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Photovoltaic Systems

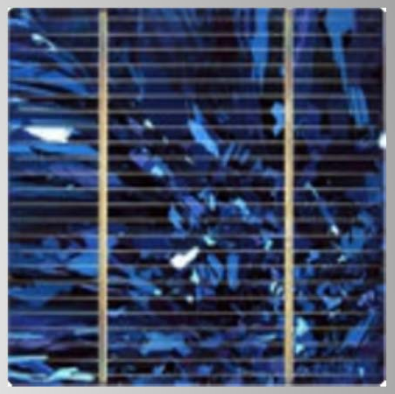
CEPMF Module 3

Why Photovoltaic ?

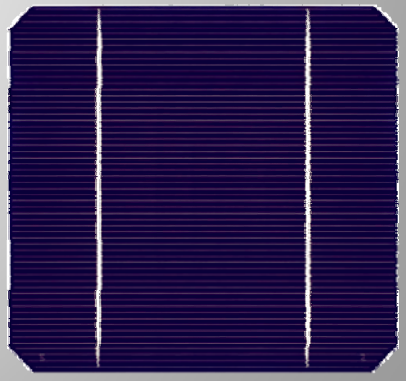
- Few regulatory hurdles
- Planning permission often not required
- Relatively easy to get if required
- Little up-front investment at risk
- Quickly installed, income quickly obtained
- Generation accurately predictable

Silicon Photovoltaic Cells

- 37,000,000 kW of PV made in 2013
- World market share
  64% monocrystalline silicon
  18% polycrystalline silicon
- Even greater UK dominance of silicon
- Poly lower efficiency but cheaper
- Difference in price closing



