e.g. trees or buildings). The model makes some important assumptions and approximations. However, the results are useful as a rough guide and have been shown to match reasonably well to observed wind conditions.

At a height of 45 m above ground level (agl) the average annual wind speed in Mid Sussex is shown in Figure A.1. It can be seen that the majority of average wind speeds are in the range 6.3 – 6.6 ms^{-1}. Developers will typically consider wind turbines in areas where the average wind speed is 6 ms^{-1} or higher.

Wind speed is only one factor influencing the commercial viability of wind turbines of course. The other relevant factors are considered in the following sections.

A.1.1 Wind Turbine Development

When considering the installation of any turbine the owner or developer needs to consider what size of turbine is best suited for the wind resource available. The feed-in tariffs (FiTs) for wind turbines are structured according to the rated output of the turbine (in kW). The physical size of turbines within each FiT band is summarised in Table A.1.

Table A.1 Working Definition of Wind Turbine Sizes

Feed-in Tariff Band (Installed Capacity) (kW)	Hub Height (m)		Blade Diameter (m)		Total Height (m)		Comment
	Min	Max	Min	Max	Min	Max	
Less than or equal to 1.5	10	18	1	3.2	10.5	19.6	
1.6 – 15	10	25	2.8	9	11.4	29.5	
16 – 100	15	39	9	22	19.5	50	
101 – 500	30	65	13.5	56	36.75	93	
501 – 1,500	30	80	40	77	50	118.5	

Feed-in Tariff Band (Installed Capacity) (kW)	Hub Height (m)		Blade Diameter (m)		Total Height (m)		Comment
	Min	Max	Min	Max	Min	Max	
1,501 – 2,000	60	105	60	93	90	151.5	Most common max size is 127 m
2,001 – 3,000	60	105 76		126 98		168	145 m is maximum consented currently

Note: Hub height measures the distance from the ground to the centre point of the rotating blades of the turbine. Total height measures the height from ground level to the tip of the blades when at their greatest vertical extent.

A.1.2 Methodology

A number of constraints need to be applied when considering the potential for wind development in the region.

Table A.2 Constraints Considered for Wind Assessment

Constraint	Description	Impact on siting of wind turbine
Wind Resource	Reviewing published average wind speed data for areas within the Mid Sussex boundary	Wind turbines best sited where mean average wind speeds are highest.
Environmental	Designated landscapes, heritage sites, wildlife sites and protected species	Development needs to be sensitive to these designations and key features of interest
Infrastructure	Roads, railways, power lines, airfields, airports	Turbines need to be sited away from major infrastructure
Noise	Separation distances to buildings and development areas	Wind turbines must be sited at sufficient distance from existing buildings to ensure noise levels meet national requirements.
Flood Risk	Proximity to water courses	Siting turbines in areas of flood risk would require expensive foundations and make access for maintenance more costly
Ministry of Defence	MOD owned sites and related radar operation issues	Turbines need to be at a distance from MOD sites that avoids any compromising of MOD activities.
Grid Connection	Proximity to a feasible grid connection point	This will indicate whether substantial cabling and support infrastructure may be required
Grid Capacity	Availability of the distribution network to incorporate the additional power output.	Lower network capacity may require upgrades to grid infrastructure such as substations and safety systems (at a cost to the wind developer)
Safeguarded CAA sites, NERL and other radar systems (aviation issues):	Potential issues of interference with radar systems.	Careful siting will minimise impacts on radar systems and reduce any potential mitigation costs
Radio / Communications Links / fixed microwave links:	Existing location of communication links	Careful siting will minimise impacts on the links and reduce any potential mitigation costs

Constraint	Description	Impact on siting of wind turbine
Construction Outline	construction requirements	Avoiding complex development areas (e.g. wetland areas), minimising the need for more complex wind turbine infrastructure.
Access	Ease of access to site for construction / maintenance.	Due to the size of medium to large scale wind turbine components access can determine if a site will be physically and economically feasible.

Each of these constraints reduces the available land area where there is greatest potential for wind development. The following figures show the areas of land affected by each constraint.

Figure A.1 Average Annual Wind Speed in Mid Sussex

Figure A.2 Environmental Designations

Figure A.3 Cultural Designations

Figure A.4 Infrastructure Constraints

Figure A.5 Radar/Communications Constraints

Figure A.6 Noise Buffer Constraints

Details of the constraints applied in determining the wind capacity potential in Mid Sussex are summarised in Table A.3.

Table A.3 Buffers Applied to Site Constraints

Constraint	Minimum Buffer Requirement[22]	Minimum Buffer Justification	Maximum Buffer Requirement[23]	Maximum Buffer Justification
Motorway	Blade Tip fall over (125m) measured to edge of highway boundary – normally post and rail fence.	National Planning Policy Guidance Note 22 (Companion Guide[24]) defines fall over distance as being "the height of the turbine to the tip of the blade" (p.171, para 51) and states in para 52 that: "it may be advisable to achieve a set-back from roads and railways of at least fall over distance". When commenting on the Reading the turbine the Highways Agency in 2002 required a separation distance of 2 blade lengths from the tower to the motorway fence i.e. 70m, whereas the total height of the turbine is 120m. The Reading Turbine is actually 149m from MW boundary. NB If the maximum separation buffer cannot be achieved, the Highways Agency, as statutory consultee, should be consulted in DP1.	Blade Tip fall over + 50m (175m for 125m N90) measured to edge of highway boundary – normally post and rail fence.	Highways Agency: SPATIAL PLANNING ADVICE NOTE: SP 02/06 States: "Assessment of the risk associated with structural failure suggests that a reasonable offset would be to site the wind turbines at a distance of not less than (H + 50) metres where H is the maximum height to the tip of blade. The offset should be measured from the highway boundary fence rather than the edge of carriageway so as to ensure the safety of our roadside equipment and our workforce. However, analysis of the risk posed by 'icing' suggests that it would be wise to adopt a minimum offset of 100 metres. Therefore, no turbine should be sited closer to the trunk road boundary than the greater of (H + 50) or 100 metres." The later edition Spatial Planning Advice Note 04/07 "Planning Applications for Wind Turbines sited near to Trunk Roads" advises that commercial wind turbines should be set back from the trunk road boundary by their height + 50m, which is widely understood to mean blade tip + 50m.

[22] The minimum separation distance considered reasonable to expect the Local Planning Authority and the consultee to accept. There is a probability that negotiation and discussion will be required. **It is important to note that:**

1. The results of the Feasibility Study, in terms of turbine numbers, predicted annual energy production and costs are based on the minimum separation distances to identified constraints, unless the maximum separation distance can be achieved without reducing the installed capacity of the site and
2. These buffers are to be treated as guidance only, since it is not possible to stipulate separation distances for every site specific eventuality.

[23] Considered the failsafe separation distance, where no negotiation with consultees/LPA will be required and no material planning objections will be put forward once the planning application has been submitted.

[24] In England this is the national planning advice on wind energy, which all local planning authorities will use as guidance when assessing planning applications.

Constraint	Minimum Buffer Requirement[22]	Minimum Buffer Justification	Maximum Buffer Requirement[23]	Maximum Buffer Justification
Trunk Road	Blade Tip fall over measured to edge of highway boundary – normally post and rail fence.	The 2nd Swaffham Turbine (120m blade tip) is 150m from the Trunk road. The Swaffham Ecotech turbine (100m blade tip) is 125m. Not aware of any turbines within fall over distance to Trunk Roads. Consider this is an appropriate minimum separation distance for reasons set out for motorways. NB If the maximum separation buffer cannot be achieved, the Highways Agency, as statutory consultee, should be consulted in DP1.	Blade Tip fall over + 50m measured to edge of highway boundary – normally post and rail fence.	Consider this is an appropriate maximum separation distance for reasons set out for motorways.
A Road	Blade tip fall over measured to the edge of the highway boundary.	Consider this is an appropriate minimum separation distance for reasons set out for motorways, given the likely traffic flows on main roads. Aware of one example of a 120m blade tip turbine being approved 82m from an A road (Manchester City Football Club). NB If the maximum separation buffer cannot be achieved, the Highways Authority, as statutory consultee, should be consulted in DP1.	Blade tip fall over measured to the edge of the highway boundary +10%.	Precautionary principle, considered best practice approach.
B Road	50m (assumed max blade length) from center point of turbine tower i.e. no part of blade should be overhanging the highway boundary.	Arguably, contrary to advice contained with in PPS22, but there are examples of turbines within fall over distance to minor roads. NB If the maximum separation buffer cannot be achieved, the Highways Authority, as statutory consultee, should be consulted in DP1.	Blade tip fall over measured to the edge of the highway boundary.	Precautionary principle, based upon guidance in PPS22: "it may be advisable to achieve a set-back from roads and railways of at least fall over distance". Discussions with planning officers has shown that adherence to this guidance is expected.
Minor Road	50m from center point of turbine tower i.e. no part of blade should be overhanging the highway boundary.	Arguably, contrary to advice contained with in PPS22. BUT: 2nd Swaffham Turbine is within fall over distance of a minor road (c.35m). The Reading turbine is 48m from a minor road. A turbine in Dagenham (Ford) is over sailing a road with public access – although there have been incidents of ice fall… There are other examples of operational wind turbines within fall over distance to minor roads. i.e. Royd Moor turbines (0.5mw bonus) operating	Blade tip fall over measured to the edge of the highway boundary.	Precautionary principle, based upon guidance in PPS22: "it may be advisable to achieve a set-back from roads and railways of at least fall over distance". Discussions with planning officers has shown that adherence to this guidance is expected.

