Appendix 5:

MCS Solar Shade Evaluation Procedure

GUIDANCE DOCUMENT

MGD 005 ISSUE 1.0

Solar PV Shade Evaluation Procedure

A method to determine Shade Factor

This document was prepared by the MCS Working Group 2: Solar PV Systems.

It is published by The MCS Service Company Ltd.

The MCS Service Company Ltd welcomes comments of a technical or editorial nature and these should be sent to *meetings@mcscertified.com*

The MCS Service Company Ltd
Innovation Centre,
Sci-Tech Daresbury,
Keckwick Lane,
Cheshire WA4 4FS

www.mcscertified.com
hello@mcscertified.com
0333 103 8130

ABOUT MCS

Giving you 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.

We're here to ensure it's a positive one.

Working with industry we define, maintain and improve quality – certifying products and installers so people can have confidence in the low-carbon technology they invest in. From solar and wind, to heat pumps, biomass and battery storage, we want to inspire a new generation of home-grown energy, fit for the needs of every UK home and community.

About

The Microgeneration Certification Scheme Service Company Ltd (MCSSCo Ltd) trades as MCS and is wholly owned by the non-profit MCS Charitable Foundation. Since 2007, MCS has become the recognised Standard for UK products and their installation in the small-scale renewables sector.

We create and maintain standards that allow for the certification of products, installers and their installations. Associated with these standards is the certification scheme, run on behalf of MCS by Certification Bodies who hold UKAS accreditation to ISO 17065.

MCS certifies low-carbon products and installations used to produce electricity and heat from renewable sources. It is a mark of quality. Membership of MCS demonstrates adherence to these recognised industry standards; highlighting quality, competency and compliance.

Vision

To see MCS certified products and installations in every UK home and community.

Mission

To give people confidence in low-carbon energy technology by defining, maintaining and improving quality.

Values

1. We are expert – ensuring quality through robust technical knowledge
2. We are inspiring – helping to reshape energy in UK homes and communities
3. We are collaborative – working with industry and government to create positive change
4. We are principled – operating in a way that's clear, open and fair
5. We are determined – supporting the UK's drive towards a clean energy future

TABLE OF CONTENTS

1 INTRODUCTION & PURPOSE

This is a guidance document. It is neither a mandatory MCS requirement, nor contains mandatory requirements, unless expressly stated as such in an MCS installation standard (MIS) using the words "should" or "shall" in the refence to MGD 005 or its clauses.

The purpose of this document is to describe a procedure to assess the potential impact of shading on a solar Photovoltaic array as a result of both near and far objects. The result is a shade factor (SF) which can be used to modify the amount of electricity that it is predicted might be generated by a proposed solar photovoltaic (PV) system.

This procedure has been designed to provide a simplified and standardised approach for MCS contractors to use when estimating the impact of shade on system performance. It is not intended to be as accurate as more sophisticated methods such as, for example, those included in proprietary software packages. It is estimated that this shade assessment method will yield results within 10% of the actual annual energy yield for most systems. Unusual systems or environments may produce different results.

Where the proposed location for the PV array is subject to significant shading from numerous objects, and making assessment difficult, then installation in that location may simply not be appropriate and the customer should be advised. Near shading especially will have a considerable effect on system performance and should be avoided. Solar PV systems should not be sold where the impact of shade could be severe.

Module level power electronics can also be considered to reduce the impact from shading although this shade evaluation procedure does not account for the benefit of such devices because of the variability between projects. Proprietary software can be used to model shade both with and without module level power electronics.

HEALTH WARNING

This evaluation method implies the need to undertake assessment at height which can be very dangerous. In most cases it should be possible to follow the method without climbing on roofs provided you can be confident the result is representative.

Where users of this method decide working at height is necessary then all appropriate precautions should be taken to reduce the risk of death or injury from falling.

2 SHADE EVALUATION PROCEDURE

Where there is a potential for shading from objects further than 10m away from the centre midpoint of the array then the procedure given in clause 2.1 shall be used.

Where there are objects at or less than 10m away (near shade) from the centre midpoint of the array then the procedure stated in clause 2.2 shall be used.

Assessment shall be undertaken and recorded using the Sunpath chart given in Appendix B to represent the potential irradiance which could be blocked by objects on the horizon at differing times of the day and of the year (as indicated by the different arcs).

Note: where manipulating or drawing on the Sunpath chart on a computer it is important the proportions of the chart are not distorted.

2.1 OBJECTS FURTHER THAN 10M

<u>Principles</u>

The chart has a total of 84 segments each of which has a value of 0.01.