Polycrystalline cell



Monocrystalline cell

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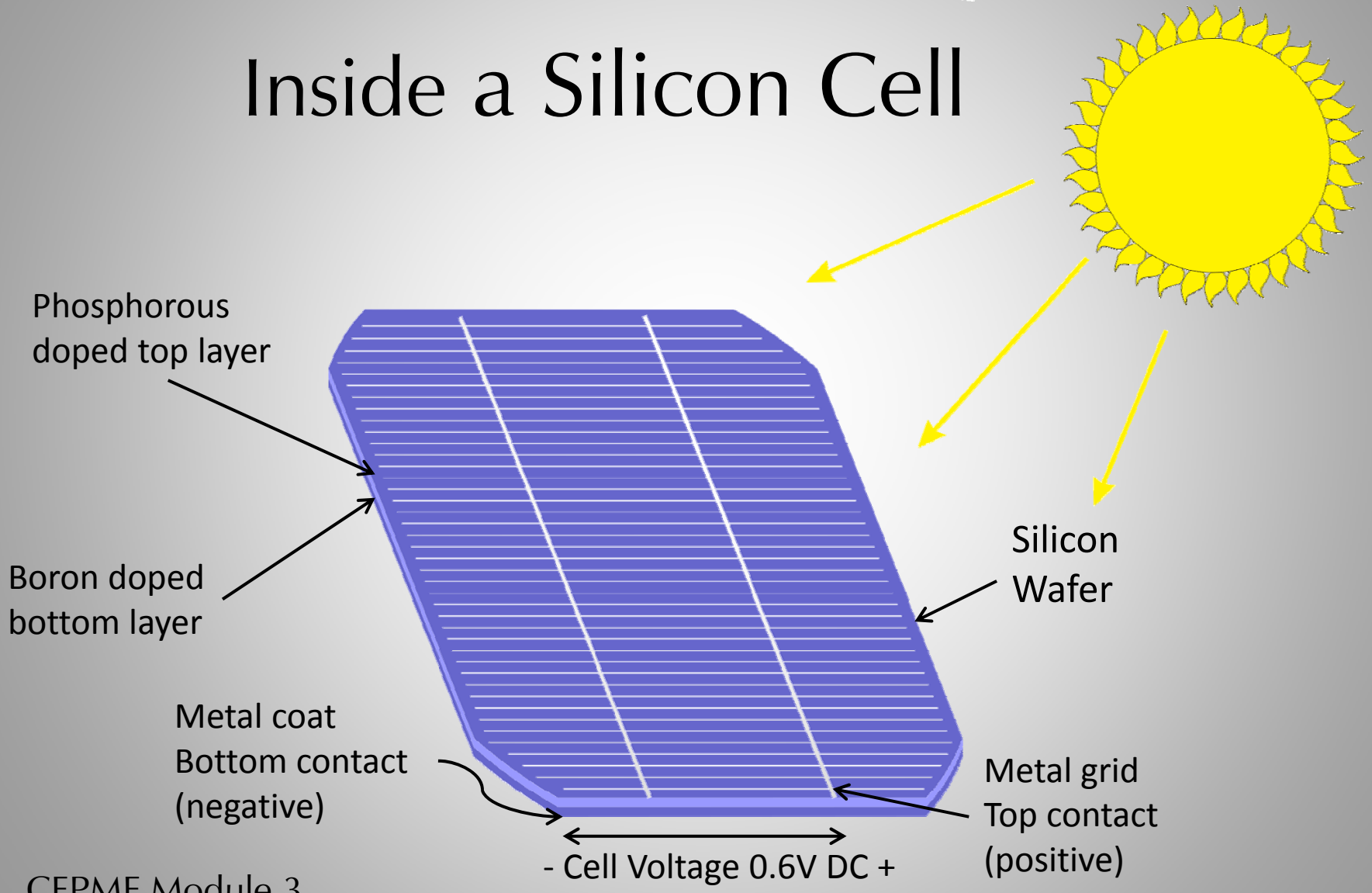
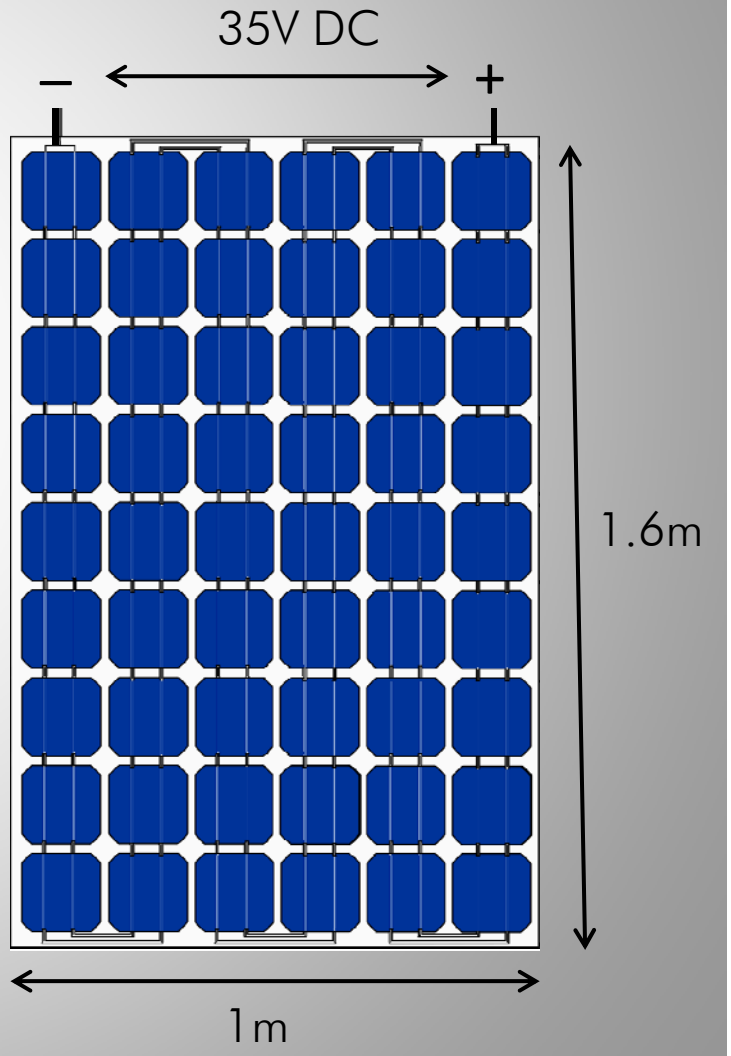
Inside a Silicon Cell