Constraint	Minimum Buffer Requirement[22]	Minimum Buffer Justification	Maximum Buffer Requirement[23]	Maximum Buffer Justification
		since 1993 within fall over distance to minor road. B If the maximum separation buffer cannot be achieved, the Highways Authority, as statutory consultee, should be consulted in DP1.		
Unclassified Road, but adopted public highway.	50m from center point of turbine tower i.e. no part of blade should be overhanging the highway boundary.	As for Minor Road above.	50m from center point of turbine tower i.e. no part of blade should be overhanging the highway boundary.	As per Map A: Justification for minor roads.
Railway (all)	Blade tip fall over measured to the edge of the railway track.	Companion Guide to PPS22 states: "it may be advisable to achieve a set-back from roads and railways of at least fall over distance". NB If the maximum or minimum separation buffes cannot be achieved, Network Rail, as statutory consultee, should be consulted in DP1.	Blade tip fall over +10% measured to the edge of the railway track.	Network Rail, objected to a planning application for 5 turbines in Sedgemoor District Council in 2006, where a turbine was exactly fall over distance to track. The objection was only removed when the scheme was amended and a fall over +10% separation distance was achieved.
Permanent Structures which are not buildings i.e. water tanks; communications towers.	If there is no public access, no buffer should be applied. However, account needs to be taken of construction activities which may require that a 15m buffer is applied for the foundation. For structures used for the storage of "hazardous materials" blade tip fall over distance.	These are essentially plant and machinery not on public land. There do not appear to be any insurance restrictions for these non occupied buildings. The PSB would though need to undertake an appropriate Risk Assessment to ensure that Personnel accessing the plant are adequately protected i.e. wearing a hard hat in the area swept by the turbine blades.	50m from center point of turbine tower i.e. no part of blade should be overhanging the structure. For structures used for the storage of "hazardous materials" blade tip fall over +10% separation distance.	Precautionary approach based on tone of PPS22. It is arguable that nearby sites covered by the Control of Major Accident Hazards (COMAH) Regulations and Nuclear Installations will require consultation and/or site specific risk assessments in DP1.
Public Car Parks and Public Open Space	50m buffer from centre of turbine i.e. not over hanging.	Public Car Parks and public open spaces are in effect public rights of way (PROW). PPS22 states that: "and the minimum distance is often taken to be that the turbine blades should not be permitted to over sail a public right of way."	Blade tip fall over distance.	Companion Guide to PPS22.
Private/Staff car parks	No Buffer, but ideally 50m buffer from centre of turbine i.e. not over	The option to lease should specify that it may be necessary for health and safety reasons to exclude access under the swept area of the	Blade tip fall over distance (125m) from centre point of turbine	Minimises any potential safety risk, in terms of ice and component/blade failure.

Constraint	Minimum Buffer Requirement[22]	Minimum Buffer Justification	Maximum Buffer Requirement[23]	Maximum Buffer Justification
	hanging.	turbine – should, for example, insurance be problematic and/or a planning condition on health and safety is attached.	tower.	
Commercial Buildings	No over sailing of building by blades i.e. 45m buffer for N90.	Contrary to PPS22 Companion Guide, which states: "Fall over distance (i.e. the height of the turbine to the tip of the blade) plus 10% is often used as a safe separation distance". However: The Reading turbine (120m blade tip) is 68m from an office building; A turbine (120m blade tip) at Dagenham is 77m from a commercial building; Business Development are aware of 2 turbines with blades oversailing a factory by up to 8m i.e. towers 27m from factory. But due to a reported component failure incident and risk of ice, the blade swept area i.e. circle of 35m radius is fenced off to prevent access and walkways/fire escapes within swept area have been roofed. At Manchester City Football Club, a 120m to blade tip turbine was approved within a car park, 52m from an athletic stadium and 110m from main football stadium. However, due to concerns from the Health and Safety Executive the turbine is no longer being built. NB There are potentially public liability and safety issues which need addressing regarding public access beneath the swept area of the turbine blades e.g. some turbine manufactures require all personnel to wear hard hats under the turbine and explicitly state that manufacturers are not liable for public injury caused by mechanical failure/ice through. INSURANCE Ace confirmed that having a building within the topple zone is material information; however, in the context of clients portfolio, advised that it	137.5m (fall over +10% for a 125m tip turbine)	Complies with recommendations set out in the Companion Guide to PPS22 (Blade tip fall over distance +10% "often used as a safe separation distance"). However, Nordex have restrictions over the maximum height of buildings and proximity to turbines. Advice from Nordex being that no part of the swept area should be affected by turbulence of

Constraint	Minimum Buffer Requirement[22]	Minimum Buffer Justification	Maximum Buffer Requirement[23]	Maximum Buffer Justification
		wouldn't impact the overall premium. Aon's advice was to apply commonsense and consider each site on a case-by-case basis. The following flags increase the level of concern on insurance terms: Occupied buildings; High value buildings and infrastructure (eg electricity pylons, pipelines, bridges etc); Large congregations of people; and Proximity of the building to the turbine (particularly if it approaches the oversail area).		
Third party Residential Building[25]	Site layout design should be based on the 40dB contour which will typically result in a separation distance of 500m. Where predicted turbine noise levels exceed 40dB there needs to be evidence that prevailing back ground noise will be no more than 5dB below predicted turbine noise i.e. if turbine noise predicted to be 42dB background needs to be 37dB. For sites in Scotland with	Based on known planning conditions it is assumed that the LPA will require a daytime limit of between 35-40dB or background +5dB, normally whichever is the greater. A more conservative approach is taken by applying the 40dB contour, in recognition of parliamentary pressure to revise noise guidance and review permissible separation distances between turbines and properties. The use of the 40dB contour also takes account of the fact that PfR sites have emerged to be often in rural areas, where background noise levels are low. At Feasibility, the issue of visual dominance/over bearing on residential properties should be taken into account i.e. if 500m achieved but property is at the bottom of a hill with uninterrupted principal views to the turbine on top of the hill, this is unlikely to achieve planning permission.	35dB contour which will typically result in a separation distance of 750m .	750m is arguably the minimum optimum separation distance to ensure that visual and noise effects do not significantly affect residential amenity, and takes account of backbench MP calls for set separation distances between turbines and housing. It should be noted that each site should be considered on its merits and planning appeals have been dismissed on residential amenity grounds even where separation distances considerably in excess of 450m have been achieved. The 35dB noise contour represents the definitive safeguard beyond which currently no noise monitoring or assessment is required. Important to note the 2009 Shipdham Appeal decision, in which the Inspector found (broadly) that background monitoring must be undertaken at the Noise Sensitive Property, since otherwise

[25] For all noise sensitive constraints in Feasibility Studies, the noise contour derived separation distance should in the first instance be based on the 80m hub Nordex N90 High Speed 2.5MW turbine. If the relevant noise contour cannot be achieved the 80m N90 Low Speed 2.5MW turbine should be used. Judgement is required for sites where existing background noise levels may allow the minimum 43dB buffer to be exceeded. The Feasibility Study should be based upon the turbine selected for achieving compliance with the minimum buffer requirement.

Constraint	Minimum Buffer Requirement[22]	Minimum Buffer Justification	Maximum Buffer Requirement[23]	Maximum Buffer Justification
	10 or more turbines, the Feasibility Study should include three layout designs: 1. No properties within 35dB contour; 2. No properties within 750m of any turbine; 3. No properties within 40dbB contour. Layout design 2 (750m) should be used as the basis for the MW capacity of the site. Caravan Parks and campsites are classed as noise sensitive land uses and should be treated as third party residential buildings. Although a degree of judgment is required for campsites.	40dB is the upper daytime level and assumes that background noise levels are no more than 35dB. (taking into account the reduction of 2dB from LAeq – LA90 and use of 4m receiver height and use of mixed ground and reflect published guidance: (2009) Prediction and Assessment of Wind Turbine Noise. Acoustics Bulletin, Volume 34 Issue 2.) Bowdler, D., Bullmore, A., Davis, B., Hayes, M., Jiggins, M., Leventhall, G. & McKenzie, A. Companion Guide to PPS22 states (p.171 para 51). "The minimum desirable distance between wind turbines and occupied buildings calculated on the basis of expected noise levels and visual impact will often be greater than that necessary to meet safety requirements. Fall over distance (i.e. the height of the turbine to the tip of the blade plus 10% is often used as a safe separation distance." Examples of minimum separation distances to turbines include: Due to high background noise levels Manchester approved turbine (120m blade tip): Nearest 3rd party residential property is 125m. The Swaffham Ecotech turbine is 360m from nearest 3rd party house. An ecotricity turbine at the B&Q warehouse in Worksop, is believed to be <200m from housing. Dundee Turbines: Closest property is 330m from a turbine, however, noise (monitoring found no excedence of permitted levels) shadow flicker complaints - turbines programmed to shut down. Again there are safety concerns regarding residential properties if located within c.300m of turbines – some reports indicate that ice is thrown upto 250m from turbines and that the max		there is significant doubt about the representativeness of the data – if a resident therefore denies access, it could be problematic. Secondly the Inspector, found that planning conditions alone were not sufficient to protect NSP's. Therefore advice from the HMP is that all developments should comply with ETSU without mitigation being required, since conditions requiring/enforcing mitigation are open to legal challenge on the basis of failing some of the 6 tests for conditions set out in Planning Circular 11/95. So, if turbines need to be powered down to meet noise limits, significant risk that EHO not accept mitigation (since not enforceable) and an open invitation to objectors to challenge the decision.