By marking objects on the horizon according to their height and orientation in relation to the proposed array the segments that are touched are then counted to derive the Shade Factor

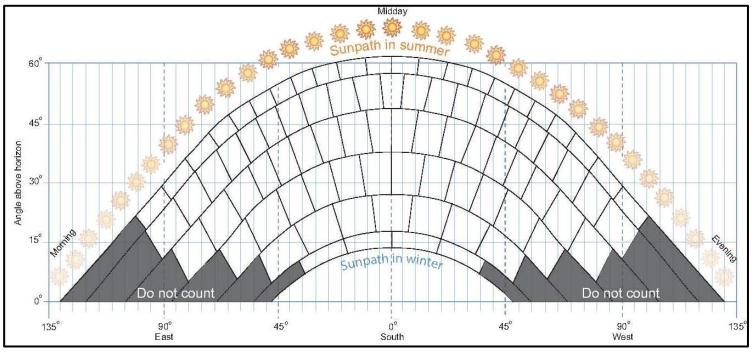


Figure 1: Sunpath chart showing segments

<u>Location</u>

Stand as near as possible to the base and centre of the proposed array, e.g. through an upstairs window, unless there is shading from objects within 10m (e.g. aerials, chimneys, etc.) in which case follow the procedure given later.

<u>Tools</u>

As a minimum the tools required to undertake this analysis are a compass and a device to measure the elevation of obstacles on the horizon such as an inclinometer.

Other more sophisticated tools can be used, and a selection are discussed in Appendix A

<u>Detailed Method</u>

Looking due South (irrespective of the orientation of the array), draw a line showing the uppermost edge of any objects that are visible on the horizon (either near or far) onto the Sunpath chart.

This line is called the "horizon line", an example of which is shown here:

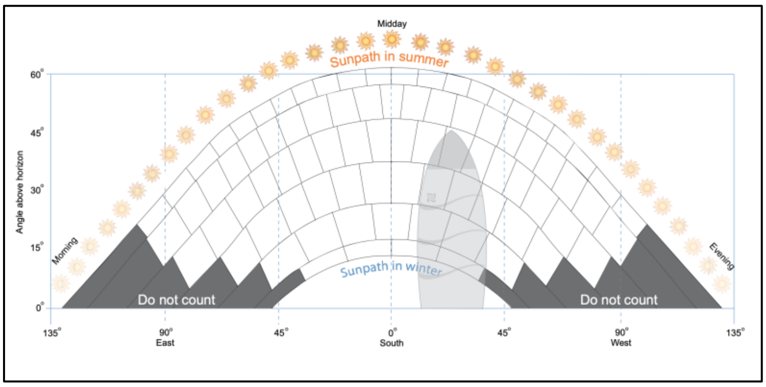


Figure 2: Sunpath Chart with object on the horizon

Once the horizon line has been drawn, the number of segments that have been touched by the line, or that fall under the horizon line shall be counted, in the following example you can see there are 11 segments covered or touched by the horizon line.

