The MCS shade evaluation procedure

Part 1 – The procedure explained
The MCS shade evaluation procedure

Part 1 – The procedure explained

a) Overview of MCS performance evaluation method – and how the shading analysis fits into this
b) Why MCS introduced the new shade method
c) Introduction to Sunpath diagrams
d) The MCS Sunpath chart
e) Rules for using the MCS chart
f) Rules for using and presenting “alternative methods”

Part 2 – How to record shade onto the chart

(next presentation)
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Part 1 – The procedure explained

a) Overview of MCS performance evaluation method – and how the shading analysis fits into this
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Part 2 – How to record shade onto the chart
(next presentation)
PV Guide contains a wholly new procedure to estimate the annual performance (kWh) of PV system.

The purpose of the standardised procedure is intended to prevent miss-selling and overestimation of PV system performance.

The procedure is designed to ensure that all customers receive a system performance estimation completed using the same method.
Old (SAP) method did not take into account the geographic location

Wanted a better allowance for pitch and orientation

Emerging evidence that systems consistently outperformed the SAP estimate

**Old shade calculation was far too crude**

New method designed to be relatively straightforward, and crucially ... **auditable**
PV Guide Section 3.7.2
Standard Estimation Method

The approach shall be as follows:

1. Establish the electrical rating of the PV array in kilowatts peak (kWp)
2. Determine the postcode region
3. Determine the array pitch
4. Determine the array orientation
5. Lookup kWh/kWp (kK) from the appropriate location specific table

6. **Determine the shading factor (SF)**
Using shade factor procedure set out in 3.7.7

Annual AC output (kWh) = kWp x Kk x SF
1. MCS Performance evaluation - overview

PV Guide Section 3.7.2
Standard Estimation Method

- Array pitch ... 5° steps
- Array orientation ... 15° steps

Excel file download on MCS site

Annual AC output (kWh) = kWp x Kk x SF
1. MCS Performance evaluation - overview

PV Guide Section 3.7.2
Standard Estimation Method

- Array pitch ... 5° steps
- Array orientation ... 15° steps

Excel file download on MCS site

Annual AC output (kWh) = kWp x Kh x SF
2. Why MCS introduced new shade method

The old SAP option ...

<table>
<thead>
<tr>
<th>Overshading</th>
<th>% of sky blocked by obstacles</th>
<th>Overshading factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy</td>
<td>&gt; 80%</td>
<td>0.5</td>
</tr>
<tr>
<td>Significant</td>
<td>&gt; 60% - 80%</td>
<td>0.65</td>
</tr>
<tr>
<td>Modest</td>
<td>20% - 60%</td>
<td>0.8</td>
</tr>
<tr>
<td>None or very little</td>
<td>&lt; 20%</td>
<td>1.0</td>
</tr>
</tbody>
</table>

But ...

- “percentage of sky blocked” - very open to interpretation
- 20% shade could have a significant effect on a PV system – yet old SAP method ignores any shade up to 20%
2. Why MCS introduced new shade method

MCS received evidence of badly shaded installations ...

But an installer could probably argue ... “well actually only 20% of the whole sky is blocked by the tree”

But an installer could probably argue ... “Definitely less than 20% of the whole sky is blocked by the chimneys”
2. Why MCS introduced new shade method

MCS received evidence of badly shaded installations ...

The rules made it very difficult for MCS certification bodies to police the old shading procedure.

The rules meant badly shaded arrays could be installed – yet the installer could still provide the customer with an output estimate that took no account of the shade effect... They could argue that “less than 20% of the sky was obscured”
2. Why MCS introduced new shade method

MCS received evidence of badly shaded installations ...

Some installers seemed to underestimate the effect of near shading (e.g. chimneys, flue pipes, aerials etc)

The SAP rule enforced this misapprehension (if less than 20% of the sky obscured, SF=1)

NB .. Not only is this system shaded from the adjacent roofs, there is also a soil pipe and a satellite dish shading the array
2. Why MCS introduced new shade method

The new MCS shade method has two key features ...