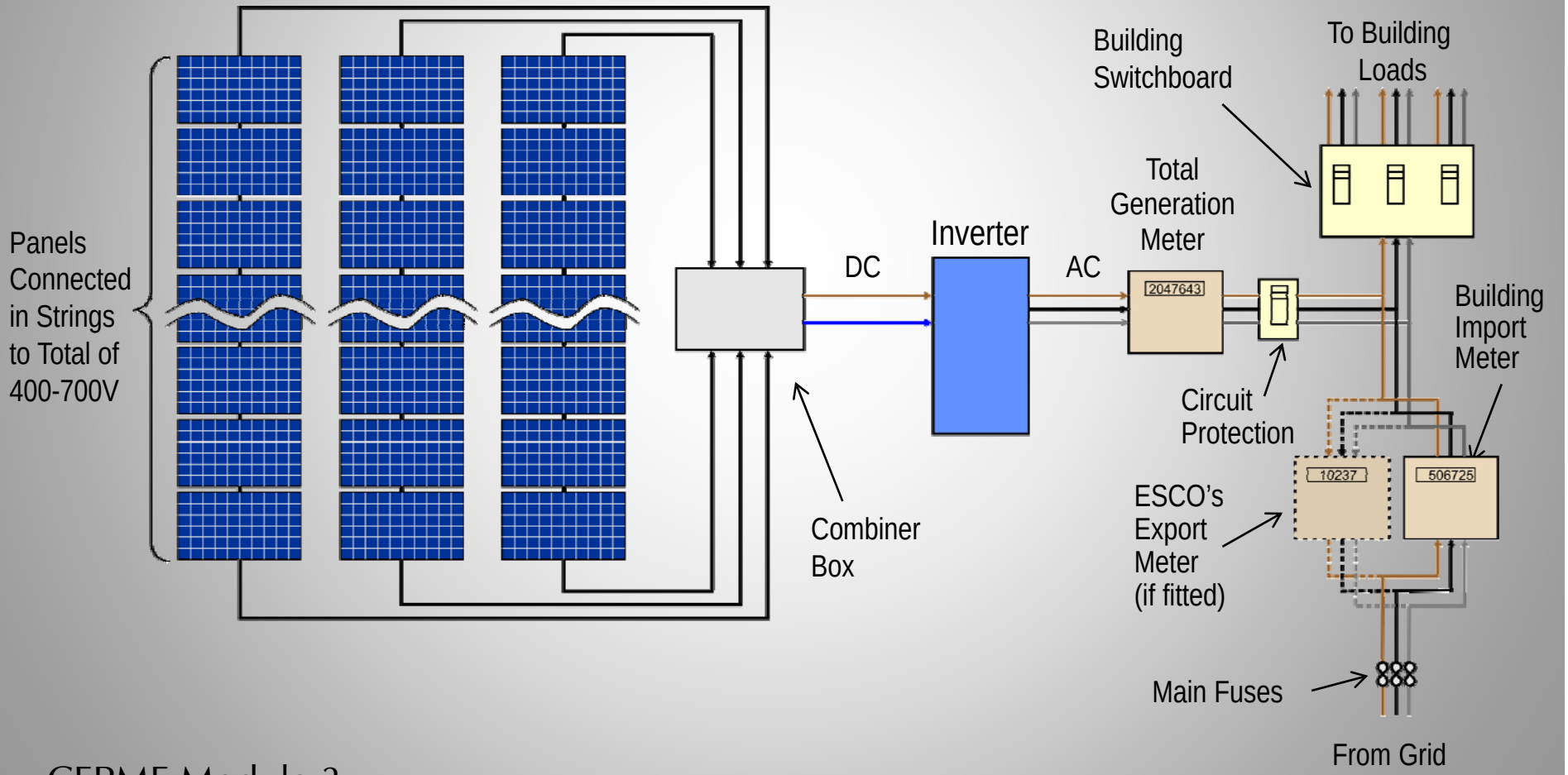
Photovoltaic Panels

Typical Grid Connected PV Panel

- Rating 220W – 330W at this size
- Price in bulk 45p/W to £1/W
- Cheapest per kW with ≈250W panels
- All cells connected in series
  voltage = 0.6V x number of cells
- Weight 15kg – 18kg
- 50 – 70 mm thick



System Connection



Site Considerations

- Size of roof
- Orientation of roof
- Shading of roof
- Strength and durability of roof
- Ease of access to install system
- Capacity of building electrical supply
- Special status of building
- Ability of someone to commit to a 20 year lease.

