Appendix 4

to

Solar BOT Scope Book

Rev. 0

September 14, 2023

REVISION RECORD			
Revision No.	Approval Date	Section / Page Revised	Reason / Description of Change
0	9/14/2023	All	Initial Issue

APPENDIX 4: ENERGY MODEL

The following table will be used to establish Seller's bid basis in regard to the PV Plant performance and estimated annual Energy Yield. Seller shall complete all of the information requested in the below table in order to establish said basis of their bid. These Energy Yield model inputs, once agreed to and finalized as part of the Agreement will form the basis of the Appendix 7 – Performance Test Plant Capacity Model inputs, except as modified in Appendix 7 to account for adjusted system losses which are applicable at the time of the test vs. the assumed annual Energy Yield, such as soiling losses and module degradation / Light Induced Degradation (LID).

Once Seller and Buyer agree to the inputs, any Seller change in the inputs that may decrease performance must be approved by Buyer.

Refer to examples in Table 1 below for guidance on various testing scenarios:

Table 1: Energy Model Examples

Input	Annual Energy Yield Estimate Model	Plant Capacity Model
Soiling Rates	Include reasonable/agreed to monthly soiling profile estimates for the year.	Soiling stations' measurements are averaged during test period and then entered into all of the monthly averages for the model.
LID	Year-1 guaranteed module losses less the Year 2 – 30 annual degradation (Year-1 = 2.00% / 0.45% Annual, so modeled LID would be 2.00 – 0.45 = 1.55%)	Module manufacturer guidance for LID test data may be used. This can be adjusted down from the guaranteed rate, to remove the margin included in the OEM warranty rates. 50% of the LID warranty rate or 1.0% have been accepted values in the past. Annual Degradation is then added to this value as the average installed life of the modules on the site. e.g., average installed duration for the modules is 6 months, add on 0.45% * 6/12 = 0.225%, overall LID = 1.225%
Annual Degradation	OEM Guaranteed Rate (e.g. 0.45%)	0.00% (included in LID)
Module Quality	If flash test data is not available, 25% of the positive bin tolerance. e.g., 625W module +5/-0 bin tolerance. 5/625 = .008 = 0.8%, so take 25% of that and it gives you a -0.2% module quality model input value.	Actual average positive binning tolerance based on flash test results. So if average flash test for all modules was +2.5W then you would use 2.5/625 = .004 = 0.4% or a -0.4% modeling input for the capacity test.

		CERTAIN ENERGY MODEL INPUTS			
Nº	CHARACTERISTICS	UNITS	DATA		NOTES
1	**REFERENCE SITE CONDITIONS**	-	Bid Basis – Annual Energy Yield Estimate	Performance Test Plant Capacity Model	
1.1	Annual Global Horizontal Insolation (GHI) @ ground level	kWh/m² /year			
1.2	Annual Diffuse Horizontal Insolation (DHI) @ ground level	kWh/m² /year			
1.3	Altitude (above sea level)	ft			
2	**WEATHER DATA**	-			
2.1	Data source	-			
2.2	Period of data collection	months			
2.3	Distance from site or spatial resolution	km			
2.4	Uncertainty	%			
3	**MODEL PARAMETERS**	-			
3.1	Installed Capacity (DC)	MWp			
3.2	Nominal Power (AC)	MW			
3.3	Nominal Power at Electrical POI (AC)	MW			
3.4	DC/AC ratio	-			
3.5	PVsyst Software Version (should be as bid)	-			
3.6	Transposition Model	-			
3.7	Meteorological File Parameters (should be as bid)	-			Interval end is preferred
3.8	Post Processed Losses	%			
3.9	**PV Modules**	-			
3.9.1	PV module manufacturer and model	-			
3.9.2	PV module power at STC	Wp			
3.9.3	Technology	-			

		CERTAIN ENERGY MODEL INPUTS			
Nº	CHARACTERISTICS	UNITS	DATA		NOTES
3.9.4	Number of PV Modules per string	-			
3.9.5	Total number of PV Modules installed	-			
3.9.6	Total number of strings	-			
3.10	**Inverters**	-			
3.10.1	Inverter manufacturer and model	-			
3.10.2	Input voltage rating	V_{dc}			
3.10.3	Number of strings per inverter	-			
3.10.4	Number of inverters	-			
3.11	**Mounting System**	-			
3.11.1	Tilt angle of rotation limits of tracking system	°			
3.11.2	Backtracking	Yes / No			
3.11.3	Orientation of PV Modules (azimuth)	°			
3.11.4	Installation type (portrait / landscape)	-			
3.11.5	Rows and columns per mounting structure	- x -			
3.11.6	Ground Coverage Ratio	%			
3.12	**Array losses**	-			
3.12.1	Module quality loss	%			See example in Table 1
3.12.2	Module mismatch losses	%			
3.12.3	String mismatch losses	%			
3.12.4	Light induced degradation losses	%			Refer to example in Table 1
3.12.5	IAM losses defined by manufacturer	Yes / No			
3.12.6	Constant thermal loss factor	$W/m^2/k$			
3.12.7	Wind loss factor	$W/m^2/k/m/s$			

		CERTAIN ENERGY MODEL INPUTS			
Nº	**CHARACTERISTICS**	**UNITS**	**DATA**		**NOTES**
3.12.8	Soiling losses January February March April May June July August September October November December	%			Refer to example in Table 1
3.12.9	Ground Albedo January February March April May June July August September October November December				Average Annual and Monthly
3.12.10	Spectral correction applied	Yes / No			
3.13	**Cabling**	-			
3.13.1	DC ohmic losses @STC (Max/Calculated)	%			
3.13.2	AC ohmic losses @STC (Max/Calculated)	%			
3.14	**Transformers**	-			
3.14.1	Transformer type	-			
3.14.2	Number of transformers	-			
3.14.3	Constant Loss	W			
3.14.4	Peak Power Loss	W			
3.15	**System losses**	-			

		CERTAIN ENERGY MODEL INPUTS			
Nº	**CHARACTERISTICS**	**UNITS**	**DATA**		**NOTES**
3.15.1	Year 1 (starting at the Substantial Completion Payment Date) degradation	%			
3.15.2	Annual degradation	%			Refer to example in Table 1
3.15.3	Light soaking effect	%			
3.15.4	Inverter losses	%			
3.15.5	Auxiliary losses	%			
3.15.6	Unavailability	%			
3.15.7	Combined Uncertainty	%			
4	**ANNUAL PERFORMANCE RESULTS**	-	**PVsyst Results**	**Final Results**	Final Results include all post-processing work (assume 0% unavailability for model)
4.1	Net electricity production (P50)	MWh/yr			
4.1.3	30-year average, P50	MWh/yr			
4.2	Specific Yield (Year 1, starting at the Substantial Completion Date, P50)	kWh/kWp/yr			
4.3	Performance Ratio (Year 1, starting at the Substantial Completion Date, P50)	%			

***** END OF APPENDIX 4 *****