Constraint	Minimum Buffer Requirement[22]	Minimum Buffer Justification	Maximum Buffer Requirement[23]	Maximum Buffer Justification
		distance debris could be thrown is ~600m. Nordex guidance (Precautions for Icing Conditions, 2007) on ice through states “Objects, which are closer to a wind turbine than 1.5 x the sum of hub height and rotor diameter, can be endangered from falling ice.” Noise levels from microwind maybe limited to 45dB (DCLG News release 13/3/08).		
Residential property owned by the PSB (ie within PSB property Boundary and confirmed as being in residential use)	No residential property within blade tip fall over distance +10%. In addition, where possible, the turbine layout should be configured to ensure that predicted noise levels do not exceed 55dB.	As for third party residential (fall over +10% to occupied buildings requirement in PPS22) and ETSU (summary, para 24) advises that lower noise levels can be increased from 35-40 to 45dB and that the level above background can be increased beyond the permitted 5dB level. As ETSU states that it is the lower day and night limits which can be increased to 45dB it may be (this is an untested theory) possible to increase the maximum permissible day time level to 50dB (as there is a difference of 10dB between the lower limits for third parties and those with a financial involvement). A 5 dB increase in the ETSU-R-97 stakeholder limit may also be permissible, as this would then result in a minimum buffer justification sound level which would be broadly comparable to the lower of the WHO’s guidance levels for gardens or balconies, generally applicable to daytime, and would not be seen as being too dissimilar to the ETSU-R-97 guidance. However, this would still result in higher than acceptable noise levels at night, which would require the provision of secondary glazing at the property and alternative ventilation, unless windows (existing/new) in the same room could open onto non-noise affected facades. Worth noting that although the Noise Exposure Criteria set out in PPG24 Noise apply to new housing and existing noise levels (i.e. new housing adjacent to motorways) a noise level of 55dB is deemed acceptable, although mitigation maybe required. Legal agreement can be negotiated with PSB to	300m. 45dB noise contour	ETSU-R-97 stipulates that the fixed lower day and night time limits can be 45dB where the occupier has a financial . In areas where background levels are above 45dB it would be possible to decrease the separation distance until the background + 5 has been complied with. NB This is dependent upon changes to the tenancy agreement or financially involving the occupier (not the owner) of the property.

Constraint	Minimum Buffer Requirement[22]	Minimum Buffer Justification	Maximum Buffer Requirement[23]	Maximum Buffer Justification
		agree acceptable noise. Although at the limits of acceptability, negotiation/legal agreement may be possible with PSB to remove residential use of building. NB This is dependent upon financially directly involving the resident (not the owner) of the property (as set out on p66 of ETSU-R-97, through for example, rent reduction.		
Staff Accommodation i.e. at hospitals.	Not within the blade tip fall over distance +10%. In addition, where possible, the turbine layout should be configured to ensure that predicted noise levels do not exceed the 53dB (LA90) noise contour.	Distance based on fall over +10% to occupied buildings requirement in PPS22. Using the 53dB(LA90) noise contour assumes a 20dB attenuation for closed windows with 2dB subtracted to allow for conversion from LAeq to LA90, resulting in internal noise levels of 35dB – in compliance with ETSU-R-97. This approach is based on the accommodation being either closed ventilation (windows do not open) and/or the EHO/PSB accepting that it is sufficient mitigation for the windows to be shut if noise is disturbing occupiers. It also assumes that outside space for these receptors is not considered to be noise sensitive. Government guidance available in “Health Technical Memorandum 08-01: Acoustics” does not consider permanent staff accommodation and therefore the most appropriate UK design guidance is BS 8233:1999 “Sound insulation and noise reduction for buildings - Code of practice”. The protection of staff outdoors is not relevant and hence only internal levels require consideration. The 53 dB level may cause an exceedance of the desirable internal level of 35 dB (BS 8233:1999) by 3 dB, if an assumed maximum of 15 dB and not 20 dB attenuation through the window. However, in modern healthcare facilities closed windows even this may be acceptable as HVAC systems should provide acceptable levels of ventilation. If existing background (night-time) noise levels exceed 53dB at the external façade of the accommodation, likely that noise levels from the turbines could be increased to match but not	Not within the blade tip fall over distance +10%. In addition, where possible, the turbine layout should be configured to ensure that predicted noise levels do not exceed the 43dB (LA90) noise contour.	This assumes that windows are opening and that the EHO/PSB considers that noise levels should take this into account. Based on principal of ETSU-R-97 that there is a 10dB(A) allowance for attenuation through an open window and that 2dB is subtracted to allow for the use of LA90 rather than LAeq. This approach achieves the 35dB sleep disturbance noise level with an open window. If existing background (night-time) noise levels exceed 43dB at the external façade of the accommodation, likely that noise levels from the turbines could be increased to match but not exceed background levels.

Constraint	Minimum Buffer Requirement[22]	Minimum Buffer Justification	Maximum Buffer Requirement[23]	Maximum Buffer Justification
		exceed background levels. There may though be a requirement to ensure that the frequency distribution of noise is taken into account. i.e. that lower frequency noise from turbines does not exceed the lower frequency background noise.		
Hospital Wards (measured to external façade)	Not within the blade tip fall over distance +10%. In addition, where possible, the turbine layout should be configured to ensure that predicted noise levels do not exceed the 48dB (LA90) noise contour.	Distance based on fall over +10% to occupied buildings requirement in PPS22. The World Health Organisation 1999 Guidelines for Community Noise recommends that the guideline values indoors on wardrooms are 30dBLAeq. Using the 48dB(LA90) noise contour assumes a 20dB attenuation for closed windows with 2dB subtracted to allow for conversion from LAeq to LA90. This approach is based on the accommodation being either closed ventilation (windows do not open) and/or the EHO/PSB accepting that it is sufficient mitigation for the windows to be shut if noise is disturbing occupiers. It also assumes that outside space for these receptors is not considered to be noise sensitive. The HTM-08-01 (for new healthcare buildings) recommends that internal sound levels during the night are 35 dB LAeq,T, there may therefore be some latitude in increasing the minimum buffer to 53dB where the windows do not open. The Hayes McKenzie Partnership adopted this approach when conducting a noise assessment for a 2008 planning application for a wind turbine at the QEH Hospital in King's Lynn. If existing background (night-time) noise levels exceed 48dB at the external façade of the ward, likely that noise levels from the turbines could be increased to match but not exceed background levels.	Not within the blade tip fall over distance +10%. In addition, where possible, the turbine layout should be configured to ensure that predicted noise levels do not exceed the 38dB (LA90) noise contour.	This assumes that windows are opening and that the EHO/PSB considers that noise levels should take this into account. Based on principal of ETSU-R-97 that there is a 10dB(A) allowance for attenuation through an open window and that 2dB is subtracted to allow for the use of LA90 rather than LAeq. If existing background (night-time) noise levels exceed 38dB at the external façade of the ward, likely that noise levels from the turbines could be increased to match but not exceed background levels. The HTM-08-01 (for new healthcare buildings) recommends that internal sound levels during the night are 35 dB LAeq,T, there may therefore be some latitude in increasing the maximum buffer to 43dB where the windows open.
Prison accommodation Blocks (measured to external façade)	Not within the blade tip fall over distance +10% In addition, where possible, the turbine layout should be configured to ensure that	Using the 53dB(LA90) noise contour assumes a 20dB attenuation for closed windows with 2dB subtracted to allow for conversion from LAeq to LA90, resulting in internal noise levels of 35dB – in compliance with ETSU-R-97. This approach is based on the accommodation	Not within the blade tip fall over distance +10%. In addition, where possible, the turbine layout should be configured to ensure	This assumes that windows are opening and that the EHO/PSB considers that noise levels should take this into account. Based on principal of ETSU-R-97 that there is a 10dB(A) allowance for attenuation through an open window and that 2dB is subtracted to allow for the use of LA90

