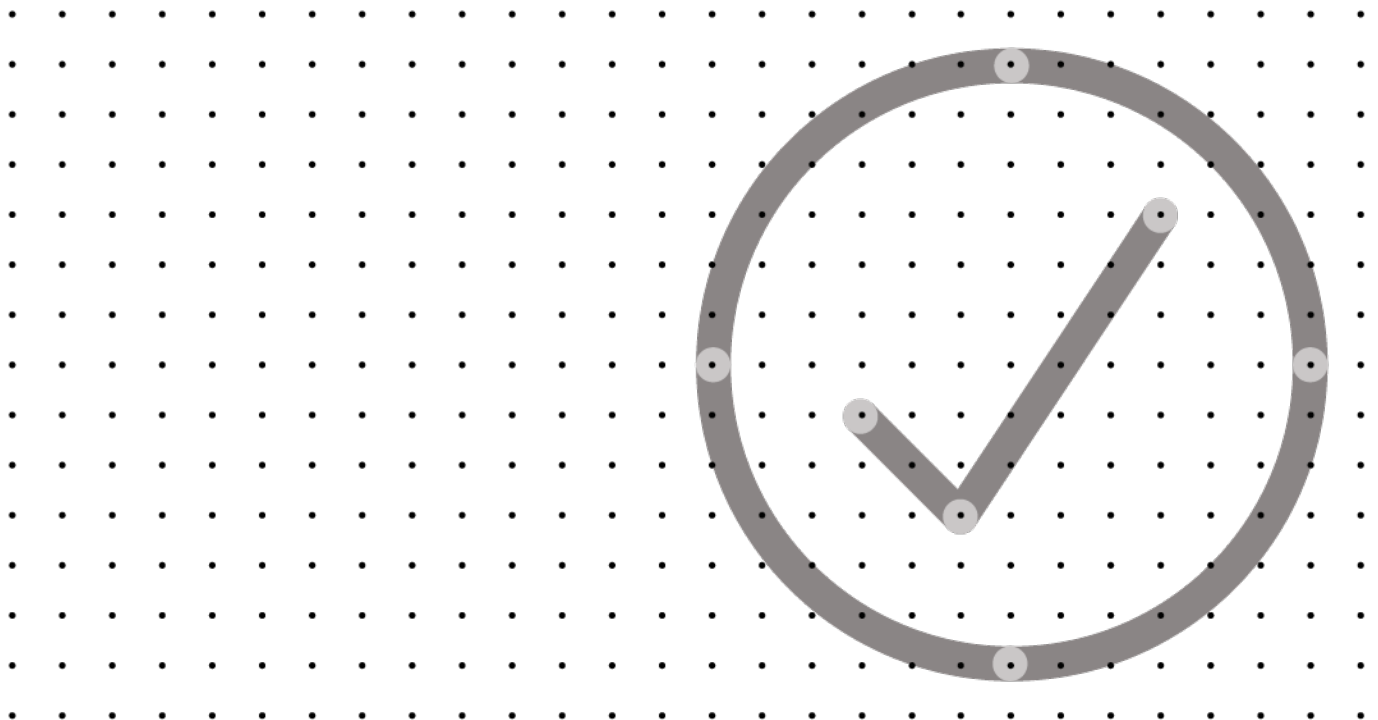


MCS 2025

Small Wind Turbine: Installation Standard



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ABOUT MCS

MCS: Giving everyone confidence in home-grown energy

With energy costs constantly rising and climate change affecting us all – low-carbon technology has a bigger and bigger role to play in the future of UK energy. MCS is here to ensure it's a positive one.

MCS is the UK's quality mark for small-scale renewable energy technologies like solar PV, solar heating, heat pumps, biomass, and battery storage. We have two main roles – setting and maintaining standards, and providing consumer protection.

Our Standards define how certified renewable energy installations should be designed and installed using MCS certified products. They are a benchmark for quality developed in close consultation with industry through independent technical working groups.

The Standards are owned by The MCS Foundation (a charitable trust), but maintained and developed by MCS.

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CHANGES TO STANDARDS

When MCS Standards are revised, the issue number is also revised to indicate the nature of the changes. This can either be a whole new issue or an amendment to the current issue. Details will be posted on the website at www.mcscertified.com

Technical or other significant changes which affect the requirements for the approval or certification of the product or service will result in a new issue. Minor or administrative changes (e.g. corrections of spelling and typographical errors, changes to address and copyright details, the addition of notes for clarification etc.) may be made as amendments.

The issue number is given on the left of the decimal point, and the amendment number on the right. For example, issue 3.2 indicates that it is the third significant version of the document which has had two sets of minor amendments.

Users of this Standard should ensure that they are using the latest issue.

Amendments issued since publication

Issue No.	Amendment details	Date
1.0	First Publication for MCS:2025 1.0	01/01/2025

FOREWORD

Compliance with this Standard is mandatory for MCS Contractors certified to MCS: 2025.

The purpose of this Standard is to specify best practice in achieving high-quality low carbon technology installations. Whilst it is not possible to ensure safety, this Standard provides requirements which should help mitigate potential safety risks associated with the design and installation of this technology.

This document contains references to other documents which may be either normative or informative. At the time of publication any editions of those documents, where indicated, were valid. However, as all documents are subject to revision, any users of this document should apply the most recent editions of those referenced documents (unless a dated version is specified).

NOTE:

This MCS Installation Standard makes use of the terms ‘must’, ‘shall’ and ‘should’ when prescribing certain requirements and procedures. In the context of this document:

- the term ‘must’ identifies a requirement by law at the time of publication;
- the term ‘shall’ prescribes a requirement or procedure that is intended to be complied with in full and without deviation;
- the term ‘should’ prescribes a requirement or procedure that is intended to be complied with unless reasonable justification can be given.

Compliance with this MCS Installation Standard does not in itself confer immunity from legal obligations.

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1 PURPOSE & SCOPE

This Standard specifies the requirements for MCS Contractors undertaking the supply, design, installation, set to work and commissioning of small wind turbine systems located on dedicated free-standing/guyed towers, supplying permanent buildings, and normally connected in parallel to the electricity distribution network. The scope of this Standard is defined as small wind turbine systems with power outputs of between 0W and 50kW, measured at a wind speed of 11.0m/s. Systems that never operate in parallel to the grid (i.e. off grid systems) are not in scope for this standard.

2 DEFINITIONS

Refer to Scheme Rules for general definitions (not specific to small wind). For technical definitions please see below.

Term	Definition
Micro and Small Wind Turbines	Systems having an electrical output up to 50kW measured at a wind speed of 11.0 metres per second.

3 DESIGN AND INSTALLATION REQUIREMENTS

3.1 LEGISLATION

3.1.1 All applicable legislation and directives **must** be met in full.

Note: the legislation which applies may be different in England, Wales, Scotland, and Northern Ireland.

3.1.2 MCS Contractors shall ensure, and be able to demonstrate, that they are aware of all current applicable legislation.

3.1.3 Planning permission - Stand alone domestic wind turbines

Where an installation is intended to proceed with Permitted Development Rights for small wind turbines MCS 020 Planning Standards **must** be complied with. If Permitted Development Rights do not apply, then planning permission is required.

In support of a planning application MCS Contractors should, as good practice:

- Advise customers to contact their Local Planning Authority themselves.
- Urge customers to communicate with neighbours and the local community about the project at an early stage.
- Provide information to the authority on similar installations (location, equipment type, etc.).
- Provide appropriate drawings (electrical schematics for example).
- Provide information on noise levels.

3.1.4 The MCS Contractor shall ensure the proposed small wind turbine location is assessed by a competent professional experienced in small wind turbine systems to ensure that it is suitable for the installation and, by undertaking the proposed works is compliant with Building Regulations.

3.1.5 As part of standard Health and Safety Practice suitable and sufficient risk assessments (see section 3.5.5) shall be conducted before any work on site commences. This is a requirement under the Management of Health and Safety at Work Regulations 1999 and as amended in 2006 (see section 5 for document reference details).

3.1.6 The MCS Contractor shall ensure that notification under the Building Regulations has been completed prior to handing over the installation.

Note: Self-certification, in lieu of building control approval, is only permitted where installation and commissioning is undertaken by a person or organisation deemed competent and registered with a Competent Persons Scheme (CPS) approved by the relevant government department for the scope of work being undertaken. Further details can be found at <http://www.competentperson.co.uk>.

3.1.7 The MCS Contractor shall ensure the installation is compliant with the Electrical Safety, Quality and Continuity Regulations 2002 (see Section 5 for document reference details) and, in accordance with Regulation 22(2)(c), shall follow the technical requirements and procedures:

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- In Engineering Recommendation (EREC) G98 (formerly G83) for installations up to and including 16 A per phase.
- In EREC G99 (formerly G59) for installations exceeding 16 A per phase.
- In Engineering Recommendation (EREC) G100 where the export of power is to be limited.

3.1.8 Notification to the Distribution Network Operator (DNO) in accordance with the procedures set out in ENA Engineering Recommendation (EREC) G98 or EREC G99 shall be undertaken by the MCS Contractor.

3.2 MANUFACTURER'S INSTRUCTIONS

3.2.1 All equipment should be installed in accordance with its manufacturer's instructions.

3.2.2 Where the manufacturer's instructions conflict with the requirements of this Standard then the requirements of this Standard take precedence unless it can be proven that system performance, safety and durability are no worse than if the requirements of this Standard are followed.

3.3 EQUIPMENT CERTIFICATION & LISTING

3.3.1 When making installations in accordance with this Standard the small wind turbine system shall be listed under the MCS (<http://www.mcscertified.com>).