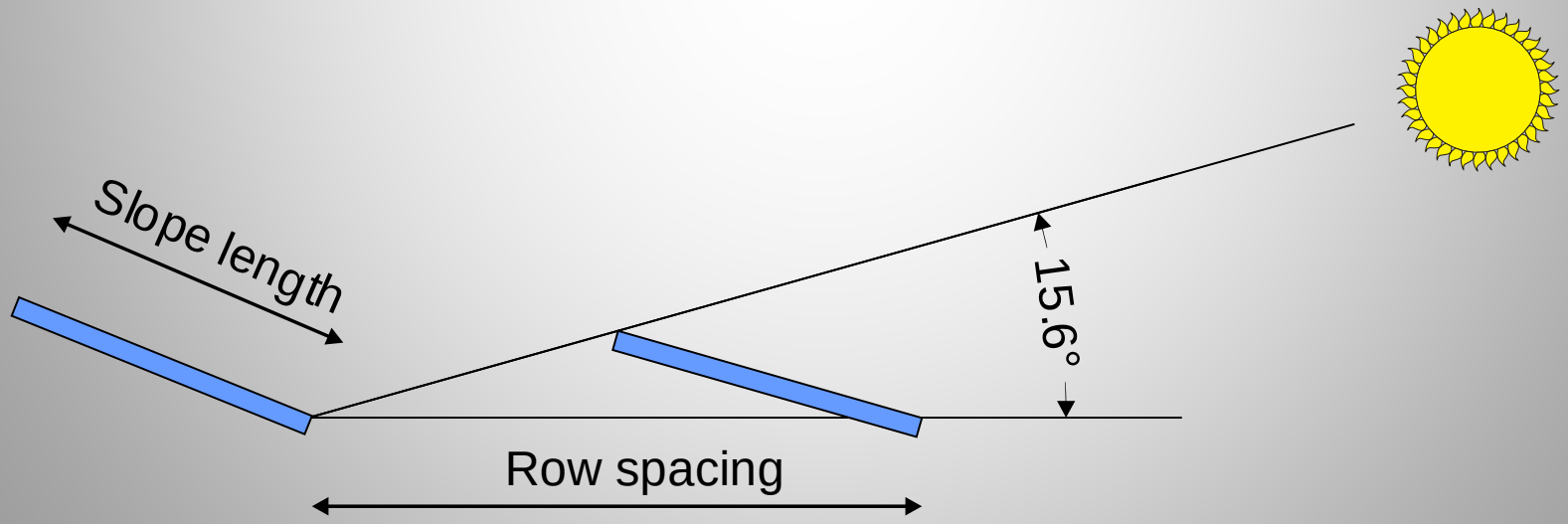
Size of Roof (sloping)

- Use ruler on Google Earth
- Measure plan length of slope
- Estimate elevation of slope ϕ
- Slope length = plan length/cos ϕ
- Draw panels shortened in slope direction by factor of cos ϕ
- Leave 1m around edge to if you hope to escape planning consent
- Count panels –
  at 250W, 4 panels = 1kW