1) Designed to better assess the affect of shade on the PV array

2) Ensures the shade assessment is properly documented
   - to enable better policing of the system
   - to help the customer understand the suitability of their roof
3. Sunpath diagrams

The MCS method is based on a Sunpath diagram

Sunpath diagrams show the location of the sun at:
- different hours of the day
- and for the different months of the year
3. Sunpath diagrams

- Vertical axis shows sun height
- Horizontal axis shows sun direction (azimuth)

- Sun's Course at its Highest Point
- Equinox
- Sun's Lowest Position

- Morning in winter
- Mid-afternoon in summer
- Evening in summer
3. Sunpath diagrams

- A variation on the standard sunpath diagram
- Designed to enable simple shade assessment
Sun low in the sky on a winters morning
3. Sunpath diagrams

Midday - winter
Sun low in the sky on a winter afternoon
3. Sunpath diagrams

- **Winter sun at midday**
  Sun low in the sky >>> long shadows
  Tree casts shade on roof

- **Spring & autumn sun at midday**
  medium shadows
  Shade on building, but not on array

- **Summer sun at midday**
  Sun high in the sky – small shadows
  No shade on building or array
The MCS sunpath chart is split into a series of 84 segments (blocks)

The idea is to draw shade objects onto the chart ... and then count the number of blocks affected

**NOTE:** The process (and options) for capturing the shade landscape and drawing it on the chart is not covered here - see the next presentation
4. The MCS sunpath chart

All blocks covered or touched by the shade object(s) need to be counted.

In this example, 11 blocks are affected.
4. The MCS sunpath chart

The maths ...

Shade factor (SF) = \(1 - (0.01 \times \text{number of affected blocks})\)

In the example above, 11 segments are affected by the object ...

\[SF = 1 - (11 \times 0.01) = 1 - 0.11 = 0.89\]

This equates to an estimated 11% reduction in output due to the shade object.
4. The MCS sunpath chart

The background (you don’t need to know this, but it may help) ...

a) The chart was developed by first modelling a series of different shade scenarios using proprietary software. The shade factor for each case was recorded. The initial model assumed a 3kWp system, pitched at 30°, facing due south, located in Birmingham.

b) Shade factors from various different iterations of an MCS chart design were then compared to the model results

c) Once a draft design was established, more modelling was done to see how the chart coped with arrays of different pitches and orientations, and also for other geographic locations

The resulting chart is clearly a compromise ... as stated in the PV guide it “yields results within 10% for most systems”.

Yes, a series of charts for different geographic locations was considered. However, it was decided that the whole process inherently is not that precise ... and that the simplicity of having one chart for the whole of the UK was an acceptable compromise. After all, installers are free to use modelling software and present an alternative estimate to the customer if they wish.

And yes, the option of adopting one of the software packages as the “MCS method” was also considered – however this was rejected due to commercial issues and perhaps most significantly, the difficulties of auditing this approach. It was also felt that the MCS chart may help prevent miss-selling, as it has to go to the customer.

Finally, eagle eyed observers will have spotted that if the whole chart is obscured SF = 0.16 While we hope that no installations will ever be put in these locations, this result reflects the output from diffuse light – ie even a wholly shaded array still has a very small output.
4. The MCS sunpath chart

**Near shading**

One of issues noted when developing the MCS chart was how it under-estimated the affect of near shade.

The shadow from near shade objects is more significant ... as the shadow moves, as the sun travels across the sky (think sundial).

This was seen as a particular issue due to the number of installations that seemed to be going ahead with near shading objects affecting them.
To address this issue, as the guide states ...

“Any objects on the horizon diagram that are 10m or closer to any part of the array, shall have a shade circle added to the diagram to reflect the severe impact that these items may have on the array performance. 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.”
To address this issue, as the guide states ...

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“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.”
4. The MCS sunpath chart

Near shading

This is the same shade object as previously. But, treating as near shade ...