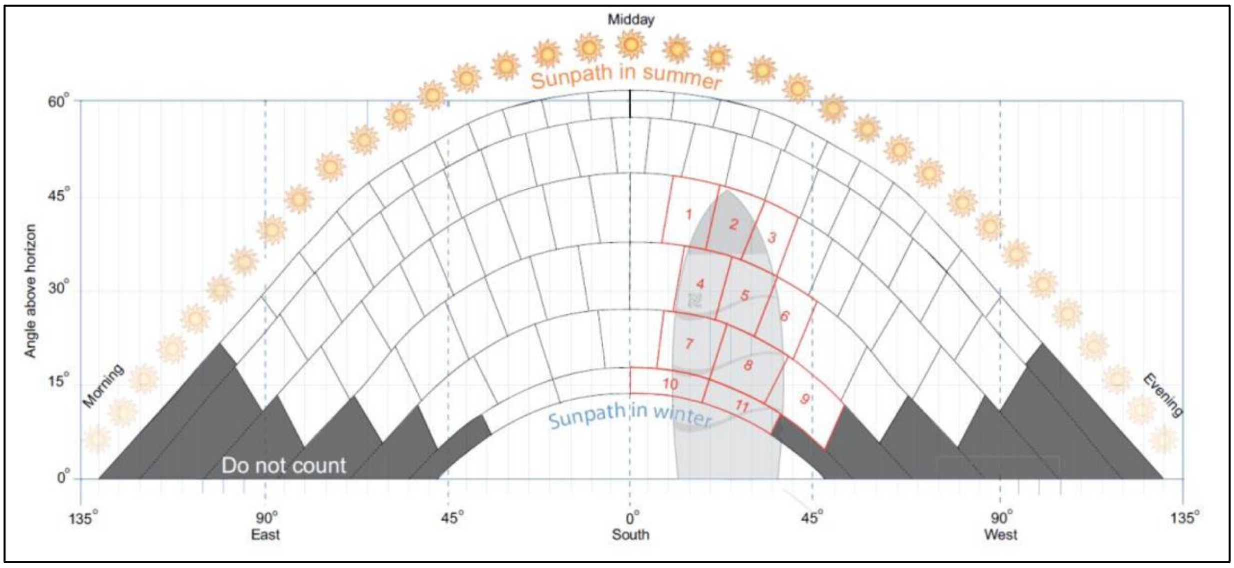


Figure 3: Sunpath chart showing segments affected and counted

In Figure 3 the total number of affected segments is 11. This number is then multiplied by their value for each segment (0.01) and the total deducted from 1 to arrive at the Shading Factor (SF) for the proposed installation. In this example the shading factor is calculated as follows:

1 - (11*0.01) = 1 – 0.11 = 0.89

Notes:

Printing the Sunpath chart onto paper to hold at arm's length and sketching the horizon will not produce a valid result.

For systems connected to module level optimisers, multiple inverters, or a single inverter with multiple independent maximum power-point trackers (MPPT), it is acceptable to do a separate calculation of SF for each sub array (each array connected to a dedicated MPPT).

2.2 OBJECTS AT, OR LESS THAN, 10M

Principles

Shading from objects close to the array (for example: vent pipes, chimneys, and satellite dishes located to the East, South, or West) can have a very significant impact on the performance of PV systems. This is because near objects cast larger shadows, and for more hours of the day, than objects further away. Objects located behind the proposed array (e.g. to the North) do not need to be considered as they will cast little, if any, shadow.

To reflect this greater impact the method counts all segments affected within a circle with a radius equal to the height of any object casting a shadow.

Where such shading is apparent, it is strongly recommended that either the array should be repositioned away from the objects casting a shadow, or the object(s) casting the shadow should be removed altogether. Then there would be no need to use this method.

A further option would to perform a series of calculations and measurements that would allow you to create a chart representative of the shadows cast by objects.

Where the installation is still to proceed, and **only when all other options have been discounted**, then the following method should be used.

Location

The reading should be taken from the array location worse affected by shade. This will usually mean a location just South of the object casting a shadow.

Tools

The same tools should be used as described previously. Additionally, a working platform should be erected or, if a roof is to be accessed only with a ladder, then fall arrest equipment should be used.

Other more sophisticated tools can be used, and a selection are discussed in Appendix A

Detailed Method

Looking due South, a standard horizon line, as described in clause 2.1, should be drawn onto the Sunpath chart.

Objects on the horizon that are 10m or closer to any part of the array, shall have a shade circle added to the chart. Where there are multiple objects within 10m, then multiple circles shall be drawn – one for each object.

The shade circle shall have a radius equal to the height of the object. The shade circle should be located so that the apex of the circle sits on the highest point of the shade object.