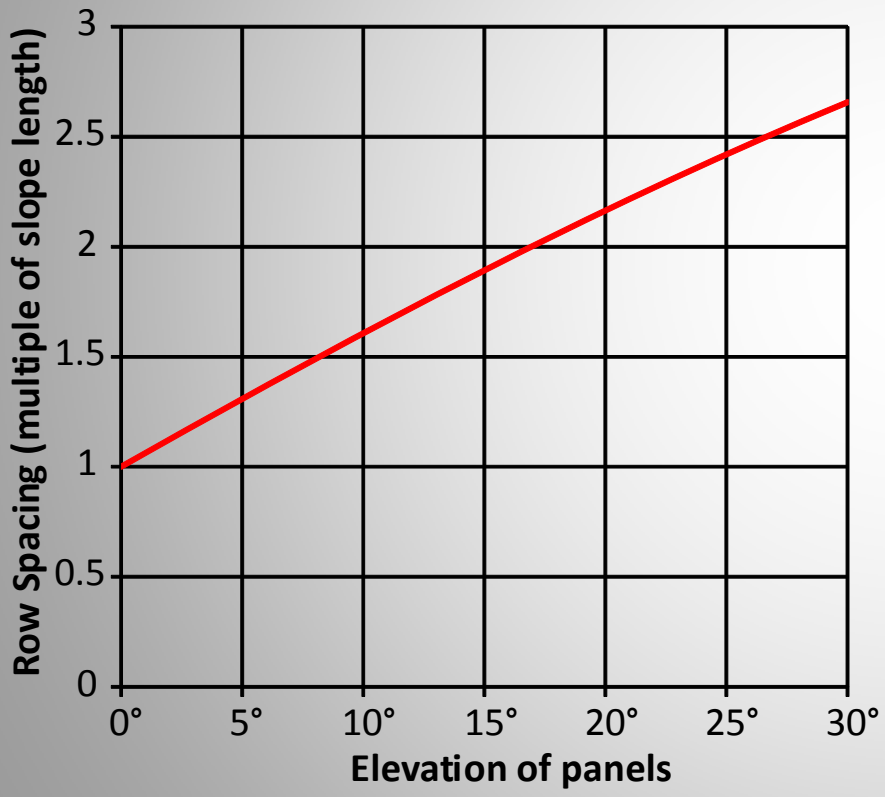
If $\phi = 45°$, cos $\phi = 0.707$ For 1m x 1.6m panels
For landscape, draw panels 0.707m x 1.6m
For portrait, draw panels 1m x 1.13m

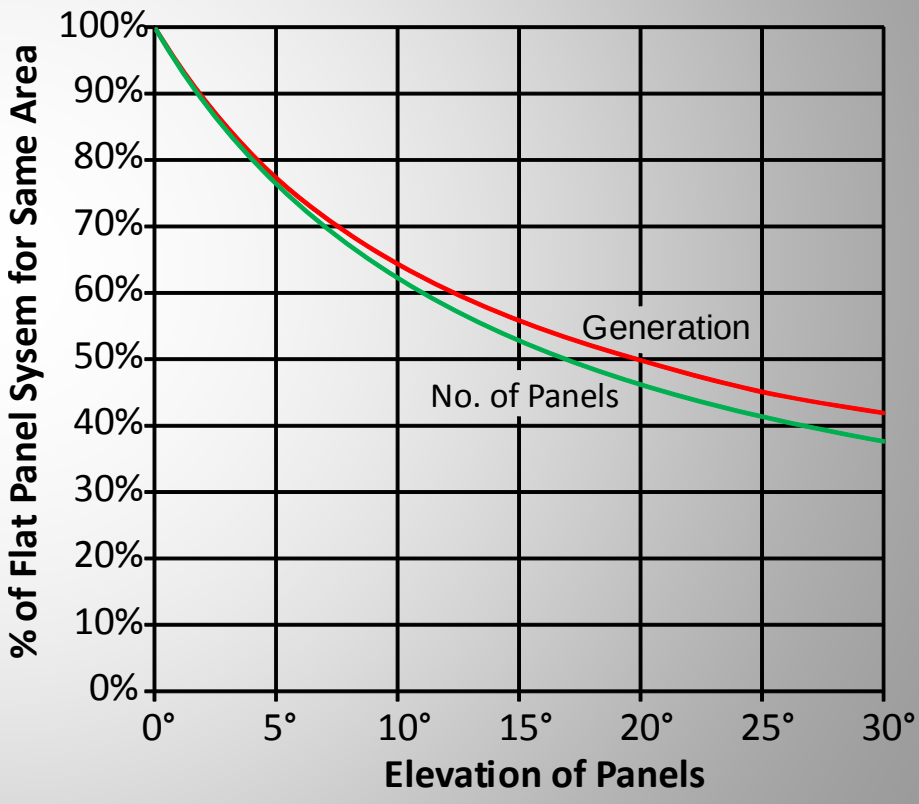
Size of Roof (Flat)

- Option 1 – lay panels flat – lose 11% output
- Option 2 - angle panels up – lose area – need planning permission
- If angled, space so one row does not shade next at noon midwinter



Size of Roof (Flat)