40 segments are now affected by the object (was 11) ...

\[ SF = 1 - (40 \times 0.01) = 1 - 0.4 = 0.6 \] (was 0.89)

This equates to an estimated 40% reduction in output due to the shade object (was 11%)
5. Rules for using the MCS sunpath chart

In this section, we will cover the following 5 rules …

A) Where to take the readings
B) Arrays with separate inverters or MPP trackers
C) Drawing the near shade circle
D) Estimates from plans (new build)
E) What information to supply to the customer

Note: as mentioned previously, how to perform the shade measurement is not covered in these slides

➤ See the next presentation
5. Rules for using the MCS sunpath chart

A) Where to take the readings

Where to take the reading depends on whether there is any near shade ...

No near shade

The reading should be taken from the midpoint of the array lower edge of the proposed array e.g. through an upstairs window

Near shade

The reading should be taken from the array location worse affected by shade

See next slide
5. Rules for using the MCS sunpath chart

A) Where to take the readings ... continued

Where there is near shade, choosing the point in the array potentially most affected by shade can be slightly complicated, but will usually mean the array location to the south of the shade object.

Shade reading should be taken behind (to the North) of the satellite dish.

This array faces exactly due South – so the shade reading could be taken either side of the dormer window.

*NB In this case the O is drawn on the right hand side ... as some shade is also expected from the adjacent roof.*
A) Where to take the readings ... continued

Where there are multiple near shade objects affecting the array, choosing the most appropriate location to take the readings can be difficult - there is also a lot to draw - in these circumstance ask yourself ...

*Is this really a suitable location for a PV array – or do I only use part of the roof?*

In the example shown here (providing the satellite dish was moved), the a smaller array to the upper section of the roof may have been the best solution.
5. Rules for using the MCS sunpath chart

A) Where to take the readings ... continued

Do we need to go onto the roof to take the reading?

This question has been asked by many installers, and the answer is:

No, as long as you are confident that the shade chart is representative of that property

- For roofs with **no** near shade: This means that an upstairs window is probably fine (see previous slide)

- For roofs **with** near shade: This means either:
  1. Getting on the roof
  2. Performing a series of measurements / calculations that allow you to produce a chart that is representative of the array location worse affected by shade
5. Rules for using the MCS sunpath chart

A) Where to take the readings ... continued

Do we need to go onto the roof to take the reading?

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- For roofs with near shade: This means either:
  a) Getting on the roof
  b) Performing a series of measurements / calculations that allow you to produce a chart that is representative of the array location worse affected by shade

Methods are available to accurately undertake a reading from ground level ... These methods are explained in the second of these two presentations

The Guide to the Installation of Photovoltaic Systems, highlights the need to minimise risk and specifically identifies the hazards of working at height. The responsibilities of employers, employees and contractors are clearly defined in the Health and Safety at Work Act. Guides to the Work at Height Regulations 2005 and other guidance are published by the HSE and are free to download from [http://www.hse.gov.uk/falls/](http://www.hse.gov.uk/falls/)
5. Rules for using the MCS sunpath chart

B) Arrays with multiple inverters or mpp trackers

In an effort to minimise the effects of shade, arrays can be either:

- Installed with multiple inverters
- Use inverters with multiple (independent) mpp tracker inputs
- Use module level power optimisers – or micro inverters

In these circumstances the PV Guide states:

“For systems connected to multiple inverters, or a single inverter with more than one MPP, it is acceptable to do a separate calculation of SF for each sub array (each array connected to a dedicated MPP tracker).”
5. Rules for using the MCS sunpath chart

C) Drawing the near shade circle

The following four rules apply to drawing the shade circle:

1. Only shade items within 10m of the midpoint of the array lower edge need to be considered

2. Items behind the array – No shade circle required

3. 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

4. The shade circle apex does not need to extend above the top of the sunpath chart
5. Rules for using the MCS sunpath chart