3.3.2 All installed equipment:

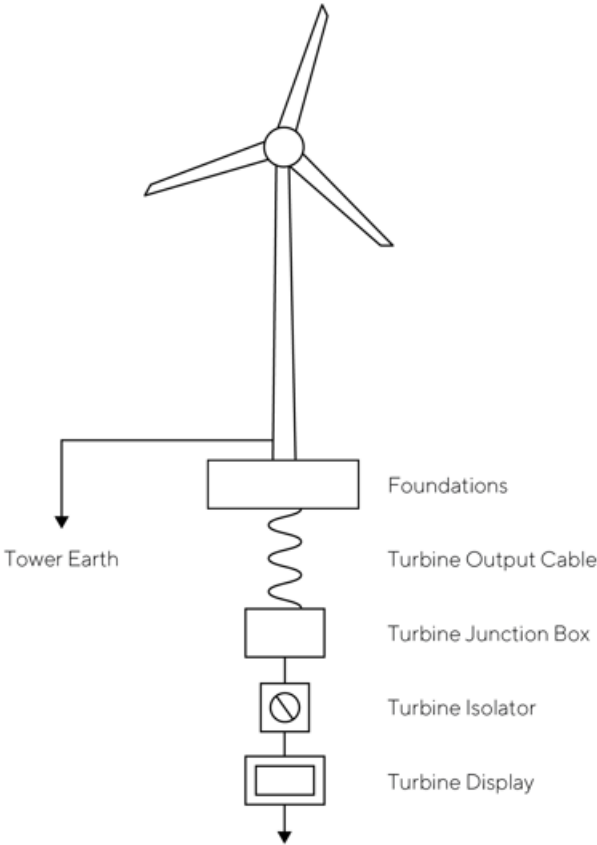
- Shall be fit for its purpose in the installation
- **Must** be CE marked in compliance with the relevant European Directives.

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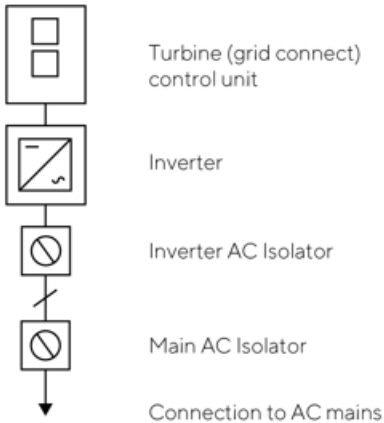
3.4 DESIGN

Figure 2 below shows diagrammatically the components of a small wind turbine that are discussed in detail in this section.

Figure 2: Small Wind Turbine – System Components



GRID CONNECTION SYSTEM



3.4.1 Wind turbine, tower, and foundations

The requirements of this section apply to **all** installations.

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3.4.1.1 Mechanical and structural requirements

3.4.1.1.1 Wind loading

The UK has a good wind resource, but severe winds occur occasionally. The turbine and tower shall not become a health and safety risk due to mechanical failure caused by high winds. A wind turbine and tower shall be selected that is at least rated to withstand wind speeds that average $5 \times V_{ave}$ of the site over a 10-minute period without any damage to its operation.

A wind turbine and its support structure shall be selected to survive a gust of at least $1.4 \times V_{ref}$ without suffering any damage that might result in any or all parts of the turbine or tower falling to the ground.

Note: A single gust is considered a 3-second gust.

Note: The wind turbine and its support structure should be selected to withstand the conditions of the site, as well as conditions no more severe than the classification the turbine system is certified to. If there is any uncertainty, the manufacturer should be consulted with.

Note: Gusts of $1.4 \times V_{ref}$ are rare, but they shall not result in catastrophic mechanical or structural damage; although it is accepted that systems may not function correctly afterwards. Manufacturers' instructions will normally require turbine inspection following severe winds. Wind speeds of $5 \times V_{ave}$ are more common, and it is important that a turbine is selected that is capable of returning to normal reliable operation after such events (in accordance with BS EN 61400-2; see Section 5 for document reference details). Some particularly exposed sites, or installations in public areas, may need to meet more stringent design requirements.

SWT Classes taken from IEC 61400-2						
		I	II	III	IV	S
V_{ref}	(m/s)	50	42.5	37.5	30	Values to be specified by the designer
V_{ave}	(m/s)	10	8.5	7.5	6	
I_{15} (Note 2)	(-)	0.18	0.18	0.18	0.18	
a	(-)	2	2	2	2	
<p>NOTE:</p> <ol style="list-style-type: none"> 1) The values apply at hub height, and; 2) I_{15} is the dimensionless characteristics value of the turbulence intensity at 15m/s, where 0.18 is the minimum value that shall be used, and noting that Annex M discusses observations regarding turbulence intensity; 3) a is the dimensionless slope parameter to be used 						

3.4.1.1.2 Turbine Support Structures

(a) General

The support structure is commonly supplied by the turbine manufacturer. This can be expected to be 'fit for purpose'. However, support structures from a third party will require detailed investigation, as well as consultation with the turbine manufacturers regarding compatibility and suitability as follows:

- a) The support structure shall be suitable for the turbine and shall be designed to prevent detrimental effects arising from movement or vibration.
- b) All parts of the tower shall be corrosion resistant (e.g., made from galvanised or stainless steel).
- c) Fixings shall be prevented from loosening through vibration (use of nylock bolts, for example).
- d) Dissimilar materials shall be isolated from each other to prevent electrolytic corrosion.
- e) The design shall ensure that any exposed moving parts are at least three metres from any point where persons or livestock may stand. It should also prevent unauthorised access.
- f) Towers should be designed in such a way as to prevent climbing by unauthorised persons (this is of relevance particularly to lattice constructions).

(b) Foundations and anchor points

Concrete foundations shall be made according to BS 8004 Foundations and BS EN 1992-1-1:2004 +A1:2014 Eurocode 2: Design of concrete structures (See Section 5 for document reference details). Key considerations include:

- a) The appropriate type and strength of concrete should be specified to suit site conditions and foundation requirements. These specifications are to be provided to the installer in the foundation instructions.
- b) Where steel reinforcement is incorporated, the requirements (including concrete cover at the edges) shall be provided in the foundation instructions.
- c) Foundations and anchor points shall be proportioned to suit local ground conditions.
- d) Foundations and anchor points shall be designed in such a way as to prevent water pooling around the tower base or the anchors.
- e) Concrete shall be thoroughly compacted with a vibrator or other means.
- f) Concrete shall be worked around all parts and into all corners and voids.

Note: Details of the foundation/anchor design - including size, ground conditions, etc - are to be included in documentation to demonstrate that the turbine support system can withstand the structural forces resulting from a $1.4 \times V_{ref}$ wind (see above).

(c) Guys

All shackles, turnbuckles, etc, shall be provided with the means to prevent loosening. An example is shown in Figure 3 below:

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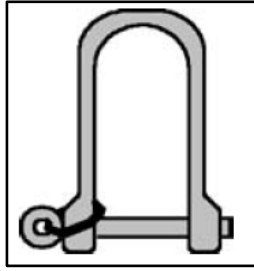


Figure 3: A Shackle Prevented from Loosening



3.4.1.2 Electrical Requirements

3.4.1.2.1 Voltage and Current - Maximum Values

To specify any part of the turbine electrical system, it is essential to know the maximum voltage and current output that can be expected - under normal or faulted operating conditions, and across the range of wind speeds it may encounter.

***Note:** Different turbine designs vary in their response to normal and faulted operating conditions. Some designs may stall when the turbine is short-circuited, but not all. Factors such as generator design, magnet type, furling mechanism, etc, will all have an influence on the output current and voltage at different wind speeds and under different operating conditions.*

It is important to note that the exact conditions under which the maximum voltage or current occurs are not important - the value is the key figure and should be known by the system engineer.

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The following information should therefore be clearly stated in the turbine documentation supplied by the manufacturer or supplier:

$V_{(max)}$ - the maximum open circuit voltage that would be generated by the wind turbine at wind speeds between 0-50m/s.

$I_{(max)}$ - the worst case, maximum steady-state current (either during normal operation or into a short circuit) that would be generated by the turbine at wind speeds between 0-50m/s.

3.4.1.2.2 Turbine output cables

- a) A turbine output cable shall be able to withstand the environmental conditions, as well as the voltage and current, at which it operates. It shall be rated to suit the environmental conditions along its entire route i.e., it should be UV-stable, waterproof, armoured, etc.
- b) The turbine output cable shall be rated for at least $U_{(max)}$ and $I_{(max)}$ (see above). This shall be calculated using standard correction factors for installation method, temperature, grouping and frequency, in accordance with BS 7671 (see Section 5 for document reference details). Sizing the cable in this way ensures that the maximum potential fault current can be safely accommodated. Correctly sized cables will avoid the fire and safety risks associated with overloading.

***Note:** In conventional systems, cables are protected by a fuse; this rapidly clears a fault before it becomes a fire or safety risk. With a wind turbine, however, the steady state fault current may be only a little more - or sometimes less - than the maximum operating current. In such cases, sizing a fuse to achieve disconnection under fault conditions is not possible. Instead, cable systems with suitable rating and protection are to be selected to minimise the risk of faults; Steel Wire Armoured (SWA) cables should be used, or the cables enclosed in protective conduit/trunking.*

- c) The turbine output cable shall be sized so that the voltage drop is in accordance with BS 7671 18th Edition IET Wiring Regulations. In any case the drop should be limited to less than 4%.

3.4.1.2.3 Turbine isolator

- a) A turbine isolator shall be installed to be able to manually isolate the electrical output of the turbine.

*Note: A manual brake on the turbine is **not** sufficient to guarantee supply isolation - brakes may slip or even fail as the wind strengthens.*

- b) The turbine isolator shall be a multi-pole device to electrically isolate all the wires coming from the turbine.

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- c) The isolator should be rated for operation at the maximum voltage and current of the turbine (see above).

Note: Isolators need to be tailored to the machine. Open circuit, short circuit or dump load switching may be appropriate.

Note: Anyone opening the isolator enclosure should be aware that turbine output cables can become energised at any time – they often represent an additional energy source within a building.

3.4.1.2.4 Turbine junction box

- a) Where turbine output cables are to be joined, a turbine junction box should be installed.

