SUNNICA ENERGY FARM

EN010106

8.114 Response to SNTS Deadline 7 Submissions in relation to Scheme Sizing and 'OverBadging'

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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1 The rationale for over-sizing solar PV peak DC capacity to the AC export capacity of the grid connection (DC:AC ratio)

1.1 Background

1.1.1 In Say No To Sunnica's Deadline 7 post hearing submissions **[REP7-084]** the Applicant was asked to explain the rationale behind requiring a Scheme capacity of circa 630MWp when the connection capacity at Burwell was limited to 500MWp. In the Applicant's response at Deadline 8, it was explained that technical input was required to fully respond to the point raised and that a response at Deadline 9 would be provided. That is provided below.

1.1.2 Plate 1 below shows that using a 575Wp module and adjusting the available field area following the acceptance of the second changes application that the total installed capacity of the Sunnica Energy Farm could be 627 MWp. If a smaller 550Wp was used this would be reduced to 600 MWp.

Plate 1-1 Installed capacity by Field for 550Wp and 575Wp panel types and the difference between them on a field-by-field and overall basis

	FIELD	550 Wp	575 Wp	Difference
	W01	9.76	10.21	0.45
	W02	13.09	13.69	0.60
	W03	27.89	29.16	1.27
	W04	26.66	27.87	1.21
	W05	32.93	34.42	1.49
	W06	25.75	26.92	1.17
	W07	26.75	27.97	1.22
	W08	17.71	18.52	0.81
	W09	9.64	10.08	0.44
	W10	15.83	16.55	0.72
	W11	14.80	15.47	0.67
	W12	20.73	21.67	0.94
	W15	50.17	52.45	2.28
	E01	12.97	13.56	0.59
	E02	1.37	1.43	0.06
	E03	19.10	19.96	0.86
	E04	12.43	12.99	0.56
	E05	41.61	43.50	1.89
	E08	6.18	6.46	0.28
	E09	7.84	8.19	0.35
	E10	11.66	12.19	0.53
	E12	39.70	41.51	1.81
	E13	14.08	14.72	0.64
	E14	8.21	8.58	0.37
	E15	7.88	8.24	0.36
	E16	8.07	8.44	0.37
	E17	7.62	7.97	0.35
	E18	5.81	6.07	0.26
	E19	15.79	16.50	0.72
	E20	10.44	10.92	0.48
	E21	9.47	9.90	0.43
	E22	6.10	6.38	0.28
	E24	7.81	8.16	0.35
	E25	6.38	6.67	0.29
	E26	4.90	5.12	0.22
	E27	6.21	6.49	0.28
	E28	5.36	5.60	0.24
	E29	7.02	7.34	0.32
	E30	17.08	17.85	0.77
	E31	28.51	29.80	1.29
	E32	4.60	4.81	0.21
As per original DCO submission	TOTAL MWp	626	654	28
Remove W01, W02, 3.5ha from W04 and E05	TOTAL MWp	600	627	27

1.2 Over-sizing and losses

1.2.1 The peak power for the solar scheme is measured in Watts Peak which produce direct current (DC). As shown above the scheme as designed using the 575Wp module would enable 627MWp to be installed. The solar scheme has an accepted Bilateral Connection Agreement with National Grid which permits 500MW AC (alternating current) of power to be exported to the transmission network. As a result, the scheme has been designed around that constraint such that it can never export more than the maximum capacity of the grid connection. The higher the DC:AC ratio the more electricity will not be able to be used resulting in conversion losses and a lower power production in terms of specific yield (kWh/ kWp/ year). Alternatively, by installing a higher DC:AC ratio there will be more times that the scheme will be able to output at or close to the maximum 500MW capacity threshold thereby producing more low-carbon electricity.

1.2.2 The installed power capacity rating is the maximum power provided by the panels under standard conditions, as measured under laboratory studies using an industry standard set of assumptions including 1000 W/m2 of irradiation and 25ºC of temperature. If the irradiation is lower the power output will decrease and the reverse is also true, that if the irradiation is higher the power output will increase. The DC power output needs to be transformed to AC, this happens using the inverters and then the voltage needs to be increased from 690V to 400kV which is carried out by the transformers.