Constraint	Minimum Buffer Requirement[22]	Minimum Buffer Justification	Maximum Buffer Requirement[23]	Maximum Buffer Justification
	predicted noise levels do not exceed the 53dB (LA90) noise contour.	being either closed ventilation (windows do not open) and/or the EHO/PSB accepting that it is sufficient mitigation for the windows to be shut if noise is disturbing occupiers. It also assumes that outside space for these receptors is not considered to be noise sensitive. If existing background (night-time) noise levels exceed 53dB at the external façade of the cell block, likely that noise levels from the turbines could be increased to match but not exceed background levels. There is no known design guidance for acceptable noise levels at prisons.	that predicted noise levels do not exceed the 43dB (LA90) noise contour.	rather than LAeq. This approach achieves the 35dB sleep disturbance noise level with an open window. If existing background (night-time) noise levels exceed 43dB at the external façade of the cells, likely that noise levels from the turbines could be increased to match but not exceed background levels.
Halls of Residence	Not within the blade tip fall over distance +10% In addition, where possible, the turbine layout should be configured to ensure that predicted noise levels do not exceed the 53dB (LA90) noise contour.	Using the 53dB(LA90) noise contour assumes a 20dB attenuation for closed windows with 2dB subtracted to allow for conversion from LAeq to LA90, resulting in internal noise levels of 35dB – in compliance with ETSU-R-97. This approach is based on the accommodation being either closed ventilation (windows do not open) and/or the EHO/PSB accepting that it is sufficient mitigation for the windows to be shut if noise is disturbing occupiers. It also assumes that outside space for these receptors is not considered to be noise sensitive. If existing background (night-time) noise levels exceed 53dB at the external façade of the Hall, likely that noise levels from the turbines could be increased to match but not exceed background levels.	Not within the blade tip fall over distance +10% In addition, where possible, the turbine layout should be configured to ensure that predicted noise levels do not exceed the 43dB (LA90) noise contour.	This assumes that windows are opening and that the EHO/PSB considers that noise levels should take this into account. Based on principal of ETSU-R-97 that there is a 10dB(A) allowance for attenuation through an open window and that 2dB is subtracted to allow for the use of LA90 rather than LAeq. This approach achieves the 35dB sleep disturbance noise level with an open window. If existing background (night-time) noise levels exceed 43dB at the external façade of the hall, likely that noise levels from the turbines could be increased to match but not exceed background levels.
Public Building ie Schools	Not within the blade tip fall over distance +10% In addition, where possible, the turbine layout should be configured to ensure that predicted noise levels do not exceed the 53dB (LA90) noise contour.	Public buildings have a much greater sensitivity than commercial/industrial buildings. PPS22 Companion guide p171, para 51: "Fall over distance…. Plus 10% is often used as a safe separation distance". The World Health Organisation 1999 Guidelines for Community Noise recommends that the background sound pressure level in classrooms does not exceed 35dB (55dBLAeq – 20 dB subtracted for attenuation through a closed	Not with in 450m. In addition, where possible, the turbine layout should be configured to ensure that predicted noise levels do not exceed the 43dB (LA90) noise contour (to classroom façade) and/or	Minimises any potential safety risk, in terms of ice and component/blade failure and minimises power loss from turbine shut down due to noise and shadow flicker. 43dB standard ETSU night time level allowing for attenuation through open window.

Constraint	Minimum Buffer Requirement[22]	Minimum Buffer Justification	Maximum Buffer Requirement[23]	Maximum Buffer Justification
	No playing field should be within the 53dB(LA90) noise contour	window and an allowance of 2dB for LAeq – LA90 conversion). The 53dB LA90 contour should be measured at the nearest classroom façade. “Building Bulletin 93 - Acoustic Design of Schools. A Design Guide” provides design guidance for new schools. Internal targets range from 30 to 40 dB LAeq, 30min and when corrected for the LA90, 10min metric and the temporal variation, the levels are comparable to those stated within the WHO guidance. The WHO guidance also recommends that for outdoor playgrounds the SPL from external noise sources should not exceed 55dB (53 = -2dB for LAeq-LA90). Increasing the minimum buffer requirement to 48dB would reduce the risk of community concerns unless the school has some direct involvement with the proposals, i.e. an interactive science project. 48 dB would be comparable to the lower WHO guidance level. Achieving these levels is dependent on the ventilation in the school not being dependant on opening windows.	53dB(LA90) noise contour to playing field.	
PSB Property Boundary	5m from maximum horizontal length of blade tip. So 55m if max blade length assumed to be 50m.	Ensures that there is no possibility turbine will oversail 3rd party land and provides some degree of micro—sighting should it be required.	- -	
Public Right of Way	50m from centre point of turbine tower i.e. no part of blade should be overhanging the public right of way.	Companion Guide to PPS 22 states (p172 para 57) “Similarly, there is no statutory separation distance between a wind turbine and a public right of way. Often, fall over distance is considered an acceptable separation, and the minimum distance is often taken to be that the turbine blades should not be permitted to oversail a public right of way.” At a Public Inquiry in August 2007, no challenge was raised to turbines located just overhang separation distance from public footpaths. Industry wide premise that turbines should not oversail public rights of way.	Blade tip fall over distance.	Companion Guide to PPS22.

Constraint	Minimum Buffer Requirement[22]	Minimum Buffer Justification	Maximum Buffer Requirement[23]	Maximum Buffer Justification
Bridleway	50m from centre point of turbine tower i.e. no part of blade should be overhanging the public right of way.	Para 56 p. 172 of the Companion guide sets out that the British Horse Society has suggested a 200m separation distance. The BHS November 2008 policy note on turbines reiterates the 200m distance, but with a maximum separation to national trails of 4 x tip height i.e. 500m. BUT tested at appeal (Cemmaes Wind Farm) the inspector concluded: "What cannot be concluded from the evidence is that there is a generic proven difficulty (I.e. with wind turbines and horses). What can be concluded is that the 1995 BHS policy, which may influence many riders, riding schools and clubs is overtly alarmist in a way which is not supported by evidence. It is not accepted that wind turbines necessarily or even more than occasionally alarm horses. The evidence is not there". A presentation at a BHS conference has also recently concluded that wind turbines pose no discernible risk to horse riding.	200m from centre point of turbine tower.	To appease and minimize any cause for objection from horse riding community, in line with PPS22 companion guide.
Woodland	Non classified woodland no buffer. However, where there is sufficient space on site, after all other constraints have been taken into account, turbine locations should avoid over sailing all woodland i.e. 45m buffer. A 70m buffer for a 125m tip turbine should be applied to any Ancient Woodland.	No specific statutory guidance recommending separation distances. However, ecological importance of woodlands for birds and bats increases with the age and species diversity of the woodland. To prevent unnecessary loss of habitat through construction of foundations. Natural England Feb 2009 guidance on Bats and Wind Turbines identifies that some bat species have a high sensitivity to wind turbines and as a result a minimum separation distance of 50m between the habitat and the blade tip is required. This equates, broadly, to a separation distance of 70m between turbine tower and the edge of the habitat. In some instances the removal of sufficient woodland to achieve a 70m or less separation distance and additional net replanting elsewhere, may be an acceptable mitigation option. Also, bat roosts can be moved under license in cases of	70m from centre point of turbine for all woodland (as shown on a 1:25,000 map/site visit). This distance should be maximised where other site specific constraints allow.	Ecological surveys may identify bat populations within woodland, for which Natural England are likely to require a separation distance. Natural England Feb 2009 guidance on Bats and Wind Turbines identifies that some bat species have a high sensitivity to wind turbines and as a result a minimum separation distance of 50m between the habitat and the blade tip is required. This equates, broadly, to a separation distance of 70m between turbine tower and the edge of the habitat.

Constraint	Minimum Buffer Requirement[22]	Minimum Buffer Justification	Maximum Buffer Requirement[23]	Maximum Buffer Justification
		over-riding public interest in order to enable development - need to demonstrate though that there was no alternative and that the works are necessary for reasons of overriding public interest (not economic gain) – considered unlikely NE would want to set a precedent that the need for turbines overrides the protection in situ of bats.		
Field Boundaries and non-protected hedgerows	Non designated hedgerows and/or field boundaries no buffer. However, where there is sufficient space on site, after all other constraints have been taken into account, turbine bases should be 70m from field boundaries. In addition any removal of hedgerows should be avoided wherever possible.	Field margins and hedgerows are important wildlife corridors and are often managed for biodiversity under the DEFRA Environmental Stewardship Scheme. These features are known movement corridors for some bat species and therefore NE may request a c.70m buffer if high risk bat species are present. Removal of hedgerows requires the LPA to approve a hedgerow removal notice under the Schedule 4 of the Hedgerow Regulations (1997) and the 1995 Environment Act.	70m from turbine tower and in accordance with NE 2009 bats and wind turbines guidance.	Field margins and hedgerows are important wildlife corridors and are often managed for biodiversity under the DEFRA Environmental Stewardship Scheme. These features are known movement corridors for some bat species and therefore NE may request a c.70m buffer if high risk bat species are present. Application 1/1386/2007 refused by Torridge DC (29/2/08), due to objection from NE as turbines oversailing hedgerows used by bats commuting and foraging.
Hedgerows (protected)	70m. Can only be applied when local information and/or surveys are available to confirm that the hedge is/qualifies for protection.	Hedgerows are wildlife corridors, utilised by, for example, bats. Protected hedgerows species rich and established. Likely to be used as bat movement corridors, especially in low land/sheltered sites. Any woodland/hedgerow will need to be surveyed for breeding birds/protected species before removal.	70m	Natural England Feb 2009 guidance on Bats and Wind Turbines identifies that some bat species have a high sensitivity to wind turbines and as a result a minimum separation distance of 50m between the habitat and the blade tip is required. This equates, broadly, to a separation distance of 70m between turbine tower and the edge of the habitat.
Water Courses Adopted by local Drainage Board **and/or** those identified on a 1:50,000 map[26], including reservoirs.	15m from turbine centre point.	Drainage Boards normally require that no part of development within c.10m of an adopted drainage water course. With an assumed foundation radius of 15m, the minimum separation distance is therefore taken to be 15m. On a site by site basis this could be reviewed and an engineering solution negotiated with the Env. Agency/Drainage Board. The Environment Agency requires an 8m	70m.	Likely minimum separation distance required by Natural England to protect the use of water courses as movement corridors by birds/bats. 70m increase for N100 - BATS

[26] Local Drainage Board provides site specific maps of adopted waterways.