Note: A turbine junction box may also serve as a test point or a point of secondary isolation.

Note: The environmental and fault protection provisions in the turbine output circuit shall be maintained in the make-up and construction of any junction box.

3.4.1.2.5 Tower earth

- a) A turbine in proximity to existing lightning protection.

Where a turbine shall be mounted on a structure with an existing lightning protection system (LPS), the installers of the LPS shall be consulted so that the turbine can be correctly incorporated into the protection system, checking that no alterations to the LPS need to be made (changes to location or to the height of the air terminations for example).

- b) A turbine within an equipotential zone.

Where a turbine is mounted within the equipotential zone of a building or other structure, the tower should be bonded to the installation's main earthing terminal, in accordance with BS 7671 (see Section 5 for document reference details).

Note: Equipotential zone is defined in BS 7671 as: a zone in which exposed-conductive parts and extraneous-conductive parts are maintained at substantially the same potential by bonding, such that, under fault conditions, the differences in potential between simultaneously accessible exposed- and extraneous-conductive-parts will not cause electric shock.

- c) All other installations

The following apply in all other cases:

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- a) The turbine tower shall be connected to a dedicated earth electrode. An electrode resistance to earth not exceeding 10Ω should be achieved.
- b) The earth electrode shall be placed as close as is practical to the tower base and it shall be installed in such a way as to permit periodic inspection. Periodic inspection is important as a failure of this earth termination may have a serious impact on the system, not least in the transmission of lightning surges.
- c) The connection between the tower and the tower earth should be made with copper cable (minimum CSA of 16mm^2), taking a direct route, and avoiding sharp bends.
- d) Separation between the turbine earth and building earth shall be maintained. This is to ensure that any direct strikes on the turbine (which may be in a particularly exposed location) are not coupled directly back to the building.

Note: Where steel wire armour is used for the turbine output cable, this should not intentionally or unintentionally be coupled to the tower earth and so bring the turbine earth inside the building. This could occur if a metal junction box is used to join cables within a steel turbine tower; the metal box would be coupled to the armoured sheath by the SWA gland and also coupled to the tower by direct contact. In such a situation, a non-conductive enclosure should be used.

3.4.1.2.6 Lightning Protection

BS EN 62305-2:2012 Protection against lightning, risk management (see [Section 5](#) for document reference details), describes how to assess the likelihood of damage. This may be caused either by a direct strike or through surges induced in cables from a nearby strike. Tower earthing (see above) provides one element of protection.

(a) Dedicated Lightning Protection Systems (LPS)

If there is a risk of a direct strike, specialists should be consulted about installing a separate LPS in accordance with BS EN 62305-2:2012.

(b) Surge Protection

Cabling systems should be designed to maximise surge immunity. The following measures will act to shield the cables from inductive surges and attenuate surge transmission (by increasing inductance):

- Turbine output cables should be as short as possible, bundled together and not looped.
- Long turbine output cables (for example, those over 50m) should have an earth shield, which can be created by using earthed, armoured cable or earthed metal conduit/trunking.

Surge suppression devices will give additional protection:

- Where these are fitted to the turbine output cable, they should be attached at the tower base. In the case of long cable runs, they should be fitted at both ends.

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- Where surge suppression devices are fitted to protect specific equipment, they should be fitted as close as is practical to the device.
- Surge suppression devices shall be electrically safe and pose no electrical fire hazard.

3.4.2 Battery-connected systems

3.4.2.1 For systems that are to be connected to the DC-side of a battery storage system, the specified control unit shall be appropriate for that purpose.

3.4.2.2 For systems that are battery-connected and seeking to gain MCS certification for the battery system, MIS 3012 (The Battery Storage Installation Standard) shall be followed.

3.4.3 Grid-connected systems

Systems are of two types:

(1) A.C. generator connected via dedicated synchronisation and protection relays.

(2) Inverter connected.

(1) Systems using an A.C. generator

Note: *A wind turbine with an A.C. generator can be connected to the network via synchronisation and protection control systems. These are not normally off-the-shelf or type-tested products.*

Design, testing and commissioning of these systems shall be compliant with the requirements of EREC G98/99.

Note: *The details of such systems are beyond the scope of this document although many sections of this guide (such as isolation and labelling) will apply.*

(2) Inverter-connected systems

These commonly rely on a type-tested inverter and this provides the DNO with a relatively straightforward way to assess the system's suitability for connection. While EREC G98 does not specifically set out details for wind power, the requirements for inverter-connected PV systems are commonly adopted for wind systems.

3.4.3.1 Turbine grid-connect control unit

This provides the interface between the turbine and the grid connect inverter. It can provide voltage control as well as rectification. It may also incorporate other functions such as isolation and metering. Key considerations include:

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- a) The control unit shall be rated for the current and voltage maxima (see [Section 3.4.1.2, Electrical Requirements](#) above).
- b) If a control unit incorporates specific functions described in Section 3.4.1.2 such as isolation, the relevant requirements of that section should be applied.
- c) For wind speeds up to 50m/s, the control unit shall be designed to minimise the risk to itself or the system, from fire or shock.

3.4.3.2 Inverters

Where EREC G98 applies, inverters shall be programmed so that the automatic protection system operates at:

- Operating voltage greater than 264V phase to neutral.
- Operating voltage less than 207V phase to neutral.
- Operating frequency greater than 50.5Hz.
- Operating frequency less than 47Hz.
- Loss of mains.

The inverter should also be capable of withstanding the maximum voltage and current output supplied by the turbine control unit for winds up to 50m/s.

***Note:** A key safety concern is that the wind system should disconnect when the distribution system is not energised. This is to prevent the danger of the wind system feeding the network or local distribution system during a planned (or unscheduled) loss of mains. Such an event is known as 'islanding' and presents a potential hazard to those working on the network or distribution system. Type tests established by EREC G98 ensure that an inverter is properly protected against islanding.*

3.4.3.3 A.C. isolator

Two A.C. switch disconnectors, in accordance with BS EN 60947-3 Low-voltage switchgear and control gear - Part 3 switches, disconnectors, switch-disconnectors, and fuse-combination units (see Section 5 for document reference details), shall be provided between the inverter and the point of interconnection to the supply. One shall be installed adjacent to the inverter and the other next to the point of interconnection. If they are to be in the same room, only the latter is required. They should:

- a) Switch all live and neutral cables.
- b) Clearly show ON and OFF positions and be labelled as "wind system - point of emergency isolation". See Section 4.2.2 for examples of the labels required.

The disconnector adjacent to the point of interconnection should also be lockable - in the OFF position only - and it should be readily accessible.

When connecting switching devices, the public supply shall be considered 'the source' and the wind installation 'the load'.

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3.4.3.4 A.C. cabling

The inverter(s) should be connected, via a dedicated circuit, to a spare fuseway in the main distribution unit, or to a fuseway in an additional dedicated distribution board. A.C. cables shall be specified and installed in accordance with BS 7671 (see Section 5 for document reference details).

Note: When generating, the voltage at the inverter terminals is slightly higher than that at the distribution board. This voltage drop should be kept to a minimum so that the protection systems operate correctly. To do this, the A.C. cable between the two should be oversized to keep the voltage drop small - a 1% drop is acceptable.

3.4.3.5 A.C. fault current protection

Note: The short circuit current from an inverter is approximately equal to its full load current. Over-current protection devices cannot therefore distinguish between full load and fault conditions. Therefore, short circuit protection is not feasible - or required -at the inverter output.

Short circuit protection for the dedicated feeder cable to the inverter(s) shall be provided at the distribution board. This electrical protection is to be specified and installed in accordance with the requirements of BS 7671.

3.5 INSTALLATION

3.5.1 Metering

3.5.1.1 As a minimum metering should be installed to record and display instantaneous power output and total power generation.

3.5.1.2 If required for billing and or payment purposes the means of recording A.C. generation of the system shall be a meter approved under the European Measuring Instruments Directive (MID) showing the serial number on the front panel where it could be photographed alongside the make, model, and actual meter reading.

Note: Installation of a MID approved meter would also satisfy clause 3.5.1.1.

3.5.1.3 The means of recording power generation, be it a dedicated meter or otherwise, should be readily accessible and readable by the customer.

3.5.1.4 Where energy is taken from the grid to be stored in an EESS (Electrical Energy Storage System) and later returned to the grid or installation, that energy shall not affect the veracity of any meters recording energy generated, imported, or exported where those meters are used for billing or payment.

Note: An example would include the meter recording total generation of the small wind turbine system where the recorded energy is used for payment of financial incentives.

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Any error in that reading could cause a claim for payment to be inaccurate and fraudulent. For the avoidance of doubt this clause allows for the correct recording by the supply meter of the energy taken from the grid to be stored in the EESS.

Examples of different metering arrangements which do and do not satisfy this clause are given in the Ofgem document: Guidance for Generators: Co-location of electricity storage facilities with renewable generation supported under the Renewables Obligation or Feed-in Tariff schemes.

3.5.1.5 See also MCS Metering Guidance document.

3.5.2 Data communication & security

3.5.2.1 The data privacy and security of the site's home area network shall be maintained. Where the installation comprises of any internet connected devices:

- The device's network access credentials (username & passwords) shall be updated in consultation with the customer
- Relevant components in the small wind turbine system should comply with the technical specification ETSI Technical Specification 103 645 Cyber Security for Consumer Internet of Things (see Section 5 for document reference details).

3.5.2.2 Installations requiring local area network, home area network, and/or internet access in commercial and industrial premises shall comply with the client organisation's information technology and information security policies and procedures.

3.5.3 Safety and durability

3.5.3.1 The MCS contractor shall be able to demonstrate that the installation of the small wind turbine can be operated safely.