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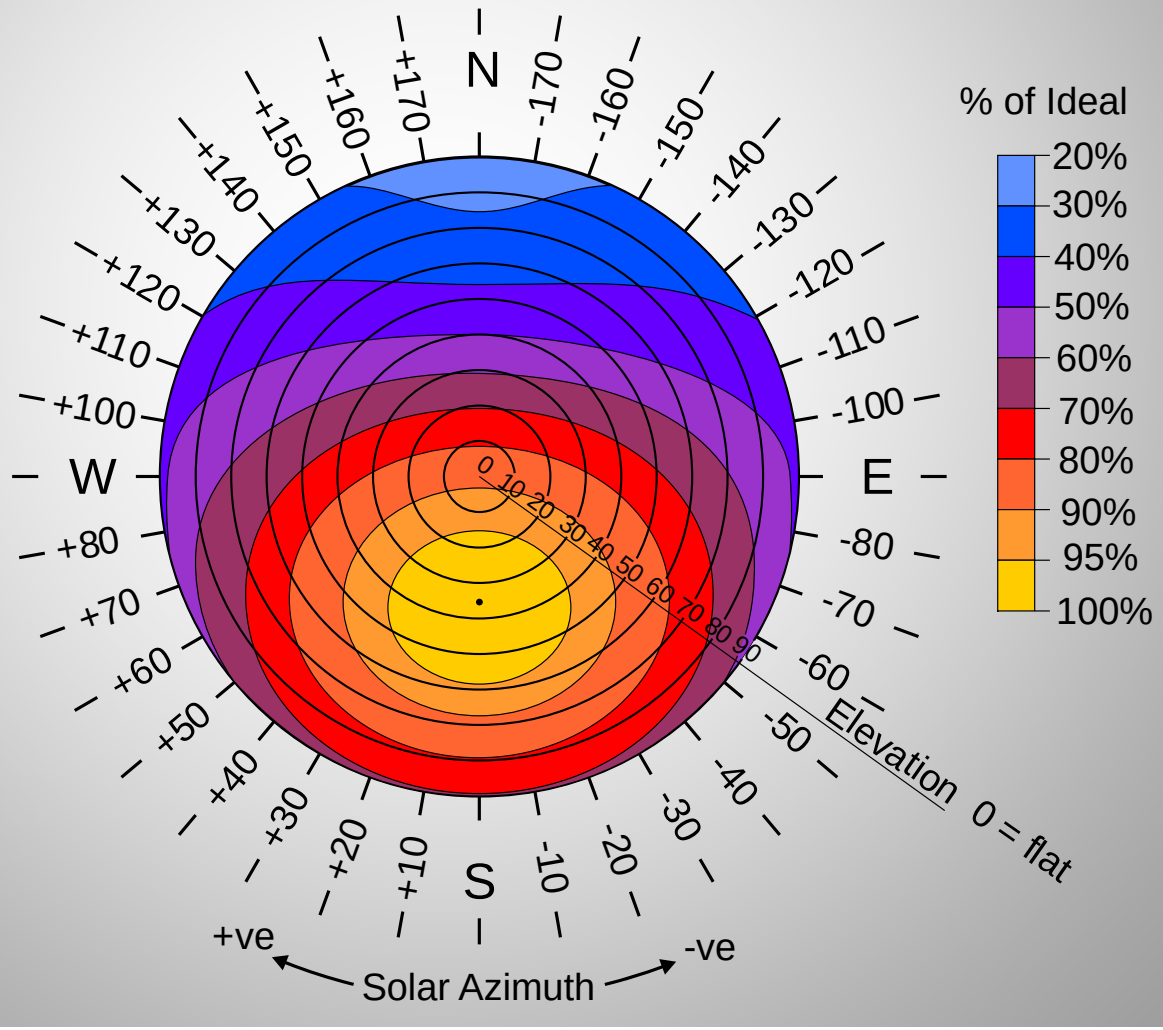
Orientation

Not as important as some think



Excel tables can be downloaded from MCS at http://tinyurl.com/ndz9jsk
Use zone 2 for south east

Ideal for this zone 1132kWh per year for each kW of system

Shading

More important than some realise

- MCS Guide to the Installation of Photovoltaic systems 2012 (http://tinyurl.com/mch7jrc) gives a method of estimating a shading factor.
- The horizon and far shading are drawn on sunpath diagram. Near shade objects (< 10m) drawn as circles, diameter = height, top of circle at top of object.
- Shading factor SF = 100% – 1% for each affected squares. e.g. 23 squares give SF = 77%
- Good guide at http://tinyurl.com/l56m9u5 & http://tinyurl.com/kzbpcvd