Constraint	Minimum Buffer Requirement[22]	Minimum Buffer Justification	Maximum Buffer Requirement[23]	Maximum Buffer Justification
		separation to main rivers, inclusive of foundations.		
Navigable Waterways i.e. canals	20m to allow for construction of turbine foundations (see water courses above).	Applied in the absence of any specific guidance or known best practice.	50m (not over sailing) to water way and any moorings or public rights of way adjoining the waterway i.e. towpaths.	Companion Guide to PPS 22 states (p172 para 57) "Similarly, there is no statutory separation distance between a wind turbine and a public right of way. Often, fall over distance is considered an acceptable separation, and the minimum distance is often taken to be that the turbine blades should not be permitted to oversail a public right of way." An assessment of whether house boats are noise sensitive receptors will need to be undertaken. This may be dependant on whether or not the boats are independently powered and can therefore relocate.
11,33kV lines (Poles)	No Buffer.[27] Oper	ation: Based on assumption that should the DNO (National Grid do not have responsibility for 11/33/132kV network) require a 1.5 x the blade tip height (187.5m for 125m tip turbines) fall over separation distance, the section of line could be placed underground or re-routed. Construction: Consideration could also be given to covering lines with "sheath insulation" and or fencing to protect construction activities within c.12m and that micro sighting will enable construction activities to not conflict with safety criteria. In addition to trenching the cable, it may be cost effective to de-energise the line, in order to comply with HSE requirements during construction, should the DNO raise no concerns with separation distance between the line and the operating turbine. NB. HSE guidance note GS6 and Energy Networks Association Technical Specification 43-8 set out that within 15 meters of any overhead line supported on steel towers or 9 meters of any	1.5 x the blade tip height (187.5m for 125m tip turbines)	Companion Guide to PPS para 55 on p.172 states that "wind turbines should be separated from overhead power lines in accordance with the Electricity Council Standard 44-8 "Overhead Line Clearances". This reference should in fact be to ECS 43-8. The EC has now been abolished and DNO's/NGrid do not appear to be applying these separation distances (fall-over+ maximum swing of overhead wires), instead are stipulating 1.5 x the blade tip height (187.5m for 125m tip turbines). Scottish and Southern have requested (Rushy Mead site) that: "The clearance between any overhead line and a wind turbine shall not be less than 1.5 times the height of the turbine, taken to the top of the turbine blade" (PR-PS-340 APPLICATION OF CLEARANCES TO OVERHEAD LINES AT LV TO 400kV).

[27] The Feasibility Study should specify the indicative costs of trenching the 11/33kV cables through the 1.5 x blade tip fall over zone.

Constraint	Minimum Buffer Requirement[22]	Minimum Buffer Justification	Maximum Buffer Requirement[23]	Maximum Buffer Justification
		overhead line supported on wood poles, the relevant network operator must be consulted. i.e. DNO for 11/33kV lines.		
11,33,66 and 132kV electricity lines	Not over sailing, for 11 and 33kV poled lines and tip height plus 10% for 33, 66 and 132kV lines on pylons.	11,33 and 132kV (Not 132 in Scotland) lines are the responsibility of the DNO. If the maximum buffer cannot be achieved consultation with DNO to be undertaken. Tip height + 10% for 33-132kV based on National Grid's minimum requirement for 275kV and above lines. Notwithstanding this, if the installed capacity of the site would be likely to support the cabling of over head lines this should be taken into account.	1.5 x blade tip height.	Scottish and Southern DNO have advised (September 2009): "The clearance between any overhead line and a wind turbine shall not be less than 1.5 times the height of the turbine, taken to the top of the turbine blade" (Ref.PR-PS-340 APPLICATION OF CLEARANCES TO OVERHEAD LINES AT LV TO 400kV) Note that this reference has not been validated.
275 – 400kV in UK and 132kV in Scotland	Tip height plus 10%[28]	In England and Wales National Grid are responsible for 275kV and above. In Scotland National Grid are responsible for 132kV and above. In October 2009, National Grid issued PS(T)087 – Issue 2 – Overhead line separation from wind turbines. It establishes that there is no impact on transmission lines by turbines that are sited more than 3 rotor diameters away from the line. In addition it does not prohibit closer sitting (provided that separation is greater than topple distance) but instead encourages early communication with NGET. The definition of topple distance has changed from tip height plus 20m to tip height plus 10%. National Grid, when consulted by Local Planning Authorities on planning applications (e.g. Ford	3 rotor diameters (c.300m).	In some instances National Grid have requested a separation distance much greater than blade tip height +10%, due to extra strain/wear and tear placed on the HVLines caused by turbulence and wake effects from the turbines. This issue has yet to be tested at Public Inquiry. Current guidance from National Grid (PS(T)087 – Issue 2 – Overhead line separation from wind turbines) is that there is no impact on transmission lines by turbines that are sited more than 3 rotor diameters away from the line.

[28] Assumes that cost of trenching HV line is not economic.

Constraint	Minimum Buffer Requirement[22]	Minimum Buffer Justification	Maximum Buffer Requirement[23]	Maximum Buffer Justification
		Turbines, Dagenham) have requested that separation distances are based on the blade tip fall over distance + the maximum calculated swing of the HV cable. Fall over +10% would be a minimum allowing for a 12m cable swing. This is broadly in line with Electricity Association Standard 43-8 Overhead Line Clearances (2004) – which is referenced in National Grid guidance "Sense of Place" these Design Guidelines have been developed by National Grid to address the issues associated with developing sites crossed by, or in the vicinity of, pylons and high voltage overhead lines.		
High pressure fuel pipelines (ie those identified through linesearch.org.uk)	125 – Blade Tip Fall Over. NB Separation distances for other fuel lines (medium, local high pressure and lower pressure gas pipelines and gas mains) should be determined by the standard separation distance required by the operator for construction activities. Local gas network operator should be consulted for information on the network in the vicinity of the site.	National Grid (Transco) has prepared a confidential internal report on separation distances between wind turbines and high pressure gas pipelines. This risk assessment concluded that blade tip fall over distance is required. Responding to consultations Transco have stated that an objection will be raised to any turbine within this distance. Experience to date is that Transco do not impose weight restrictions on plant crossing pipelines ie access tracks can cross pipelines. Clarification should be sought from pipe operator. Some turbine manufactures recommend fall over separation distances to "sour" gas pipe lines.	150m Precautionar	y principle separation distance, to allow for micro-sighting of turbines. The National Grid risk table for development near high pressure gas pipelines http://www.nationalgrid.com/NR/rdonlyres/325B83B7-096C-4599-BBE2-D944E9307509/19056/aptdstmay07.pdf identifies as negligible the risk from pilling at 150m+ to a high pressure gas pipeline.
Sewage and Water Pipes	No buffer	Not considered sensitive No	buffer	Not considered sensitive
Fixed Links (Microwave/Scanning Telemetry)	100m[29] Fixed links: 2nd and 8th Fresnel Zone (where	Default separation distance requested by majority of fixed link operators. Bacon Report/Ofcom and majority of fixed link	100m (Fixed Links) 1km + Blade length to Scanning Telemetry	Default separation distance request by majority of fixed link operators Basically scanning telemetry links operate at a

[29] Distance between blade tip (when at 90 degrees from vertical) and the centre of fixed link.

Constraint	Minimum Buffer Requirement[22]	Minimum Buffer Justification	Maximum Buffer Requirement[23]	Maximum Buffer Justification
	frequency of link is available) and/or operator defined (if achievable) Scanning Telemetry links: 8th Fresnel zone.	operators will accept a separation distance of the 2nd Freznel zone in most instances. 25m PAGER POWER additional buffer to 2nd Fresnel – LOOK AT PPower smaple report…	links.	lower frequency and so are liable to increased disruption to the signal path from turbines: http://www.jrc.co.uk/windfarms/
Turbine Warranty	-	Different manufacturers put in place different warranty restrictions and/or these maybe negotiable.	There should be no buildings taller than 15m within 300-400m of turbines and there should be no buildings within blade tip fall over distance.	Nordex advised in meeting of 8.5.08 with commercial director that they have recently turned down some single turbine sites because of their proximity to buildings. Nordex advised keeping the topple distance completely free of buildings (also driven by insurance) and restricting building heights to less than 15 feet within an approximate area of 300/400 meters of the base of the turbine.
Turbine Optimisation	5 rotor diameters down wind (SW assumed prevailing direction for turbine orientation) x 3 rotor diameters cross wind.	Minimum required to ensure turbulence and wake effects do not significantly reduced output/affect performance.	6 rotor diameters down wind (SW assumed prevailing direction for turbine orientation) x 4 rotor diameters cross wind.	More conservative separations.