Note: *This can be demonstrated by:*

- Operating the small wind turbine brake.*
- Operating the safety cut out/isolation switches.*

3.5.4 Site specific issues

3.5.4.1 In addition to the siting and sizing issues considered in Appendix C the following shall be addressed in the design of the wind turbine system for each location:

- a) The suitability of a site shall be assessed by a competent person experienced in small wind turbines., using a site survey form including at least the details given in [Appendix D](#).
- b) The class of turbine selected shall be appropriate for the conditions at the proposed site as identified through the site survey (see Appendix D).
- c) For ground-mounted or roof-mounted small wind turbines that use concrete foundations or steel support structures, MCS Contractors shall have a documented method of controlling the quality of foundations either:
 - According to the turbine manufacturer's specifications, or in the absence of these, in accordance with

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- Section 3.4.1.1.2 Turbine Support Structures, b) Foundations and anchor points as detailed above.

Note: An MCS Contractor who has not received sufficient information from the manufacturer should seriously question whether it is the appropriate product for the customer.

- 3.5.4.2 When a third-party is instructed to undertake the design and installation, the MCS Contractor shall undertake a quality control assessment, which should take the form of a documented site inspection, photographs of any excavations, reinforcing structure and concrete pouring process, along with a copy of a certificate of conformance for the concrete composition.
- 3.5.4.3 Small wind turbines, shall **not** be located in such a way as to have an adverse effect on the performance of any flue that serves fuel burning equipment (e.g., gas fire, wood burning stove, biomass boiler).
- 3.5.4.4 **Flickering Shadows:** Small wind turbines shall **not** be located or mounted in such a way as to cause unacceptable levels of flickering shadows. Shadows from rotating wind turbine blades can be cast long distances from the actual turbine, depending on the tower height and the slope of the ground. The severity and duration of exposure generally decreases with increasing distance. Shadows occur to the North of the turbine at mid-day (most relevant for offices) and to the West and East in the early morning and late evening respectively (more relevant for houses). An exposure limit of up to 30 hours per year has been established as reasonable level of exposure (see Appendix A). Unless a site specific and turbine specific assessment is carried out the small wind turbine shall be sited in accordance with the guidelines in Figure 5 below. Other suitable measures may be applied to mitigate the flickering shadows effect. For example, using a timer system to shut down the turbine during the hours of the day when there might be an issue on a few weeks of the year.

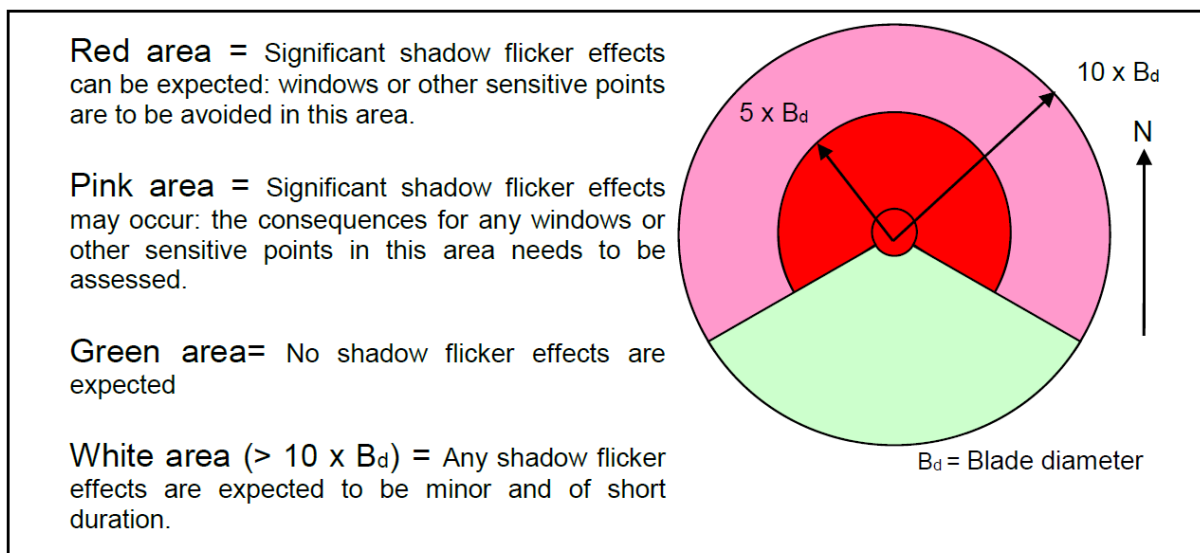


Figure 5: Diagram of Shadow Flicker Zones of Interest for the UK

Note: In Figure 5 above the small wind turbine is at the centre of the circle and North is at the top of the image. It is appropriate for UK latitudes in the Northern Hemisphere where the green sector forms an arc of approximately 100 degrees. It is suitable for small turbines mounted at

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hub heights of 3-4 times the rotor diameter B_d , where B_d is the **blade diameter** for a Horizontal Axis Wind Turbine (HAWT) or **blade length** for a Vertical Axis Wind Turbine (VAWT). Reference should be made to Appendix A for other cases/examples.

3.5.5 Responsible Siting Guidance

3.5.5.1 As required by the Management of Health and Safety at Work Regulations 1999 (as amended in 2006), see Section 5 for document reference details, the MCS Contractor shall undertake a risk assessment for the turbine’s operation on the proposed site. This risk assessment shall be in accordance with the manufacturer’s siting guidelines unless additional mitigation measures are deployed. The customer shall be made aware of these measures, the risks, and sign an acceptance in such cases.

3.5.5.2 Risk assessments shall include at least the following risks:

Zone	Extent	Typical hazard
1	Circle around the base	Fall zone: Hazard if anything fell from the turbine.
2	Hemisphere around the base	Hazard if the mast were to topple.
3	Circle around the base	Ejection zone: Hazard if something were to be ejected from the spinning rotor.
4	Reachable area	Vandalism Lowest point of rotating parts above the ground or easily accessible point.
5	Varies	Impact: Hazard from vehicle impacts.

3.5.5.3 The risk assessment(s) carried out should consider at least the following, not exhaustive, list of hazards:

Hazard	Description
Falling objects	Anything that could fall from the turbine, including structural or mechanical parts or phenomena (e.g. ice).
Tower/mast failure	The potential for structural failure leading to a full or partial collapse of the tower/mast.
Thrown or ejected objects	Anything that could be thrown or ejected from the rotating blades, including structural or mechanical parts or phenomena (e.g., ice).

Hazard	Description
Dangerous mechanical parts	Potential of accidental or intentional contact with rotating parts, considering the lowest point of rotating parts and any points that are easily accessible.
Electrical	Potential for accidental or intentional contact with electricity, including underground services. Existing site services (e.g. overhead or underground electric cables) should be identified, and exclusion zones defined.
Slips/trips/falls	Potential for slips, trips, or falls associated with the turbine, including the siting of wires, guy ropes etc.

3.5.5.4 In conducting the risk assessment, the MCS Contractor should also consider other factors. These include, but are not limited to:

- a) The potential risks to the turbine and any supporting structures or equipment from commercial (e.g., contractor) or public vehicles crashing into the tower.
- b) Any public rights of way close to the installation site.
- c) The local situation should be considered, e.g., the likely presence of children.
- d) Temporary signs, notices and barriers should be erected.
- e) The local weather conditions should be considered.
- f) Environmental phenomena, including lightning, ground stability, trees etc.
- g) Vandalism to the structure and/or safety critical components.
- h) The potential risks to the turbine and any supporting structures or equipment from adjacent premises or commercial and industrial activities.

3.5.5.5 MCS Contractors should ensure that the risk assessment(s) are documented and are able to demonstrate compliance with the relevant statutory requirements set out in general and specific health and safety legislation. There is no standard format to record the risk assessment. However, it is good practice for micro and small system installations that in addition to the written risk assessment that the findings can be additionally categorised using a zonal approach, which identifies the hazards and risks as you move away from the base of the turbine tower. This may also be visually presented to the customer, to assist the communication of the risk assessment and any mitigation measures.

3.5.5.6 Safe siting and working - The following sections demonstrate ways to mitigate the hazards identified in the risk assessment:

- a) Turbine and tower – structural and mechanical works
 - i. Structural and mechanical installation shall be actively managed and supervised by a suitably experienced and competent person.

- ii. All workers involved in the works should be fully briefed on the sequence of operations before they commence. This is to include the identification of danger areas that shall not be occupied during the erection process.
- iii. All personnel should wear appropriate personal protective equipment, including high visibility jackets, hard hat, and safety boots.
- iv. Anyone working at height should work to the requirements of the relevant statutory provisions.
- v. During installation and maintenance works, an exclusion zone shall be established to prevent persons not engaged with erection of the turbine from gaining admittance.
- vi. Standard precautions for working with rotating machinery should be taken: long hair should be tied back; loose clothing avoided; rings, necklaces and other jewellery removed.
- vii. Safe siting - anchors and guy cables for towers should be far away from roads, tracks, footpaths, etc. If there is livestock on the site, then guyed towers, their cables, and anchors should be protected by fencing.

b) Turbine Electrical Works

- i. The turbine should be verifiably and effectively braked. Live working practices are to be adopted during the initial connection of the turbine to the main output cable (see Regulations 4(4), 14 and 15 of the Electricity at Work Regulations 1989 and BS EN IEC 60934:2019 and BS EN IEC 60900:2018). See Section 5 for document reference details.
- ii. Subsequently, the turbine isolator should be secured open for all other works on the electrical system. Relying solely on a mechanical turbine brake to prevent against shock is not acceptable.

3.5.5.7 Working with Batteries

- a) Appropriate personal protective equipment should be worn, including gloves and goggles. Metal items such as rings and neck chains should be removed before commencing work. An eye wash should be near to hand.
- b) Tools for battery installation should be insulated and acid resistant. Spanners should be approved single-ended types.
- c) Work on battery installations should be carried out in a pre-planned manner to minimise the number of conductors exposed at any one time.
- d) Batteries should be adequately vented during works and any source of spark or open flame avoided.