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4. The shade circle apex does not need to extend above the top of the sunpath chart

These are new and are not contained in the PV guide
5. Rules for using the MCS sunpath chart

C) Drawing the near shade circle

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4. The shade circle apex does not need to extend above the top of the sunpath chart

The PV guide slightly contradicts itself on this issue ... but for the avoidance of doubt:
Only shade items within 10m of the midpoint of the array lower edge need to be considered ...
5. Rules for using the MCS sunpath chart

C) Drawing the near shade circle

1. Only shade items within 10m of the midpoint of the array lower edge need to be considered
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3. 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
4. The shade circle apex does not need to extend above the top of the sunpath chart

- Item behind array
  - Draw item onto shade diagram as normal
  - But do NOT draw shade circle

- Item in front of array
  - Draw item onto shade diagram as normal
  - AND draw shade circle
5. Rules for using the MCS sunpath chart

C) Drawing the near shade circle

1. Only shade items within 10m of the midpoint of the array lower edge need to be considered.
2. Items behind the array - No shade circle required.
3. 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.
4. The shade circle apex does not need to extend above the top of the sunpath chart.

(this was covered earlier)
5. Rules for using the MCS sunpath chart

C) Drawing the near shade circle

1. Only shade items within 10m of the midpoint of the array lower edge need to be considered
2. Items behind the array - No shade circle required
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4. The shade circle apex does not need to extend above the top of the sunpath chart

Where the shade object extends off the top of the chart, the circle apex can be limited to the top of the chart.
5. Rules for using the MCS sunpath chart

C) Drawing the near shade circle

1. Only shade items within 10m of the midpoint of the array lower edge need to be considered
2. Items behind the array - No shade circle required
3. 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
4. The shade circle apex does not need to extend above the top of the sunpath chart

A final point ...

If you are manipulating the shade diagram on the computer, make sure you maintain the proportions.
5. Rules for using the MCS sunpath chart

D) Estimates from plans

Obviously, where a building does not exist, it is not possible to record the shade scene. In these cases the PV Guide states:

In some circumstances however, data may need to be estimated or taken remotely. In such circumstances, any performance estimate provided to a customer should include the following statement:

“This system performance calculation has been undertaken using estimated values for array orientation, inclination or shading. Actual performance may be significantly lower or higher if the characteristics of the installed system vary from the estimated values.”

In all cases where inclination, orientation or shade has been estimated at quotation stage, e.g. for a new build development, a site survey shall be undertaken before installation commences.

Following the detailed site survey, where any factors do not match those given in the original performance estimate, the installation company shall recalculate the performance estimate and supply this in writing to the client. If the adjusted performance estimate is worse than originally predicted, the client shall be given the same cooling off period and cancellation rights (to include any right to cancel without financial penalties) that applied to the original quote. This shall apply from the date of issue of the updated performance estimate.
5. Rules for using the MCS sunpath chart

E) What information to supply to the customer

- The client needs to be supplied with a copy of the Sunpath chart
- If there is no shade then a copy of the chart with “NO SHADE” written across it should be provided
- Where the shade factor is less than 1 (i.e. when there is some shade recorded), the PV Guide states that the following disclaimer needs to be added to the quote: “This shade assessment has been undertaken using the standard MCS procedure - it is estimated that this method will yield results within 10% of the actual annual energy yield for most systems.”
5. Rules for presenting alternative estimates

It is recognised that installers may want to present an alternative estimate of system performance to the client – particularly where they are concerned that the MCS method is not as accurate as they would like.

In such circumstances, the PV Guide states:

“Additional estimates may be provided using an alternative methodology, including proprietary software packages, but any such estimates must clearly describe and justify the approach taken and factors used and must not be given greater prominence than the standard MCS estimate.”

“In addition, it must be accompanied by a warning stating that it should be treated with caution if it is significantly greater than the result given by the standard method.”
The MCS shade evaluation procedure

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Part 2 – How to record shade onto the chart

The next presentation ...