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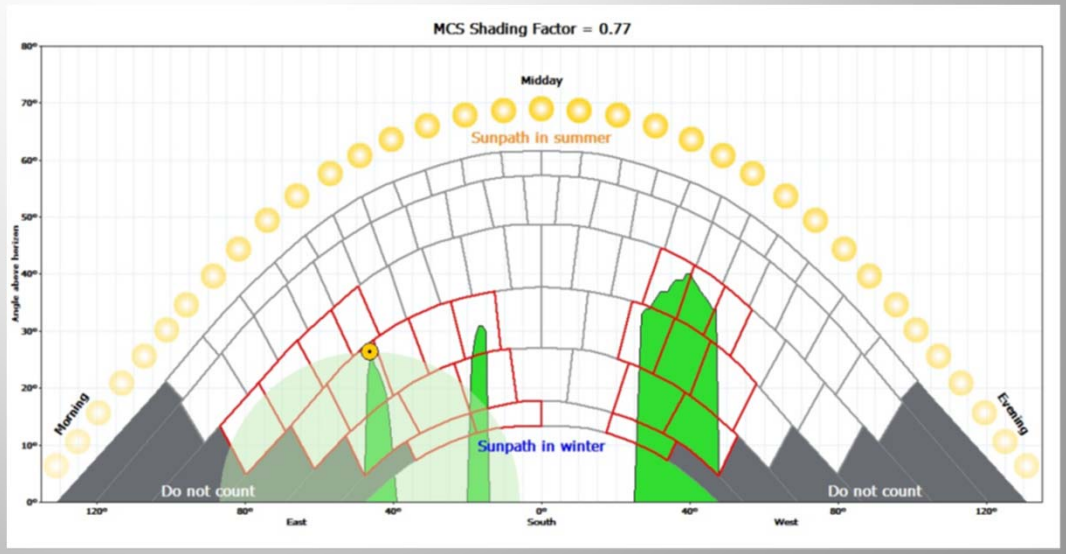
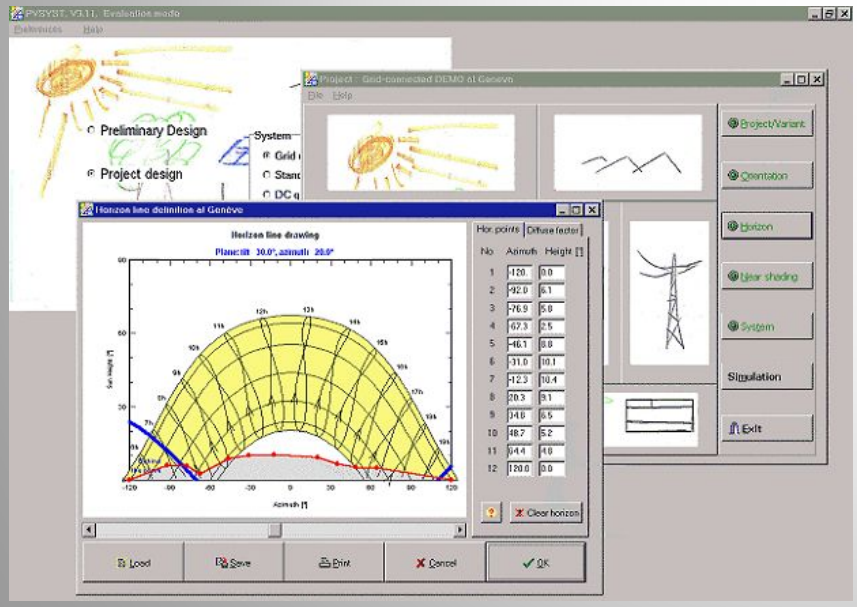
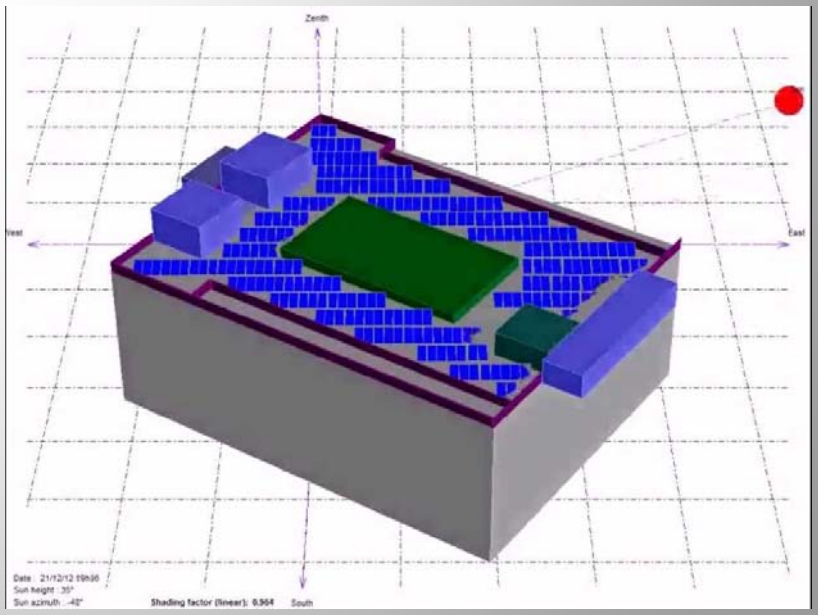