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4 COMMISSIONING, TESTING & DOCUMENTS

4.1 COMMISSIONING & TESTING

- 4.1.1 The small wind turbine system shall be commissioned according to a documented procedure to ensure that the system is safe, has been installed in accordance with the requirements of this Standard and the manufacturers' requirements, and is operating correctly in accordance with the system design.
- 4.1.2 Inspection and testing of the completed system **must** be carried out to the requirements of BS 7671. See Section 5 for document reference details.
- 4.1.3 Accurate performance testing of a turbine is only possible where an anemometer reading at the hub height is available. For most small wind turbine systems, such data will not be available. Readings from the system display meter will often be the only means to determine how well the system is working.
- 4.1.4 An installation and commissioning inspection checklist for the whole installation is also included for information in Appendix B. This, or a similar document prepared by the installer, should be completed and a copy provided to the customer.

4.2 DOCUMENTATION & LABELLING

- 4.2.1 MCS Contractors shall collate a comprehensive document pack to reside with the installation, which, as a minimum, includes:
 - a) Turbine support structure specifications – including where appropriate, an assessment of local ground conditions as well as the installation requirements, specification of materials etc. and including any relevant structural engineer’s report.
 - b) Drawings, specifications and instructions for assembly, installation, and erection of the equipment.
 - c) Copies of all forms and checklists used to commission the system.
 - d) An operator’s instruction manual.
 - e) The maintenance requirements and maintenance services available.
 - f) Manufacturer user manuals and warranty details.
- 4.2.1.1 The following should be included in the installation, operation, inspection, and maintenance documentation:
 - (i) Installation
 - a) Details of all loads, weights, lifting points, special tools, and procedures necessary for the handling, installation, and operation of the system.
 - b) Requirements for cranes, hoists and lifting equipment (including all slings, hooks, and other apparatus) necessary for safe lifting Checklist to confirm proper lubrication and pre-service conditioning of all components.
 - c) Details of the manufacturer's recommended erection procedures.

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- d) Identification of critical fasteners as well as details of procedures for confirming torque and other requirements.
- e) A set of field assembly and installation drawings.
- f) Minimum design requirements for the foundation and anchor system.
- g) A complete wiring and interconnection diagram.

(ii) Operation

- a) Details of safe operating limits.
- b) A description of start and shutdown procedures.
- c) Procedures for functional checks on the protection subsystems.
- d) A description of the subsystems and their operation.

(iii) Inspection and maintenance

- a) Maintenance and inspection cycles and procedures.
- b) A schedule prescribing frequency of lubrication and type of lubricant or any other special fluid.
- c) Procedures for unscheduled maintenance and emergencies.
- d) Schedules for guy inspection and re-tensioning, bolt inspection and torquing (including tension and torque loading details).
- e) Diagnostic procedures and a trouble-shooting guide.

4.2.1.2 Documentation referring specifically to the wind turbine will usually be produced by the wind turbine manufacturer. The installer will make some additions - for example, the wiring and interconnection diagram.

4.2.1.3 System-dependent documentation requirements to be provided include:

- a) $V(\max)$ and $I(\max)$ calculations (see [Section 3.4.1.2 Electrical Requirements](#)).
- b) Battery maintenance schedules (watering, equalisation, etc).
- c) Warranty information.
- d) Noise levels.
- e) Design life of system parts.
- f) A maintenance record sheet.

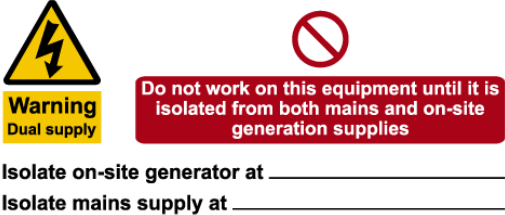


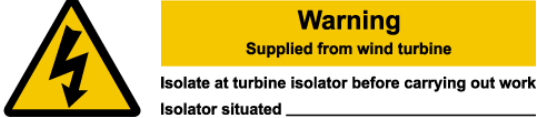
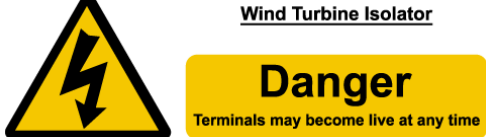


4.2.2 MCS contractors shall label components in accordance with the following (See section 4.2.3 for examples of the labels required):

- a) The isolator enclosure should be clearly labelled "Danger, terminals may come live at any time". The enclosure should bear the label "Wind Turbine Isolator" with the ON and OFF positions clearly marked. All labels shall be clear, easily visible and be constructed and fixed to remain legible and in place throughout the design life of the system..
- b) The junction box shall be labelled "Wind Turbine Junction Box - Danger, terminals may come live at any time". All labels shall be clear, easily visible and be constructed and fixed to remain legible and in place throughout the design life of the system.

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- c) Turbine direct-connect control unit: It shall be labelled "Supplied from wind turbine. Isolate at turbine isolator before carrying out work. Isolator situated"
- d) Turbine battery control unit: It shall be labelled "Supplied from wind turbine. Isolate at turbine isolator before carrying out work. Isolator situated....."
- e) Turbine grid-connect control unit: It shall be labelled "Supplied from wind turbine. Isolate at turbine isolator before carrying out work. Isolator situated....."
- f) Where a wind turbine provides an additional source of supply within a building, circuit protection devices, loads and all points of isolation shall be labelled "Supplied from wind turbine. Isolate at turbine isolator before carrying out work. Isolator situated"
- g) Circuit protection, and all points of isolation shall be labelled with "Supplied from wind turbine. Isolate at turbine isolator before carrying out work. Isolator situated:"
- h) A circuit diagram marked with the contact telephone number for the supplier/installer/maintainer of the equipment shall also be displayed.
- i) All labels shall be clear, easily visible and be constructed and fixed to remain legible and in place throughout the design life of the system.

4.2.3 The list of labels required for a grid connected system are as follows:

Description	Example
<p>Warning: Dual Supply Label</p> <p>Dual supply labelling must be provided at the service termination, meter position and all points of isolation between the small wind turbine system and supplier terminals to indicate the presence of on-site generation and indicating the position of the main A.C. switch disconnecter.</p>	 <p>The example shows a yellow triangular warning sign with a lightning bolt and a red prohibition sign. Below the signs are two labels: a yellow 'Warning Dual supply' label and a red 'Do not work on this equipment until it is isolated from both mains and on-site generation supplies' label. Below these are two lines of text: 'Isolate on-site generator at _____' and 'Isolate mains supply at _____'.</p>
<p>Warning: Inverter Label</p> <p>In addition to an inverter warning label best practice is also to supply label that reads: "not to block ventilation", to be placed next to the inverter to ensure the customer does not block the vents of the inverter. This can cause a loss in system performance as the inverter will de-rate when it reaches maximum operating temperature.</p>	 <p>The example shows a yellow triangular warning sign with a lightning bolt and a yellow rectangular label with the text: 'Inverter Warning Dual Supply Isolate both A.C. and D.C. before carrying out work'.</p>
<p>Danger: Do Not Disconnect D.C. Plugs Label</p> <p>Connectors readily accessible to ordinary persons shall be of the locking type, requiring a tool or two separate actions to separate and shall have a label attached that reads: 'Do not disconnect D.C. plugs and sockets under load'. Turn off A.C. supply first.</p>	 <p>The example shows a yellow triangular warning sign with a lightning bolt and a red prohibition sign. Below the signs is a yellow rectangular label with the text: 'Danger Do not disconnect D.C. plugs and sockets under load Turn off A.C. supply first'.</p>
<p>Warning: Supplied from Wind Turbine Label</p> <p>Attach label to all equipment directly supplied by the small wind turbine.</p>	 <p>The example shows a yellow triangular warning sign with a lightning bolt and a yellow rectangular label with the text: 'Warning Supplied from wind turbine Isolate at turbine isolator before carrying out work Isolator situated _____'.</p>
<p>Danger: Wind Turbine Isolator Label</p> <p>Attach label to wind turbine output isolator enclosure.</p>	 <p>The example shows a yellow triangular warning sign with a lightning bolt and a yellow rectangular label with the text: 'Wind Turbine Isolator Danger Terminals may become live at any time'.</p>
<p>Danger: Wind Turbine Junction Box Label</p> <p>Attach label to all wind turbine output cable junction boxes.</p>	 <p>The example shows a yellow triangular warning sign with a lightning bolt and a yellow rectangular label with the text: 'Wind Turbine Junction Box Danger Terminals may become live at any time'.</p>
<p>Warning: Wind System Point of Emergency Isolation Label</p> <p>For use on all A.C. switches/disconnects. Note: ON and OFF positions should be clearly labelled.</p>	 <p>The example shows a blue circular warning sign with a white exclamation mark and a blue rectangular label with the text: 'Wind System Point of emergency isolation'.</p>
<p>Wind System Generation Meter Label</p> <p>To identify the wind system generation meter.</p>	<p><u>Wind System Generation Meter</u></p>

At the interconnection point, the following shall also be displayed:

- Circuit diagram.
- Summary of protection settings that have been incorporated in the equipment.
- A contact telephone number for the supplier/installer/maintainer of the equipment.

All labels shall be clear, easily visible and be constructed and fixed to remain legible and in place throughout the design life of the system.

5 PUBLICATIONS, REFERENCE, & FURTHER READING

The lists below are provided so that MCS Contractors know which documents have been used as a basis for the development of the requirements of this MIS Standard and they are able to further research topics if they need to do so.