1.2.3 The export limit as DC from the solar panels is determined by the installed inverter power. It is common practice to install more DC power through the solar panels than the available inverter power to ensure that the inverter operates as much of the time as possible close to its maximum capacity. Noting that each DC solar panel only produces power to its nominal (maximum nameplate) capacity when the light conditions are optimal owing to daily and seasonal differences. This ratio of installed solar PV to inverter power is measured as the DC:AC ratio. A standard DC:AC ratio design in the UK market is between 1.25:1.00 to 1.40:1.00 DC:AC ratio. At this level there is a good balance of energy production and losses based on the DC:AC inverter conversion rates. It is estimated by the Applicant that from the operating large-scale solar PV in the UK more than 90% will be within this range of DC:AC ratio.

1.2.4 The inverter is the piece of equipment that limits the maximum capacity that can be exported at the point of connection to the National Grid, and this is independent of the installed capacity in terms of DC. Inverters are typically oversized to compensate for system losses. The export limit as AC power into the national grid is also limited by the Bilateral Connection Agreement with NGESO which is 500MW.

1.2.5 In conclusion, the design of the system Sunnica has considered the system losses at HV (high voltage) and MV (medium voltage) lines, inverters, and transformers. The project has been designed to compensate for those losses to ensure that it can export 500MW at the Point of Connection (POC). To do this the electrical design for the scheme has included 516.8 MW of solar PV inverters and 627MWp of installed solar PV. The resulting DC:AC ratio is 1.21: 1.00. The approach taken is entirely consistent with other solar farm developers, which has been accepted through DCO examination.

1.3 Annual production

1.3.1 Technically it is possible to reduce the installed power capacity. The result will be a scheme that is below 1.25:1.00 DC:AC ratio and that performs sub-optimally in comparison to the industry standard.

1.3.2 If the scheme were to be reduced in size, then the overall annual energy generation that it was able to deliver would also be reduced as the amount of time that the Scheme is maximising its grid connection is reduced.

1.3.3 A working example using the data from table 1 above is presented in table 2 below. This compares the proposed scheme with another alternative which removes fields: E12 (41.51 MWp), E13 (14.72 MWp) and E05 (43.50MWp) a combined loss of total 99.72 MWp installed capacity solar PV from the overall proposed installed capacity solar PV total of 627 MWp. The result would be an installed capacity of 527.28 MWp solar PV.

1.3.4 Foregoing this level of energy production by reducing the power capacity of the scheme would result in an annual loss of 100 GWh of renewable energy as set out in the table below. This loss of renewable energy would be able to power 34,603 UK households assuming an annual equivalent electricity use of 2,900 kWh.

Plate 1-2 Energy generation average by month and overall annual production comparing 627MWp and 527 MWp

	Original DCO Submission **625MWp** (550 module)	Original DCO Submission updating module (575Wp) + Remove W01, W02, 3.5ha from W04 and E05 (**627MWp**)	Original DCO Submission updating module (575Wp + Remove W01, W02, 3.5ha from W04 and E05 + Removing E12+E13+E05 (**527MWp**)
Date	E_Grid exported by PV (GWh/mth)	E_Grid exported by PV (GWh/mth)	E_Grid exported by PV (GWh/mth)
January	15.28	15.28	12.80
February	25.27	25.37	21.29
March	52.86	53.31	44.86
April	77.17	77.67	65.43
May	84.46	85.07	71.86
June	85.98	86.69	73.30
July	86.52	87.35	73.67
August	74.37	75.13	63.26
September	61.37	61.86	52.07
October	37.16	37.64	31.63
November	18.95	19.03	15.95
December	12.67	12.72	10.65
Yearly total	632.02	637.12	536.77

1.4 Conclusion

1.4.1 In conclusion all solar schemes over plant above the contracted amount of power that can be delivered to the National Grid for the reasons set out above. A typical ration is 1.25:1.00 to 1.40:1.00 DC:AC ratio and Sunnica is already at the bottom end of that range. Therefore, there is no ability to remove additional fields from the Scheme without having a consequential effect on the amount of power which can be exported into the National Grid thereby undermining the government's energy policy and legal commitments to meeting net zero.