A.2 # Solar

A.2.1 Solar Photovoltaics (PV)

Solar PV systems exploit the direct conversion of daylight into electricity in a semi-conductor device. The individual cells are interconnected to form a module (more commonly known as a panel). These modules can either be mounted on building roofs (a roof mounted array) or simply installed at ground level (a ground based array or solar farm). A typical domestic installation will cover a roof area of 7 – 14 m^2 with an output of 1 – 2 kW of electricity (referred to as kW peak output or kWp). Solar farms typically range in size from around 1ha -50 ha (depending upon land availability).

To maximise the electricity output from a solar PV system it needs to be:

- Orientated to be South facing; and
- Clear from any obstruction (overhanging trees or vegetation) or overshading from neighbouring buildings.

The electricity output from solar PV panels can be used directly in the home or business premises to which they are connected. During periods of the day when any surplus electricity is generated (i.e. more than is needed for use in the premises) then this can be exported to the national grid. Present feed-in tariffs offer owners of these systems a tariff payment for each kWh of electricity produced. Any exported electricity attracts an additional (lower) payment for each kWh supplied to the grid.

A.2.2 Solar Assessment Methodology

Previous assessment work focused on building mounted solar photovoltaics (PV)[30]. The assessment methodology applied the following working assumptions:

- Domestic properties (including flats) – 25% will have suitable aspect features; will not have planning constraints and will not be subject to shading. These roofs will accommodate a 2 kW rated system. A load factor of 0.09 is used in estimating the potential annual energy yield from these systems.
- Commercial properties – 50% will not have issues with shading; these properties will accommodate a 5 kW system. A load factor of 0.09 is used in estimating the potential annual energy yield from these systems.

The present study has extended the scope of assessment to include ground mounted solar PV arrays. Available land areas within the Mid Sussex District Council boundary have been reviewed. This excludes all Grade 1 agricultural land and accounts for a buffer around buildings.

Key issues to address in the assessment of available land areas include:

[30] 'West Sussex Sustainable Energy Study', Centre for Sustainable Energy (2009)

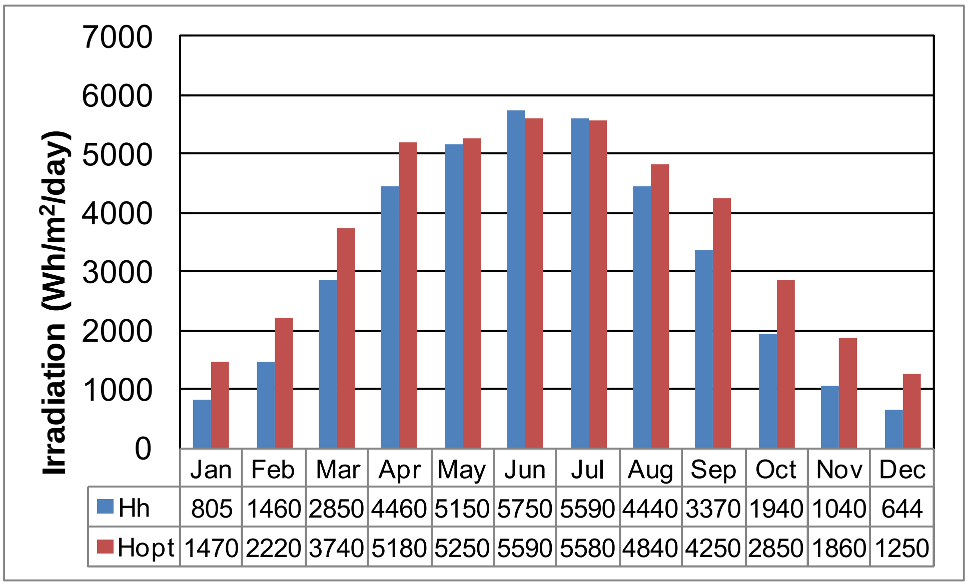
- Land area – area of unconstrained land available for development, constraints include watercourses, waterbodies, pathways, trees, overhead lines etc.;
- Land use – high value agricultural land should be retained for agricultural use where possible, brownfield sites are the most desirable;
- Topography – flat land is most suitable for solar development, otherwise levelling of the land may be required which incurs additional costs and site works;
- Sensitivity – if the site has value in terms of local or national designations is it likely to be unsuitable for development;
- Flood risk – areas with significant risk of flooding could be problematic for developments;
- Glint and Glare - Glint and glare results from reflection of sunlight off solar panels, it is not likely to be a major issue but can present an issue for aviation/driver safety;
- Landscape and Visual –any nearby sensitive receptors increase the visual impact of the potential development.

A.2.3 Solar Resource

The average incident solar radiation in Haywards Heath (as representative of Mid Sussex as a whole) is estimated to be 2,760 Wh/m^2 /day for a horizontal plane (Hh) and 3,290 Wh/m^2/day on an optimally inclined plane (Ho), corresponding to an average annual solar radiation of 1,142 kWh/m^2 and 1,343 kWh/m^2 respectively[31]. The optimum inclination angle for solar panel installed in Mid Sussex is 38°. Figure A.9 shows the local average monthly radiation based on long term averages.

[31] http://re.jrc.ec.europa.eu/pvgis/apps4/pvest.php PVGIS © European Communities, 2001-2012

Figure A.9 Long Term Average Monthly Radiation in Haywards Heath



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hh	805	1460	2850	4460	5150	5750	5590	4440	3370	1940	1040	644
Hopt	1470	2220	3740	5180	5250	5590	5580	4840	4250	2850	1860	1250

PVGIS © European Communities, 2001-2012

A.2.4 Ground Based Solar PV Arrays

In addition to the key issues outlined in Section A.2.2, there are general issues that need to be considered when looking at a ground-based solar PV development.

- **Security** of a solar farm is an important consideration. Sites are generally surrounded by security fencing with monitored CCTV cameras installed. Natural features such as hills, rivers etc. can assist in securing a site. Ideally a site would have one secure entrance and be difficult to access from other locations. Isolated sites are vulnerable.

- **Delivery** of solar panels and associated equipment is done by a standard vehicles with no abnormal loads required with the potential exception of the transformer. Some sites may not have standard access.

- **Grid capacity**: Should a development be considered beyond this assessment, there are two important factors to be considered: the nearest grid connection point and the capacity of the local network to accept the additional electricity generated by the solar farm. It is strongly recommended that the local Distribution Network Operator is contacted to establish the grid capacity and the cost of connecting to the local grid network. The point of any connection will depend upon existing local electrical loads and the scale of any proposed solar PV development. This level of detail isn't available at this stage of assessment.

- **Land Availability** – The size of land area will determine the energy generating potential of the proposed solar PV array. As an approximate rule of thumb 2 Ha of land is required for each 1 MW of generating capacity[32].

- **Gradient Slope –** Land areas with a slope of 5% or more are difficult to develop in terms of optimising the orientation of panels (as well as general accessibility issues).

- **Orientation of Slope –** South facing slopes are best suited to maximising energy yields.

Application of these constraints results in land area availability as shown in Figure A.7 (Area of Solar Ground Based Array Potential). This results in a total potential land area of around 25 Ha.

A.2.5 Energy yield calculation

The potential solar farm capacity has been calculated based on a density of 1MWp per 1.5 hectare and the estimated annual energy output then calculated using the method outlined in the '*Guide to installation of Photovoltaic systems MCS 2012*'[33]. A kWh/kWp value of 871 has been used based on tilt angle of 20^{o} which is not optimal for this area but allows greater density of panels to fit into the available area. Orientation directly south and no shading has been assumed.

Of the total potential land area around 1% may be developed; this would yield a development capacity of 13 MWp.

A.3 Hydro

Hydropower is a technology that is well established. Water flowing from a higher to a lower level is used to drive a turbine, which produces mechanical energy, which is usually turned into electrical energy by a generator. The energy produced is directly proportional to the flow volume of water and the head (distance from higher to lower level). There are high head–low volume applications and low head-high volume applications.

Larger scale projects involve a reservoir where a large body of water is stored (dammed) and then released to lower level enabling energy generation. The larger majority of schemes, however, are so called run-of-river schemes where water flow is diverted along a channel and through a turbine before being discharged back into the river at a lower point. A further design type, the Archimedes screw turbine, can be located directly in the flow of the river.

A.3.1 Hydro Assessment Methodology

The Environment Agency (EA) published a report looking at the opportunities for hydropower alongside the environmental sensitivity associated with exploiting hydropower opportunities to give a national overview[34]. This therefore provides a guide as to areas most likely to have potential to host a hydropower scheme. It is indicative

[32] http://www.solar-trade.org.uk/solarFarms.cfm (Accessed February 2014)

[34] Mapping Hydropower Opportunities and Sensitivities in England and Wales, Environment Agency (2010)

only, and does not avoid the need for further analysis on a site by site basis to assess the viability of any given scheme.

The EA study suggests a number of potential sites within Mid Sussex that may sustain a hydropower scheme. These have been reviewed with regard to:

- General location – proximity to built up areas
- Ecological – proximity to designated habitat areas and any specific species
- Landscape/Historic – proximity to conservation area or significant landscape features
- Flood risk – extent of flood risk zone

The potential sites identified are listed in Table A.4.