Document Reference	Document Title	Edition/ Date of Publication	Available From
BS 7671: 2018	Requirements for Electrical Installations (IET Wiring Regulations Eighteenth Edition).	18 th Edition 2 nd July 2018	British Standards Institution (BSI): www.bsi-global.com or The Institution of Engineering and Technology (IET) ISBN 978 1785 61170 4
ISBN-13: 978-1-78561-966-3	Code of Practice for In-service Inspection and Testing of Electrical Equipment.	5 th Edition 2020	https://electrical.theiet.org/guidance-codes-of-practice/
BS EN 61400-2:2014 (IEC 61400-2:2013)	Wind Turbines – Part 2: Small Wind Turbines.	October 2014 Incorporating corrigendum October 2019	British Standards Institution (BSI): https://shop.bsigroup.com/ProductDetail?pid=0000000000030404669 ISBN 978 0 539 06899 3
EREC G98	ENA Engineering Recommendation G98. Requirements for the connection of Fully Type Tested Micro-generators (up to and including 16A per phase) in parallel with public Low Voltage Distribution Networks on or after 27April 2019.	Issue 1 Amendment 4 04/06/2019	https://www.energynetworks.org/assets/images/Resource%20library/ENA_EREC_G98_Issue_1_Amendment_4_(2019).pdf
EREC G99	ENA Engineering Recommendation G99 Requirements for the connection of generation equipment in parallel with public distribution networks	Issue 1 Amendment 6 10/03/2020	https://www.energynetworks.org/assets/images/Resource%20library/ENA_EREC_G99_Issue_1_Amendment_6_(2020).pdf

Document Reference	Document Title	Edition/ Date of Publication	Available From
	on or after 27 April 2019.		
EREC G100	ENA Engineering Recommendation G100 Technical Requirements for Customer Export Limiting Schemes	May 2018	https://www.energynetworks.org/assets/images/Resource%20library/ENA EREC G100_Issue_1_Amendment_2_(2018).pdf
MCS 020	MCS Planning Standards for Permitted Development Installations of Wind Turbines and Air Source Heat Pumps on Domestic premises.	Issue 1.3 01/05/2015	https://mcscertified.com/wp-content/uploads/2019/07/MCS-020.pdf

Document Reference	Document Title	Edition/ Date of Publication	Available From
ISBN-13: 978-1-83953-041-8	Code of Practice for Electrical Energy Storage Systems.	2 nd Edition 2020	https://electrical.theiet.org/guidance-codes-of-practice/
ISBN-13: 978-1-83953-017-3	Guide to Cables and Cable Management.	2020	https://electrical.theiet.org/guidance-codes-of-practice/
ETSI EN 303 645	ETSI Technical Specification 103 645 Cyber Security for Consumer Internet of Things.	V2.1.2 June 2020	https://www.etsi.org/deliver/etsi_ts/103600_103699/103645/02_01_02_60/ts_103645v02_0102p.pdf ISBN 978-92-9204-236-3
BS 8004: 2015+A1: 2020	Code of practice for foundations.	30/06/2015	https://shop.bsigroup.com/ProductDetail?pid=0000000000030403579 ISBN 978 0 539 06626 5
BS EN 1992-1-1:2004 +A1:2014	Eurocode 2: Design of concrete structures. General rules and rules for buildings.	23/12/2004	https://shop.bsigroup.com/ProductDetail/?pid=0000000000030286962 ISBN 978 0 580 83726 5
BS EN 62305 - 2:2012	Protection against lightning. Risk management.	30/04/2013	https://shop.bsigroup.com/ProductDetail/?pid=0000000000030174634 ISBN 978 0 580 61193 3

Document Reference	Document Title	Edition/ Date of Publication	Available From
BS EN IEC 62485-1:2018	Safety requirements for secondary batteries and battery installations. General safety information.	25/05/2018	https://shop.bsigroup.com/ProductDetail/?pid=0000000000030369834 ISBN 978 0 580 52171 3
BS EN 60947-3 18/30361074 DC	Low-voltage switchgear and controlgear - Part 3 switches, disconnectors, switch-disconnectors, and fuse-combination units.	13/04/2018 Current, Draft for public comment.	https://shop.bsigroup.com/ProductDetail?pid=0000000000030361074
UK Statutory Instruments 1999 No. 3242 2006 No. 438	The Management of Health and Safety at Work Regulations 1999. And as amended in 2006.	No. 3242 1999 No. 438 2006	https://www.legislation.gov.uk/ukSI/1999/3242/contents/made ISBN 978 0 110 85625 4 https://www.legislation.gov.uk/ukSI/2006/438/contents/made
HSR25 (Third edition) UK Statutory Instruments 1989 No. 635	The Electricity at Work Regulations 1989.	HSR25 (Third edition) Published 2015.	https://www.hse.gov.uk/pubns/books/hsr25.htm ISBN 978 0 7176 6636 2
BS EN IEC 60900:2018	Live Working. Hand tools for use up to 1 000 V AC and 1 500 V DC.	August 2018	https://shop.bsigroup.com/ProductDetail?pid=0000000000030392368 ISBN 978 0 539 04072 2
BS EN IEC 60934:2019	Circuit breakers for equipment (CBE).	September 2019	https://shop.bsigroup.com/ProductDetail/?pid=0000000000030338982 ISBN 978 0 580 93657 9
HSWA	Health & Safety at Work etc. Act 1974.	C 37 1974	https://www.legislation.gov.uk/ukpga/1974/37/contents ISBN 978 0 105 43774 1
UK Statutory Instruments 2002 No. 2665	Electrical Safety, Quality and Continuity Regulations 2002	24/10/2002	https://www.legislation.gov.uk/ukSI/2002/2665/pdfs/ukSI_20022665_en.pdf ISBN 978 0 110 42920 5
BS EN 17037:2018	Daylight in Buildings	May 2019	https://shop.bsigroup.com/ProductDetail/?pid=0000000000030342286

Document Reference	Document Title	Edition/ Date of Publication	Available From
			ISBN 978 0 580 94420 8
	Mathematical Model of the Structure of Strong Winds Harris R I & Deaves D M	May 1978	ISBN 978 0 860 17086 0
	Ofgem document: Guidance for Generators: Co-location of electricity storage facilities with renewable generation supported under the Renewables Obligation or Feed In Tariff schemes	17/07/2020	https://www.ofgem.gov.uk/system/files/docs/2020/07/storage_guidance.pdf
Global Wind Atlas (GWA)	GWA	Last updated April 2021	https://globalwindatlas.info/

APPENDIX A – DETAILED ASSESSMENT OF SHADOW & FLICKER

A.1 SHADOW FLICKER

Northern Ireland’s Best Practice Guidance to Planning Policy Statement (PPS18 2009) suggests that “problems caused by shadow flicker are rare”.

Under certain combinations of geographical position and time of day, the sun may pass behind the rotors of a wind turbine and cast a shadow over neighbouring properties. When the blades rotate, the shadow flicks on and off; the effect is known as 'shadow flicker'.

For a person in a property to experience flickering from a wind turbine the property would need to have a narrow window facing a wind turbine. The sun would need to be relatively low in the sky and be behind the tower. The turbine nacelle would need to be facing a certain direction so that the turbine blades were turning and casting the shadow in the direction of the property. Any flicker effect would only last while the sun is behind the tower and while the nacelle was facing in that one direction.

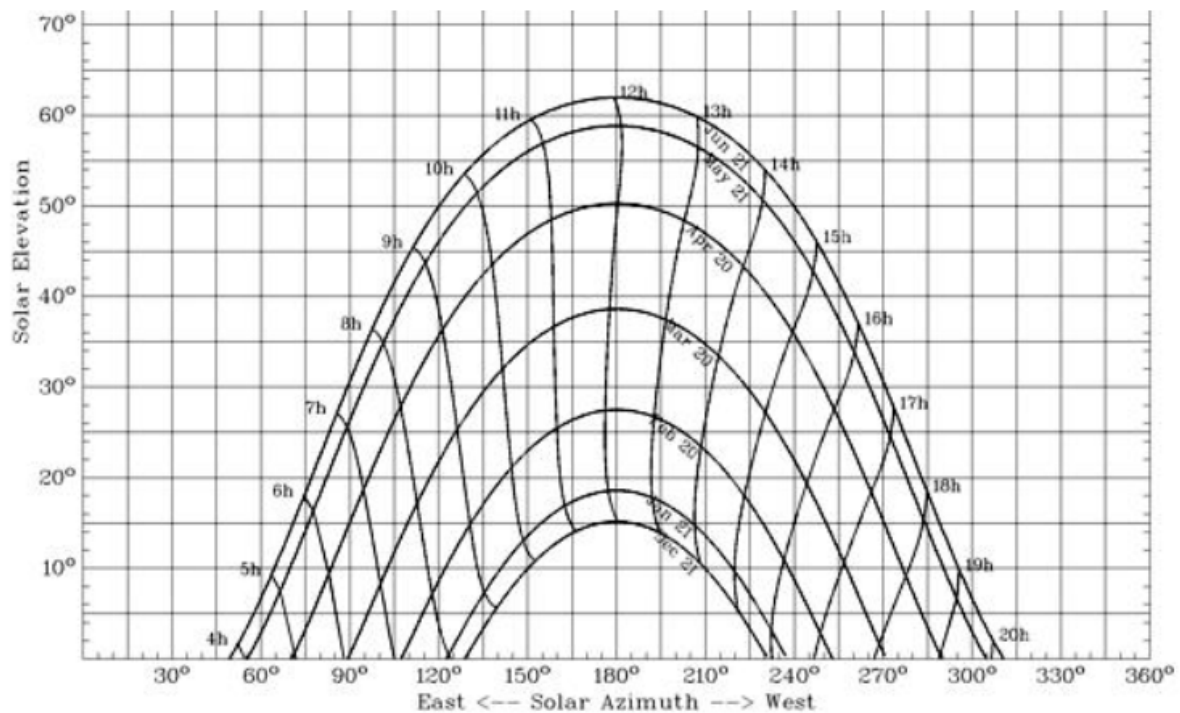
The seasonal duration of this effect can be calculated from the geometry of the machine and the latitude of the site. A single window in a single building is only likely to be affected for a few minutes at certain times of the day during short periods of the year.

The likelihood of this occurring and the duration of such an effect depends upon:

1. The direction of the residence relative to the turbine.
2. The distance from the turbine.
3. The turbine hub-height and rotor diameter.
4. The time of year.
5. The frequency of bright sunshine and cloudless skies (particularly at low elevations above the horizon).
6. The prevailing wind direction.
7. Any obstructions in the relevant direction.