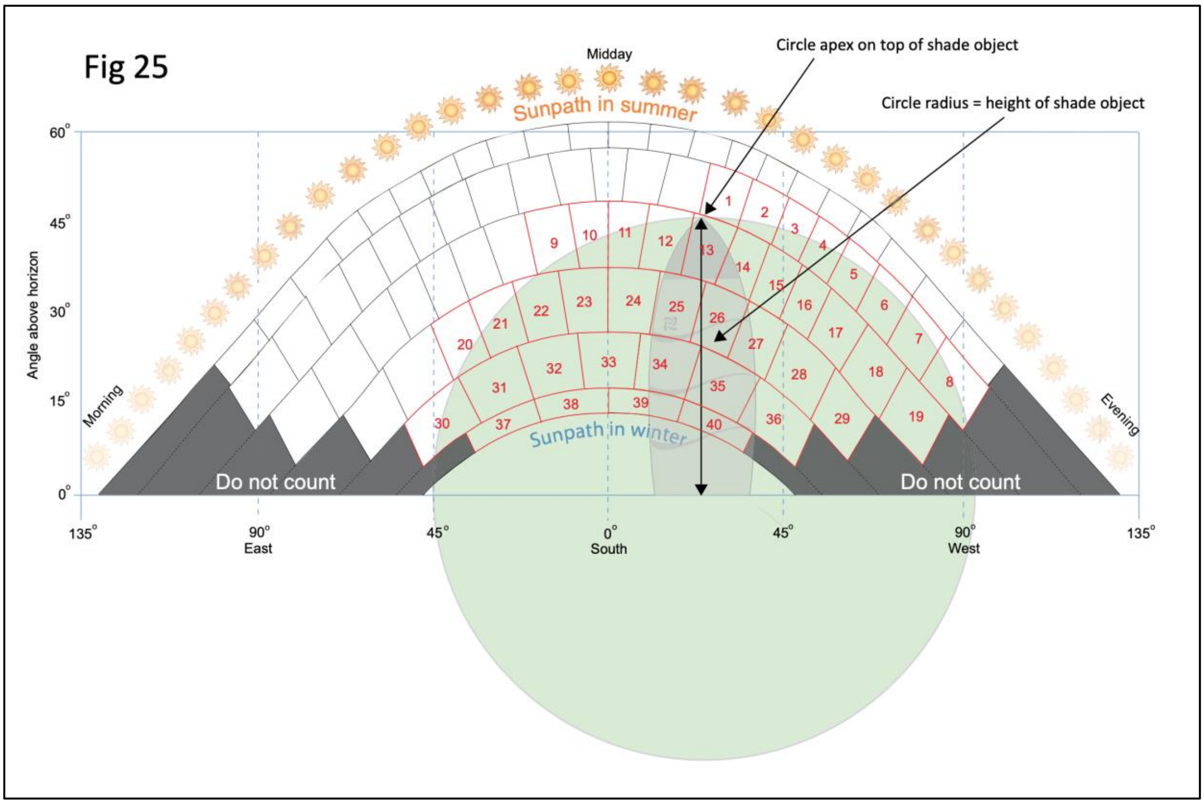


Figure 4: Sunpath chart showing near object, circle and segments counted

If the top of any object extends above the uppermost arc, which represents the Summer path of the Sun, then the apex of the circle should be located at the intersection of the object and that arc.

All segments touched by or within the shade circle should be counted as part of the overall shade analysis.

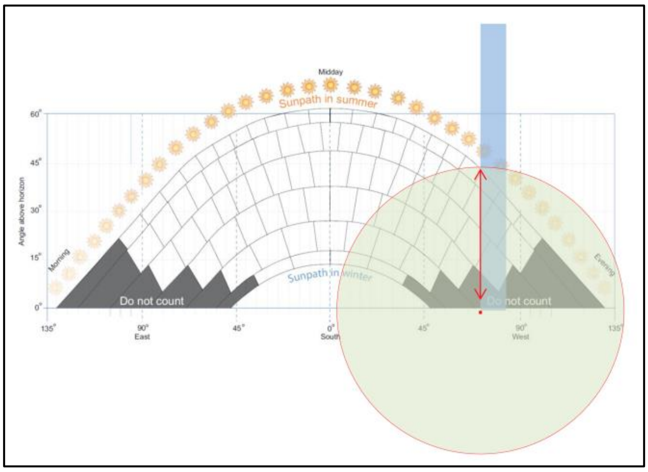
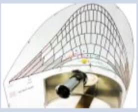
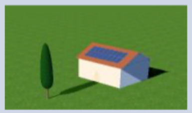


Figure 5: Object above the uppermost arc

In the example shown, using the same shade object as before but now assumed to be nearer than 10m, 40 segments are counted resulting in a shade factor of 0.6 (compared with 0.89 before).

APPENDIX A – EXAMPLES OF SHADE ASSESSMENT TOOLS

Method		Advantages	Disadvantages
	**Compass & elevation tool**	• Low cost • Readily available tools • Good for simple shade objects	• Slow • Difficult for complex shade
	**Reflective dome tool**	• Good visualisation of shade • Quick	• Needs transferring to MCS chart • Needs space to operate
	**Transparent acetate tool**	• Instant visualisation of sunpath • Quick	• Lower resolution?
	**Phone Apps**	• Instant visualisation of sunpath • Quick	• Checking (compass errors) • Identifying near objects • Needs transferring to MCS chart
	**Camera methods**	• Creates good record for client	• Needs transferring to MCS chart
	**Electronic shade analyser**	• Quick • Accurate • Remote pole mount option	• Cost
	**3D modelling** (a way of plotting existing data)	• Good for new build sites • Can animate shade travel • Can model different scenarios	• Slow • Still need to collect site data • Need object heights

APPENDIX B – SUNPATH DIAGRAM