Table A.4 Potential Small Scale Hydropower Development Sites

Ref	Feature	Estimated Maximum Head (m)	Potential Power Output Range (kW)	Development Sensitivity	Estimated Annual Energy Generation (kWh/yr)
1	Waterfall	11.4	0 – 10	Medium	37,454
2	Weir	10.9	0 – 10	Medium	35,736
3	Dam	10.0	0 – 10	Medium	22,410
4	Waterfall	9.8	0 – 10	Medium	32,320
5	Weir	9.8	0 – 10	Medium	32,205
6	Weir	9.6	0 – 10	Medium	31,497
7	Waterfall	9.4	0 – 10	Medium	30,951
8	Waterfall	9.4	0 – 10	Medium	30,809
9	Weir	9.3	0 - 10	Medium	30,658
10	Dam	9.2	0 – 10	Medium	20,511
11	Weir	8.9	0 – 10	Medium	29,252
12	Weir	8.8	0 – 10	Medium	28,851
13	Dam	8.5	0 – 10	Medium	19,052
14	Dam	7.8	0 – 10	Medium	17,405
15	Weir	7.4	0 – 10	Medium	24,332
16	Weir	7.3	0 – 10	Medium	24,858
17	Weir	7.3	0 – 10	Medium	11,913
18	Weir	7.1	0 – 10	Medium	11,599

Ref	Feature	Estimated Maximum Head (m)	Potential Power Output Range (kW)	Development Sensitivity	Estimated Annual Energy Generation (kWh/yr)
19	Weir	7.1	0 – 10	Medium	48,748
20	Weir	7.0	0 – 10	Medium	14,259
21	Dam	6.8	0 – 10	Medium	15,127
22	Weir	6.6	0 – 10	Medium	21,762
23	Dam	6.6	0 – 10	Medium	14,697
24	Weir	6.6	0 – 10	Medium	13,390
25	Dam	6.5	0 – 10	Medium	14,571
26	Weir	6.5	0 – 10	Medium	44,743
27	Dam	6.2	0 – 10	Medium	13,928
28	Dam	5.8	0 – 10	Medium	13,061
29	Weir	5.8	0 – 10	Medium	11,832
30	Weir	5.4	0 – 10	Medium	18,388
31	Weir	5.4	0 – 10	Medium	37,286
32	Weir	5.4	0 – 10	Medium	18,207
33	Weir	5.4	0 – 10	Medium	17,621
34	Weir	5.3	0 – 10	Medium	10,680
35	Weir	5.2	0 – 10	Medium	36,160
36	Dam	5.2	0 – 10	Medium	11,670
37	Dam	5.2	0 – 10	Medium	11,625
38	Weir	5.2	0 – 10	High	29,020
39	Weir	5.1	0 – 10	High	28,919
40	Weir	5.1	0 – 10	Medium	40,677

A.3.2 Site Classification

The overall sensitivity of a given site was evaluated using a three stage process. This process considered the presence of diadromous, migratory and mobile species as listed in Table A.5.

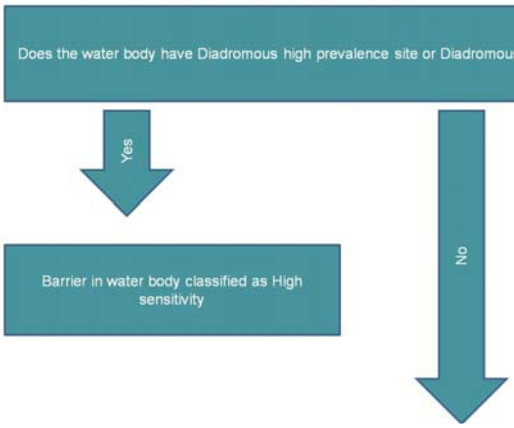
Table A.5 Fish Species Groupings

Diadromous Species	Migratory Species	Mobile Species	Non-Migratory Species
Salmon Barbel		Bleak	Bream (Silver)
Shad (Allis and Twaite)	Dace	Bream (Common)	Loach (Spined and Stone)
Lamprey	Grayling	Carp Stickleback	(3 and 9 spined)
Eel Chub		Carp	(Crucian)
Smelt Pike		Gudgeo	n
Trout		Perch	
		Roach	
		Rudd	
		Bullhead	
		Tench	
		Minnow	

The three stages of the evaluation process are as follows:

Figure A.10 Site Classification Process

Stage 1



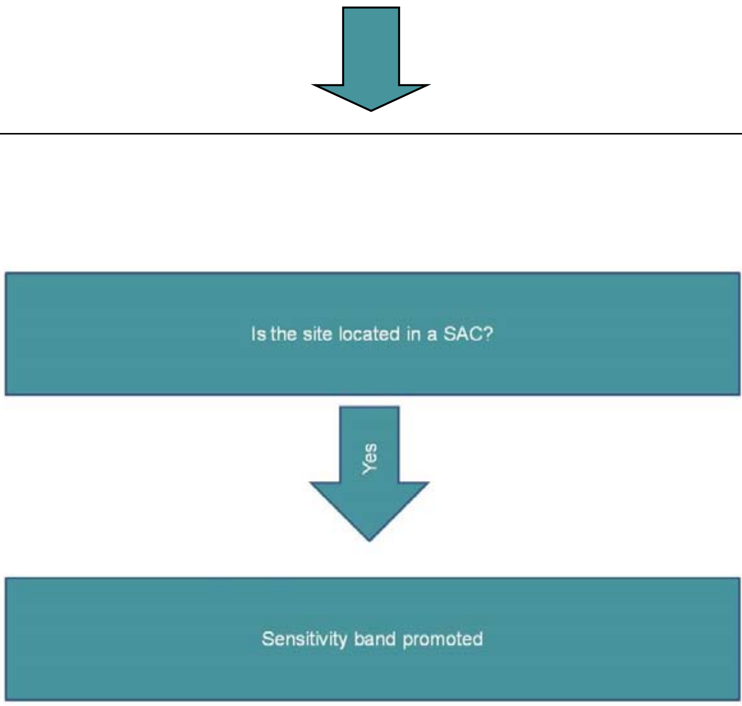
Stage 2 Site scored using:

Diadromous	Medium Probability of Presence	3 pts
	Low Probability of Presence	0 pt
Migratory Species	High Probability of Presence	4 pts
	Medium Probability of Presence	2 pts
	Low Probability of Presence	0 pt
Mobile Species	High Probability of Presence	2 pts
	Medium Probability of Presence	1 pt
	Low Probability of Presence	0 pt
	Presence of Non-migratory species not considered	

Barriers Scored based on Total Score:

Total Scores	**Sensitivity Band**
6 – 9	High
3 – 5	Medium
0 – 2	Low

Stage 3



A further categorisation of 'Win-Win' was applied to those locations with a medium to high power potential and which sit within a heavily modified water body (as defined in the Water Framework Directive).

The resulting locations of potential development are shown in Figure A.8 Areas of Hydro Development Potential.

A.4 Biomass

A.4.1 Woodland Residues and Energy Crops

The West Sussex Sustainable Energy Study provides an estimate of resource availability in terms of:

Woodland Residues – virgin (i.e. untreated) wood residues arising from forestry and arboricultural activities. The total technical resource available from sustainable management of woodland in Mid Sussex is estimated and an associated energy generation capacity determined based on combustion to generate heat.

Energy Crops – Assessment of land availability and landscape considerations provides an estimate of the land area available for the cultivation of either miscanthus or short rotation coppice (SRC) energy crops.

This resource is evaluated in terms of supplying fuel into the biomass market, rather than an energy generation potential specifically for the Mid Sussex area.

In the case of woodland residues, for example, the extent of resource depends on how much woodland is actively managed within Mid Sussex and the incentives for landowners to extract and process woodfuel.

In the case of energy crops several factors will influence the extent to which landowners will be willing to grow such crops:

- Long term supply contracts with end users;
- Financial incentives to grow and harvest the crops;
- Conflict over land-use for food production; and
- Logistics of fuel processing.

There are a number of biomass suppliers already operating in the area. For the purposes of illustration, those suppliers operating within a 50 mile radius of Haywards Heath are listed in Table A.6.