In the UK it is only true for the equinoxes (Mar 21, Sept 21) that the sun rises in the East and sets in the West. During the summer, the sun rises North of East and sets North of West; in winter it rises South of East and sets South of West.

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The sun path vertical projection diagram shows the sun path monthly, and the maximum and minimum annual declination for London.

A turbine mounted at +/-45degrees from North will never cast a shadow on to the observer. Even within the potential shadow region the following shall be considered:

1. Is there a window facing that direction? A single window in a single building is only likely to be affected for a few minutes at certain times of the day during short periods of the year.
2. Will anyone be awake (or in the office)? The sun path diagram can be examined and may show any potential flicker could be occurring at 5am

The further the observer is from the turbine the less pronounced the effect will be. There are several reasons for this:

1. There are fewer times when the sun is low enough to cast a long shadow.
2. When the sun is low it is more likely to be obscured by either cloud on the horizon or intervening buildings and vegetation.
3. The centre of the rotor's shadow passes more quickly over the land reducing the duration of the effect.

Even if the potential for flicker is considered in "greenhouse mode" i.e., an open aspect in all directions, the size of small turbines means that flicker will be imperceptible at distances greater than 10 times the diameter of the turbine.

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At closer distances, the sun will still pass through the rotor area very rapidly meaning any potential flicker will be for a noticeably short period.

To estimate the number of hours where both the wind is blowing, and the sun is shining a calculation is made. This calculation is termed “the de-rating factor”. To determine the de-rating factor, historical meteorological data are used. In the UK, the number of hours where both the wind is blowing, and the sun shining is typically only 30% of daylight hours.

A.2 PHOTSENSITIVE EPILEPSY

Causes of photosensitive epilepsy are numerous; it is much more complex than simply flickering light.

About 1% of the population suffer one or more epileptic fits during their lifetime. Of those only about 4% suffer with epileptic fits that are triggered by photosensitivity. This equates to approx. 23,200 people in the UK, or 0.04% of the population. A town of 80,000 people will have approx. 32 people at risk.

For a wind turbine to present a potential hazard to someone who is at risk from photosensitive epilepsy, all the following shall be true:

1. The wind shall be blowing and in the right direction.
2. The sun shall be shining.
3. The observer shall be within the flickering light field
4. A large percentage of the individual’s visual cortex shall be stimulated [over 25%]
5. The rotor shall be spinning at a speed that affects the specific photosensitive range of the observer.
6. The rotor spinning speed shall stay in the specific range long enough to trigger a reaction.
7. The background illumination shall be low
8. The contrast between shadow and light shall be high
9. The colour spectrum of the light shall be in the correct range to affect the individual
10. There shall be nothing blocking out the flickering light, such as blinds or a tree outside the window.
11. The individual does nothing to remove themselves from the flicker light source before it begins to affect them.

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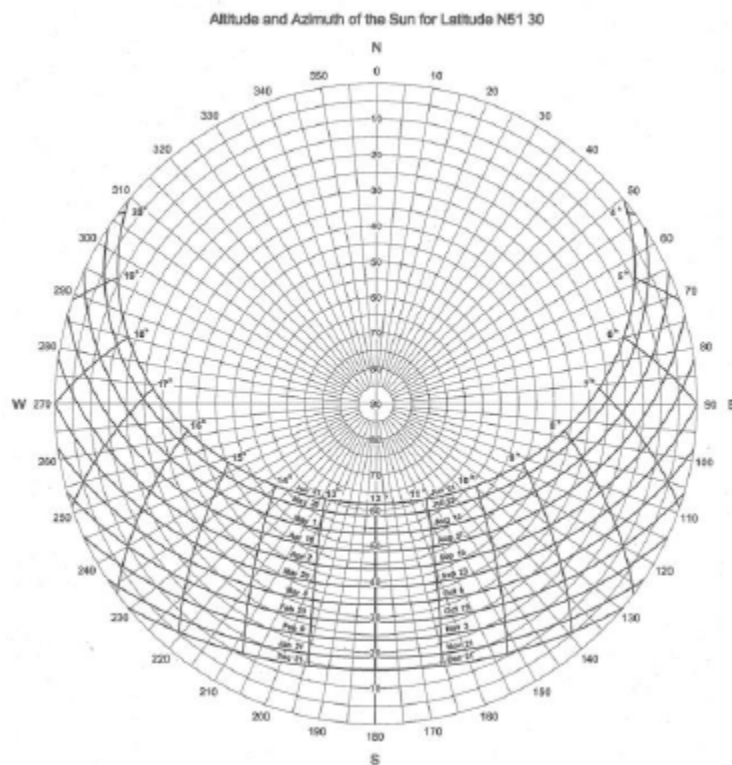
A.3 MITIGATION

Shadow flicker effects on properties are very rare and, due to their rotor size, will be even rarer with small wind turbines.

A rule of thumb has been adopted that 30 hours of shadow flicker per year is acceptable¹. This is based on those times being when:

1. The building affected is likely to be occupied
2. The occupants are likely to be awake

The size of small turbines means that flicker will be imperceptible at distances greater than 10 times diameter and unlikely to be of concern at greater than 5 times diameter. However, if nuisance occurs; a sensor can be retrofitted which shuts down the wind turbine on the rare occasion the sun and wind direction conditions both occur at the appropriate time.



¹ The only known shadow flicker regulation to date was enacted in Germany, where a court ruled that the maximum allowable flicker would be 30 hours per year (Klepinger, 2007). In addition, Dobesch and Kury (2001) recommended that shadow flicker should not exceed 30 hours per year, and the guidelines for wind power development in the State of Victoria, Australia state that shadow flicker may not exceed 30 hours per year at any dwelling in the surrounding area (Sustainable Energy Authority Victoria, 2003).

A.4 SUN PATH DIAGRAMS FOR SHADOW FLICKER

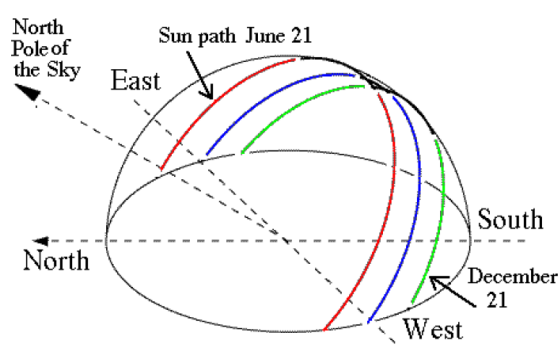
Ref: BS EN 17037:2018 Daylight in Buildings, which contains sun path diagrams for London. The diagrams are all correct for solar time. In London this is the same as GMT, but it will vary across the width of the UK.

In all cases the diagrams are assuming the observer is at ground level. Upstairs windows and turbines on roofs are more difficult to evaluate.

Shadow flicker evaluation programs:

<http://solardat.uoregon.edu/SunChartProgram.html>

<http://www.satel-light.com/core.htm>



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APPENDIX B – INSTALLATION & COMMISSIONING INSPECTION CHECKLIST

Description of System	<i>(type of turbine and rating, generator, stand alone/grid connected - if stand alone what is the main use of energy, any special features)</i>	
Check Required	Yes	No
Turbine Siting		
Is the turbine generally in a safe location (e.g. without hazard to nearby buildings and structures)?		
Has the recommended safe distance (3m) for exposed moving parts been adhered to?		
Turbine Support Structure and Sitework		
Has turbine support structure wind loading been appropriately calculated?		
Are foundations appropriate to turbine & tower?		
Are foundations appropriately sized using appropriate materials?		
Are foundations protected from water pooling?		
Are turbine support structure fixings secure?		
Are all guy shackles and turnbuckles secured?		
Are guy anchors suitable?		
Is the turbine support structure protected against climbing?		
Is lowering equipment suitable and properly stored?		
Turbine Installation		
Is the turbine installed to manufacturers' instructions?		
Is the turbine brake system working?		
Are turbine speed and vibration levels acceptable?		
Output Cables		
Are cable sizing calculations provided by the installer?		
Are cables sized to provide voltage drop of <4%?		
If not, has this been justified?		
Are the cables of suitable current rating?		
Are the cables suitable for installation method (e.g. armoured, water resistant, UV stable)?		
Are the cables professionally installed and fixed with safe routeing (e.g. at sufficient distance from heat sources and sharp surfaces/edges)?		
Are turbine electrical connections sound and weatherproof?		
Turbine Isolator		
Is the isolator correctly rated?		
Is the isolator installed correctly and all electrical connections secure?		
Are all labels in place?		
Turbine Junction Box(es) if Appropriate/Applicable		
Is the junction box installed correctly and electrical connections secure?		

Check Required	Yes	No
Is the junction box in suitable location, appropriate boxing (IP rating should be noted on documentation)?		
Are all labels in place?		
Earthing and Lightning Protection		
Is the turbine support structure earth correctly installed?		
Is lightning/surge protection correctly installed, if required?		
Turbine Metering		
Is the metering system installed correctly and are all electrical connections secure?		
Has the metering system been explained to the customer?		
Turbine Controller		
Is the control unit suitably rated for current and voltage?		
Is the controller installed correctly and all electrical connections secure?		
Is the controller in a suitable location, with appropriate boxing (IP rating should be noted on documentation)?		
Is any controller requiring heat dissipation suitably ventilated and mounted appropriately?		
Are all appropriate labels in place?		
Documentation		
Has an Operation & Maintenance manual been supplied including problem diagnostics, contact details, maintenance schedule/record sheet, etc?		
Has an Operation & Maintenance manual been supplied including (where relevant) documented procedures for stopping turbine and lowering tower safely, battery maintenance?		
Have manuals for all specific equipment been passed to the customer (including controller, inverter, etc, as appropriate)?		
Has all warranty information been passed to the customer, including system and all parts i.e. turbine, wiring, inverter/batteries?		
Has information on the system design been supplied to the customer, e.g. V(max), I(max), noise levels, electrical schematics and site layout / civil works drawings, design life of system parts?		
Has the installation certificate & test sheet (BS 7671) been supplied (as appropriate)?		
Grid-connected systems only: Has signed approval from DNO been passed to the customer?		
Grid-connected systems only: Has a printout of protection settings been supplied?		

