East Stour Solar Farm – Capacity Note

1. National Policy Statement EN3 provides that:

"2.10.50 Solar panels generate electricity in direct current (DC) form. A number of panels feed an external inverter, which is used to convert the electricity to alternating current (AC). After inversion a transformer will step-up the voltage for export to the grid. Because the inverter is separate from the panels, the total capacity of a solar farm can be measured either in terms of the combined capacity of installed solar panels (measured in DC) or in terms of combined capacity of installed inverters (measured in AC).

2.10.51 For the purposes of determining the capacity thresholds in Section 15 of the 2008 Act, all forms of generation other than solar are currently assessed on an AC basis, while a practice has developed where solar farms are assessed on their DC capacity.

2.10.52 Having reviewed this matter, the Secretary of State is now content that this disparity should end, particularly as electricity from some other forms of generation is switched between DC and AC within a generator before it is measured.

2.10.53 From the date of designation of this NPS, for the purposes of Section 15 of the Planning Act 2008, the maximum combined capacity of the installed inverters (measured in alternating current (AC)) should be used for the purposes of determining solar site capacity.

2.10.54 The capacity threshold is 50MW (AC) in England and 350MW (AC) in Wales.

2.10.55 The installed generating capacity of a solar farm will decline over time in correlation with the reduction in panel array efficiency. There is a range of sources of degradation that developers need to consider when deciding on a solar panel technology to be used. Applicants may account for this by overplanting solar panel arrays.

2.10.56 AC installed export capacity should not be seen as an appropriate tool to constrain the impacts of a solar farm. Applicants should use other measurements, such as panel size, total area and percentage of ground cover to set the maximum extent of development when determining the planning impacts of an application."

2. The Appellant has calculated the total capacity of the appeal scheme in terms of the combined capacity of installed inverters (the inverter method). This is set out below. For completeness, the modelled combined capacity of installed solar panels has also been set out, along with the DC to AC conversion ratio. This ratio is typical for projects that have <u>not</u> been overplanted[1] to account for the degradation of panel efficiency over time.

Descriptions of electrical capacity metrics and calculations for the East Stour Solar Farm	
Inverter method (used for the East Stour Solar Farm)	
249 inverters x 200,000W (nominal AC active power)	49.8MWac
Capacity taking account of generation station system losses (low voltage AC cables from Inverters to Transformers and high voltage AC cables from Transformers to Point of Connection). These AC cables and Transformers introduce predictable losses) in the region of 3-4% based upon EDF group experience in operating existing solar portfolio.	48.3 – 47.8MWac

[1] NPS EN3 defines "Overplanting" as *"the situation in which the installed generating capacity or nameplate capacity of the facility is larger than the generator's grid connection. This allows developers to take account of degradation in panel array efficiency over time, thereby enabling the grid connection to be maximised across the lifetime of the site."*

Panel method (for information)	
DC peak output of panels = 107666 panels x 590w per panel.	63.5MWdc
DC to AC ratio	1.27
Candidate panel = Canadian Solar CS7L-590MB 590W bifacial panel	590W

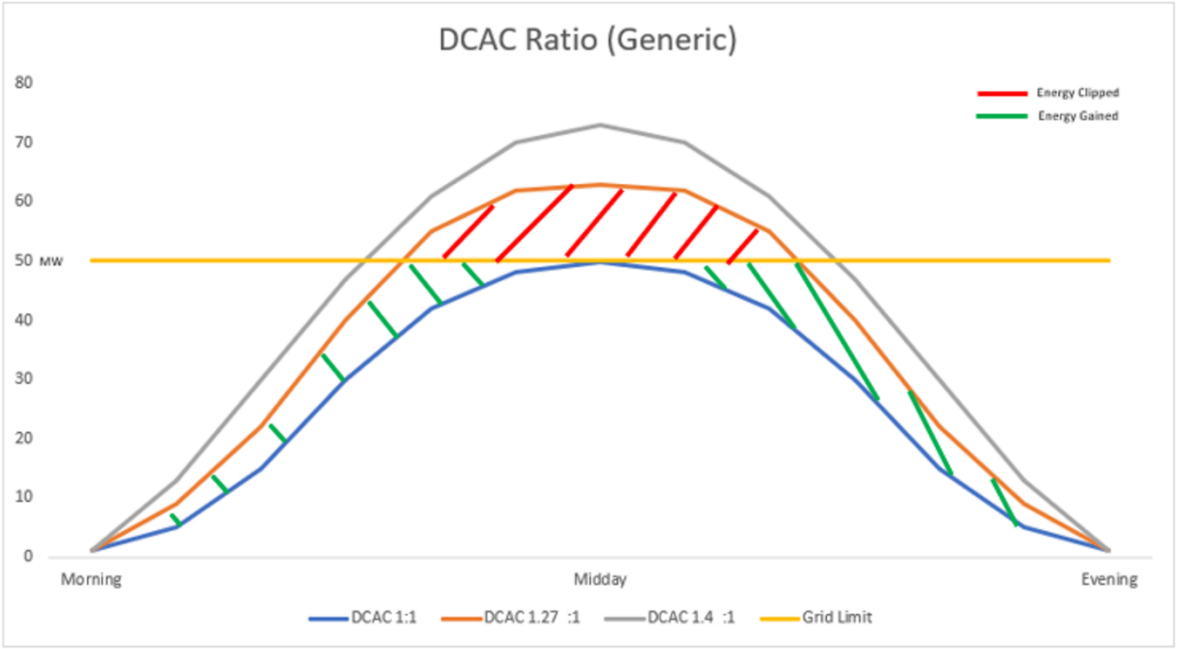
Generating Station Optimisation

3. The difference between DC and AC capacity reflects both losses in the conversation process, but also optimisation. Generating station optimisation is an industry standard design practice which seeks to maximise the utilisation of the available permitted export capacity.

4. As the irradiance from the sun varies over the course of a day, the power output from a solar farm will fluctuate from morning through to evening. If the peak output (DC) of the generating station was never capable of technically exceeding the grid connection limit, then on average, over the course of the day, the station would fail to utilise the available grid connection for a significant part of the day.

5. In order to better utilise the available connection capacity over the course of a day, it is standard practice to ensure that the generating station has sufficient peak capacity such that on average, over the course of a day, the available export capacity is maximised. Of course, the grid connection limit cannot be exceeded at any time and will be limited by the power plant control system, so any generation in excess of this limit is not exported. Thus, an electrical engineer designing such a project, must find a balance between utilising the available grid connection capacity and producing excess power that cannot be exported.

6. This balance can be expressed through the DC to AC ratio, which is necessarily a range. This range is typically between 1.1 to 1.4. The figure below seeks to illustrate the design considerations and the effects of using different ratios.



7. Distinct from this practice of generating station optimisation is what NPS EN3 defines as overplanting, which is a higher ratio that seeks to *"take account of degradation in panel array efficiency over time, thereby enabling the grid connection to be maximised across the lifetime*

of the site". This involves incorporating more capacity within a development than is needed to specifically account for degradation of panels such that the generating capacity is maximised for the lifetime of the site.

8. It is important to note that a development that is not overplanted can continue to be optimised throughout its lifetime through a maintenance regime and where necessary the replacement of solar panels.