Table A.6 Biomass Suppliers within South East of England

#	Supplier	Location	Log	Chip	Pellet	Briquette
1	ComCenSus Ltd	RH19 2PF		x		
2 Count	y Tree Surgeons Ltd	RH10 4HL	x		x	
3 South	East Wood pellets	TN8 6LD		x		x
4 Horsham	Active Woodland Trust	RH5 5HE	x			
5 Ha	yes Farm Partnership	RH20 2HL			x	
6 Liston	Products limited	BN7 3DF		x	x	
7 Balcombe	Estate	RH17 6QN	x		x	
8 South	East wood fuels	RH13 9DN		x	x	
9 Four	seasons fuel ltd	RH14 9DG	x			
10	Wiston Estate	BN44 3EA			x	
11 Sussexlogs		BN13 1NX	x			x
12 South	East wood fuels ltd	BN8 6BY	x		x	

#	Supplier	Location	Log	Chip	Pellet	Briquette
13	Brownings Farm Woodfuel	TN22 5HG	x			
14	South East wood fuels ltd	TN6 1TX		x	x	
15	Foxhills Tree services Ltd	TN33 9JR			x	
16	Crowhurst Farm Developments	TN33 9PU			x	
17	Discover Trees - Northiam	TN31 6QL	x			
18	Discover Trees	8JJ	x			
19	Home Counties Wood fuel Ltd	TN3 9JT			x	
20	Capel Group	TN12 7HE			x	
21	Phase One Joinery	TN3 8AD				x
22	CPL Kent	TN26 2PJ	x	x		x
23	Godinton Park	TN33 3BP			x	
24	Eco tree care and conservation ltd	CT4 8EU	x			
25	Cork Farm Woodfuels	CT4 8BN	x			
26	Torry Hill Farm	ME90SP			x	
27	Envirocology	ME9 9PB	x		x	
28	South East Wood Fuels	ME9 0AP		x	x	
29	GPP Wood Fuel	TN12 9RR		x		x
30	Bertie's Wood Fuel	TN11 0DU	x		x	x
31	Parkwood Logs	ME18 5BA	x			
32	Sprint fuels Ltd	ME1 3QX		x		
33	Kent County Council	DA12 3HX	x			
34	Rekola Recycling Ltd	RM1 64AT			x	
35	Balcas Brites England and wales	RM1 43TD		x		
36	Heat Logs of Barking	RM12 4XR				x

#	Supplier	Location	Log	Chip	Pellet	Briquette
37	The Renewable fuel Company (UK) Ltd	E11 2DD		x		x
38	Big K products UK ltd	N17 9QU	x			x
39	HWR Ltd	N18 3PU			x	
40	Kenkko Ltd	NW4 2DG	x	x	x	x
41	Forest Fuels Ltd	WD7 9EG		x	x	
42	Land Energy Ltd	EC1N 8HN		x		
43	Greater London	DA11 0SD	x			
44	Clearpower Ltd	W1D 2EU	x	x	x	x
45	Eastwood Power	W1S 1YH	x	x	x	
46	JR (London) Ltd	SW17 0RG		x		x
47	Log-Delivery.co.uk	KT3 3ST	x	x		x
48	CPL South London	KT9 2JT	x	x		x
49	Sam Goody Trees	KT12 4LF	x			
50	LC Energy Ltd	TW13 4NA			x	
51	South East Wood Fuels	SL0 9LA		x	x	
52	Fuel CHP Ltd - IVER hub	SL0 9LA		x	x	
53	South East Wood Fuels	HP7 0PP		x	x	
54	High Wycombe Hub	SL0 9LA		x	x	
55	Fuel CHP Ltd - Chilterns Hub	SL0 9LA			x	
56	Penn Street Farm	HP7 0PP		x	x	
57	Forever Fuels Ltd	SL6 8RT		x		
58	GV Recycling	RG5 4HJ			x	
59	Logboys	GU15 3AN	x			
60	UK Wood Pellets	RG21 8UU		x		x
61	Stickland Wood Yard	RG24 7NH	x		x	

#	Supplier	Location	Log	Chip	Pellet	Briquette
62	Hampshire Woodfuel Cooperative Ltd	RG25 2PL			x	
63	GK Benford & Co	RG29 1QX	x	x	x	x
64	Hampshire Woodfuel Cooperative, Odiham	RG25 2PL	x		x	
65	Mark Howard	GU10 5PR	x			
66	The Eko Company	GU30 7SB	x	x		x
67	Sustainability Centre (Wood4heat)	GU32 1HR			x	
68	Wesnet Services Ltd	PO8 0JE	x			
69	South Coast Firewood	PO17 5PN	x			x
70	Forest Heat Energy Ltd	PO108QA		x	x	x
71	Covers Timber & Builders Merchants	PO19 8PE		x		x
72	Dryad Tree Services	GU3 3ET			x	
73	LC Energy Ltd	GU5 9BH		x	x	
74	LC Energy Ltd	GU5 9QA	x	x	x	x
75	Redwood Tree Services Ltd	GU24 9BY			x	

Source: http://www.woodfueldirectory.org

Given the extensive number of suppliers already operating in the area it is unlikely that a significant number of further suppliers based within Mid Sussex will enter the supply market via woodland management.

In terms of large scale consumers of biomass there are a small number within the proximity of Mid Sussex (50 mile radius used for consistency with supplier data). A summary of these users is provided in Table A.7.

Table A.7 Large Biomass Consumers

Facility	Location	Capacity (MWe)	Capacity (MWth)	Total Capacity (MW)
Hoathly Hill Community Biomass Project	RH19 4QG		0.3	0.3
SHOREHAM RENEWABLE ENERGY GENERATION PROJECT	BN41 1WF		32	32
Cophall Wood (ATT)	Polegate	19	42.2	61.2
AHS Energy (Combustion)	TN31 6QP	4.5		4.5
Ridham CHP Plant	ME9 8SR	23	51	74
Redhill Road Biomass Power Plant	KT11 1EQ		2.5	2.5
Bracknell Forest Biomass Centre	Bracknell		1.1	1.1
Pegham Renewable Energy Facility (ACT – Gasification)	PO15 6SD	2		2
Basingstoke skip hire	RG24 8NU	0.75	5	5.75
Slough Heat and Power	Edinburgh. St Slough	40 20		60
Beacon Community College	Crowborough		1	1

Source: RESTATS database

All of these facilities will have existing fuel supply contracts in place. It is therefore difficult to see how further suppliers operating within Mid Sussex could easily enter the market for energy crop supply.

A.5 Solar Thermal

Solar thermal systems use solar energy to heat water which is stored in a hot water cylinder. A boiler or immersion heater is required to provide an additional source of heat over and above the energy available from the sun. Solar thermal panels (collectors) come in two designs:

- **Evacuated tube**: Water flows through a number of copper pipes, which in turn are sealed in a glass tube. This reduces heat losses and makes these systems very efficient at transferring the heat of the sun to the water;

- **Flat Plate**: Water flows through copper pipes that are encased with a glass covered plate.

Solar collectors are suitable for use in both domestic and light industrial premises as well as part of systems supplying swimming pools.

A.5.1 Installation Considerations

There are a number of factors to consider in relation to solar thermal system installation including:

a) As with solar PV systems the optimum roof space available to solar thermal systems is South facing areas with little or no immediate overshading;

b) The system must include a hot water cylinder to store the resulting hot water. It is therefore more costly to install a solar thermal system in properties with an existing combi boiler since there is no existing water tank;

c) The proposed installation area of the roof must be structurally capable of supporting the weighted of the water-filled collector;

d) Solar collectors are eligible for Renewable Heat Incentive (RHI) payments for each kWh of heat produced in a year;

e) Solar collectors are likely to be most cost effective when reducing water heating demand from electricity or oil/LPG fuelled systems, i.e. those not on the national gas grid.

A.6 Heat Pumps

There are three different forms of heat pump that can be used to provide space heating.

A.6.1 Ground Source Heat Pump

A ground source heat pump extracts heat from the ground, which can then be used to supply radiators, underfloor or war air heating systems and hot water systems. A mixture of water and antifreeze is circulated around the so called ground loop, which is a loop of pipe arranged either horizontally (in a trench) or vertically (in a borehole). The circulating water/antifreeze fluid absorbs heat from the ground and this is then passed through a heat exchanger and into the heating system.

A.6.2 Air Source Heat Pump

Air source heat pumps extract heat from the outside air using the same approach as a fridge uses to extract heat from its inside. Heat from the air is absorbed at low temperature into a fluid. This fluid then passes through a compressor where its temperature is increased, and transfers its higher temperature heat to the heating and hot water circuits of the house. The heat in the house can then be provided via an underfloor system, warm air circulated by fans or a wet radiator system using outsized radiators.

A.6.3 Water Source Heat Pump

Water source heat pumps extract heat from water bodies. These can be lakes, ponds, rivers, springs, wells or boreholes. The heat transfer rate from water is higher than that from the ground or the air. So called 'open loop' designs circulate water via a heat exchanger and then discharge it back to the original source; a 'closed loop' system operates in a similar manner to a ground source heat pump with a water/antifreeze fluid mixture being circulated through pipes set within the water source.

An extraction licence is required from the Environment Agency when using open loop heat pumps that require more than 20 m^3/day of water to be abstracted from the water source (typically a 4 kW system and above). A discharge consent is also required for the cold water that has flowed through the heat pump.

Closed loop systems do not require any licensing from the Environment Agency.

A.6.4 Heat Pump Use

The heat output from heat pumps (whether ground, air or water) is lower than a typical wet radiator system fuelled via natural gas or oil. For this reason heat pumps are generally best used with underfloor heating, providing a larger surface area for supply. If used to supply a wet radiator system then these radiators need to be much bigger than conventional systems.

While the source of heat is renewable (ground, air or water), circulating fluid requires electricity to power the pumps. For this reason heat pumps are less economic to install in areas where natural gas fed heating systems already operate. In situations where heat pumps are replacing oil or electric heating systems the savings in terms of energy and cost will be more attractive.

A.7 Future Energy Consumption

Working assumptions:

Total Housing Commitments

- All 4,213 units are delivered to 2010 Building Regulations.
- Dwelling mix is 40% : 40% : 20% in terms of 2-bed : 3-bed : 4-bed.

Future Commitments

- All 5,865 units delivered to 2016 Building Regulations.
- Dwelling mix is 10% : 40% : 40% : 10% in terms of 1-bed : 2-bed : 3-bed : 4-bed