Direct-connected Systems		
Check Required	Yes	No
General Design		
Is the load suitable for intermittent operation and direct connection?		
Are the turbine voltage and current maxima within load limits?		
Is the controller suitable for application?		
Installation		

Check Required	Yes	No
Are the dump heaters suitably mounted to prevent fire/burns and installed with high temperature cables?		
Are suitable fuses/isolation installed?		
Labelling/Signage		
Are loads, fuses and points of isolation labelled?		
Are the system schematic and installer's contact details displayed?		
Are all signs suitably fixed and durable?		

Battery Systems		
Check Required	Yes	No
General Design		
Is battery over-current protection provided within the design?		
Is manual isolation of the battery (battery disconnect) provided within the design?		
Battery Specification		
Has the battery manufacturer been contacted or their data reviewed for system recommended charge rates?		
Installation		
Is battery isolation installed such that turbine cannot directly feed the loads when the battery is disconnected?		
Is the battery in a secure, vented, and appropriate location?		
Is the battery housed suitably and terminals protected?		
Are all the cables to the battery fused, with fuses as close as practicable to the battery?		
Are battery fuses rated for D.C.?		
Is the fuse rating less than (de-rated) cable rating?		
No fuse in common between wind turbine and D.C. load (Where D.C. loads used)?		
Are inverter and controls suitably housed, mounted and ventilated?		
Are D.C. cables sized for safety and voltage drop (particularly inverter cables)?		
Are D.C. cables safely installed/routed?		
Is A.C. wiring to BS 7671?		
Is there an isolator between battery and controller/inverter?		
Are battery voltage and turbine output meters installed and visible?		
Are dump heaters suitably mounted to prevent fire/burns and installed with high temperature cables?		
Labelling/Signage		
Are all battery installation labels present (no smoking etc)?		
Are fuses and points of isolation labelled?		
Are the system schematic and installer's contact details displayed?		
Are all signs suitably fixed and durable?		

Grid-connected Systems		
Check Required	Yes	No
General Design		
Is the inverter suitably sized?		
Does the inverter carry a current Engineering Recommendation (EREC) G98/1 Type Test certificate or has agreement been reached, in writing, with DNO?		
Installation		
Is the inverter suitably installed for heat dissipation?		
Is there a local A.C. isolator (double-pole) installed adjacent to the inverter?		
Is there a double-pole A.C. isolator (lockable in the off position only) installed adjacent to at the point of interconnection with the supply?		
Is A.C. cable suitably specified and installed in accordance with BS 7671 and suitably sized (calculations provided by installer)?		
Is cabling suitably selected and secured/routed?		
Is suitable A.C. fault current protection provided at the distribution board (specified and installed in accordance with BS 7671)?		
Labelling/Signage		
Are dual supply notices installed at the service termination, meter position and all points of isolation?		
Is the point of A.C. isolation suitably labelled?		
Is a system schematic displayed?		
Are protection settings and installer's contact details displayed?		
Are all signs suitably fixed and durable?		
Has disconnection if grid fails been checked?		

Comments

Sign Off	
MCS Contractor Company Name	
Certification Number	
MCS Contractor Signature	<i>MCS Contractor Signature here</i>
Print Name	<i>Print Name here</i>
Job Title/Position	
Contact Telephone Number	
Contact Email Address	
Date	

APPENDIX C – SYSTEM SITING & SIZING GUIDANCE

C1. The following factors shall be considered when siting and sizing a small wind turbine and subsequently estimating the annual energy performance (as defined in MCS 033):

a) Wind Direction: A turbine should be exposed to prevailing winds, i.e., the direction with the best overall combination of frequency and strength. In most UK locations, the prevailing winds come from the southwest.

b) Obstructions/Obstacles: wind speed increases with height as the ground and objects close to it disrupt air flow. The 'roughness' of the ground is a measure of the way obstacles such as trees, buildings, and the surface topography act to effectively slow down the wind.

c) Turbulence: the flow of the wind is disrupted when it passes over or around objects, so a turbine should be sited to minimise the influence of obstacles (ideally from all directions). Excessive turbulence may also cause fatigue and shorten a turbine's life.

d) Tower Height: while greater height will increase energy output (higher wind speed and less turbulence, especially at sites of greater roughness), practical considerations such as cost, and ease of lowering (for maintenance) also need to be taken into account. See Figure 1 below, which illustrates that the turbine should be sited well clear of obstructions and obstacles.

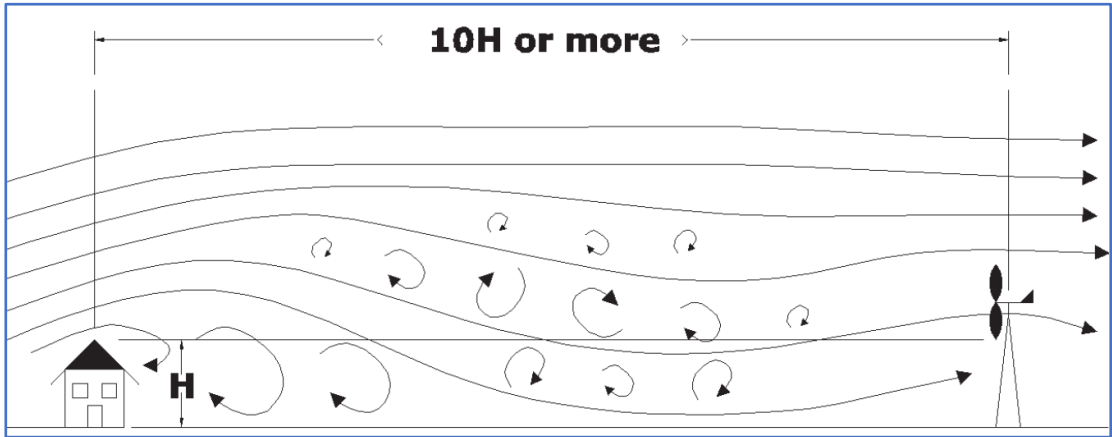


Figure 1: Impact of Siting the Turbine Clear of Obstructions & Obstacles.

e) Shadow and Flicker: Small wind turbines shall **not** be located or mounted in such a way as to cause unacceptable levels of flickering shadows. See Section 3.5.4.3 for further details and Appendix A for a detailed assessment of shadow and flicker.

f) System Losses: Losses from cables, batteries, conversion in an inverter, etc, will all result in a reduction of overall energy output. Such losses occur in any energy production process.

g) Practical issues: The ideal site for a wind turbine is on a smooth, rounded, and exposed hill-top or rise; one clear of any cliff faces and many metres from obstructions such as trees and buildings. In practice this very rarely happens. A wind turbine needs to be reasonably close to the point of energy use, or to an electricity connection. Otherwise, the cost of underground cabling may prove excessive. Location may also be limited by factors such as land ownership. The key point is to keep the turbine clear of large

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obstructions and obstacles, particularly in the path of the prevailing wind. This should take account of possible future obstructions such as tree growth.

Note: See also Section 3.5.4 for additional site-specific issues.

C2. Airspace guidance

C2.2 It is recommended to use free Civil Aviation Authority (CAA) airspace guidance tools to assist in determining areas, flight paths and airfields to avoid when siting the turbine. These can include Drone Assist and Altitude Angel tools.

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APPENDIX D – SITE SURVEY FORM

The suitability of a site shall be assessed by a competent person experienced in small wind turbines, using a site survey form including at least the details given in this section.

The site survey form used by the MCS contractor, prior to the preparation of a quotation, shall include at least the following elements:

1. Customer’s name, address, and contact details.
2. Site address, grid reference and site usage (e.g., residential, agricultural, commercial, school etc.).
3. Client expressed preferences, where applicable, to include:
 - Make / model of wind turbine.
 - Electrical connection type (grid connect, battery charging etc.).
 - Location on site.
 - Comment regarding limitations of client preferences as discussed with the client.
4. An assessment of the wind resource to include:
 - Average wind speed according to the [Gobal Wind Atlas \(GWA\)](#) for the height above ground nearest to the proposed hub height (10m or 25m).
 - Appropriate highest class of wind turbine in accordance with EN 61400-2, from the following table:

Class	I	II	III	IV
V _{ave} (m/s)	10	8.5	7.5	6

Note: V_{ave} is the average annual wind speed at hub height and the highest class means a Class I would be suitable for all sites but Class III would not be suitable where the average annual wind speed is likely to be greater than 7.5 m/s. Please refer to EN 61400-2 for the full table of information.

- Prevailing wind direction or wind rose.
- Details and distances to any obstructions to the wind.

5. An assessment of the site for mechanical installation to include:
 - Full details of ground conditions, cable distances and necessary types (e.g., armoured for buried cable runs).

6. An assessment of the electrical systems to include:

- Method of connection to consumer unit (e.g., need for a dedicated fuseway).
- Earth testing.
- Proposed location of inverter.
- Metering arrangements (location, meter type).
- Details of electricity supplier and network operator.

7. Planning considerations

- Proximity of proposed location to nearby residents and assessment of potential nuisance from noise or flicker.
- Details of listed buildings or if conservation area.
- Ecology (e.g., impact on bats' roost, flora and fauna).

8. Health and Safety considerations necessary for a risk assessment to include:

- Access arrangements for working at height.
- Electrical hazards such as live overhead cables.
- Underground utilities (e.g., gas, electric, water, telephone).
- Details of public access and any congregation zones.
- Locations of any flues serving fuel burning equipment.

9. A place for both the surveyor and the customer to sign off the document.

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