Shading

- Better Shading Factors can be obtained by building 3D models with software packages such as PVSYST http://www.pvsyst.com/en/software/download
- PVSYST is expensive, £685 up to 30kW £891 unlimited size, but offers 1 month free trial





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Strength and Durability of Roof

- Roof will need to be inspected by an engineer – usually arranged by the installer
- Panels & fixings average 15 kg/m² $\simeq$ 250 mm fresh snow
- Loading of flat roof system can be higher if held down by ballast
- Wind will exert significant pressure (or lift, if from behind) especially near the edge and even more so at the corners
- Avoid asbestos, but not everything that looks like asbestos is
- Felted and tarred roofs may not last 20 years

Ease of Access

- The Work at Height Regulations 2005 will apply to nearly all roof mounted systems
- Approved scaffolding or mobile lifts will usually be needed
- Access may be expensive if:-
  - The roof is adjacent to road, railway or someone else's land
  - Access requires reaching across lower non-load bearing areas
  - The public, especially children, normally have access below
  - The ground below is very soft and sloping
- Ground area is needed for panels, equipment, delivery vehicles and, if not available in building, accommodation for the installers

Capacity of Building Electrical Supply

- The supply to the building needs to have sufficient rating to cope with PV output
- Distribution Network Operator (DNO) will decide how big a system can be connected
- They usually require 3 phase above 7kW
- System can never be bigger than building rating
- If building rating not known, judge by meter tails
- 3 incoming fuses, 3 phase - 1 fuse, single phase

Diameter	Circumference	Rating/Phase
8mm	25mm	12.7kW
10.5mm	33mm	14.5kW
13.5mm	39mm	18.4kW
12.5mm	42mm	23.1kW
15.1mm	47mm	32.2kW
16.8mm	53mm	46.0kW

Status of Building

Planning permission is required if the building is:-

- A Listed Building or a building within the curtilage of one
- Within the curtilage of a National monument
- Flats or maisonettes
- Within a Conservation Area, National Park, Area of Outstanding Natural Beauty or World Heritage Site and the panels are on the principal or side elevation and are visible from the road (non-domestic - fronts the road)
- Has had Permitted Development Rights restricted as a condition of planning permission
- The Local Planning Authority has issued an Article 4 Direction
- Panels are higher than top of the building (excluding. Chimneys)
- The panels within 1m of the edge of the roof or another wall
- The panels are more than 200mm above the wall or roof except for non-domestic flat roof where the limit is 1m

Someone to Commit to 20 year Lease

- To pay your investors you need to ensure that the system will operate for 20 years
- Ideally you want someone who owns the freehold of the property and is the one who benefits from the electricity
- Often commercial properties are rented or on a short tem lease.
- Property companies may want to be free to redevelop the property
- Charitable trusts can be very long winded in reaching agreements

Simple Rules of Thumb

For a really good site:-

Each rated kilowatt = 4 panels = 6.5 m^2

Each rated kilowatt generates 1000 kWh a year

Each rated kilowatt costs £1000 (ex VAT)

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Thank You