

Appendix I
PVsyst Simulation

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Grid-Connected System: Simulation parameters						
Project :	Grange solar farm 250-255W 27.5KW					
Geographical Site	Grange solar farm				Country	United Kingdom
Situation	Latitude	52.8°N	Longitude	0.0°E		
Time defined as	Legal Time	Time zone UT	Altitude	5 m		
	Albedo	0.20				
Meteo data:	grange solar farm	Synthetic - Meteonorm 6.1				
Simulation variant :	Grange Farm 250W255W 27.5kW - Purchase Order					
	Simulation date	23/07/14 08h03				

Simulation parameters

Collector Plane Orientation	Tilt	20°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Erbs, Meteonorm
Horizon	Free Horizon			
Near Shadings	According to strings Shadings of thin objects		Electrical effect	80 %
			Electrical effect	20 %

PV Arrays Characteristics (4 kinds of array defined)

Sub-array "255W 6 Strings"		Si-poly	Model	STP 255-20/Wd		
			Manufacturer	Suntech		
Number of PV modules			In series	24 modules	In parallel	1380 strings
Total number of PV modules			Nb. modules	33120	Unit Nom. Power	255 Wp
Array global power			Nominal (STC)	8446 kWp	At operating cond.	7506 kWp (50°C)
Sub-array "255W 5 Strings"		Si-poly	Model	STP 250-20/Wd		
			Manufacturer	Suntech		
Number of PV modules			In series	24 modules	In parallel	20 strings
Total number of PV modules			Nb. modules	480	Unit Nom. Power	250 Wp
Array global power			Nominal (STC)	120 kWp	At operating cond.	107 kWp (50°C)
Sub-array "250W 6 Strings"		Si-poly	Model	STP 250-20/Wd		
			Manufacturer	Suntech		
Number of PV modules			In series	24 modules	In parallel	738 strings
Total number of PV modules			Nb. modules	17712	Unit Nom. Power	250 Wp
Array global power			Nominal (STC)	4428 kWp	At operating cond.	3938 kWp (50°C)
Sub-array "250W 5 Strings"		Si-poly	Model	STP 250-20/Wd		
			Manufacturer	Suntech		
Number of PV modules			In series	24 modules	In parallel	10 strings
Total number of PV modules			Nb. modules	240	Unit Nom. Power	250 Wp
Array global power			Nominal (STC)	60.0 kWp	At operating cond.	53.4 kWp (50°C)
Total	Arrays global power		Nominal (STC)	13054 kWp	Total	51552 modules
			Module area	83869 m²	Cell area	75274 m²
Inverter			Model	SUN2000-28k TL		
			Manufacturer	Huawei Technologies		
			Operating Voltage	480-800 V	Unit Nom. Power	27.5 kW AC
Sub-array "255W 6 Strings"			Nb. of inverters	690 * MPPT 1/3	Total Power	6325 kW AC
Sub-array "255W 5 Strings"			Nb. of inverters	12 * MPPT 1/3	Total Power	110 kW AC
Sub-array "250W 6 Strings"			Nb. of inverters	369 * MPPT 1/3	Total Power	3383 kW AC
Sub-array "250W 5 Strings"			Nb. of inverters	6 * MPPT 1/3	Total Power	55 kW AC
Total			Nb. of inverters	359	Total Power	9873 kW AC

Grid-Connected System: Simulation parameters (continued)

PV Array loss factors

Thermal Loss factor	Uc (const)	29.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Array#1	0.97 mOhm	Loss Fraction	1.5 % at STC
	Array#2	68 mOhm	Loss Fraction	1.5 % at STC
	Array#3	1.8 mOhm	Loss Fraction	1.5 % at STC
	Array#4	135 mOhm	Loss Fraction	1.5 % at STC
	Global		Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.4 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

System loss factors

External transformer	Iron loss (24H connexion)	12805 W	Loss Fraction	0.0 % at STC
	Resistive/Inductive losses	0.2 mOhm	Loss Fraction	1.0 % at STC
Unavailability of the system	1.8 days, 3 periods		Time fraction	0.5 %

User's needs :

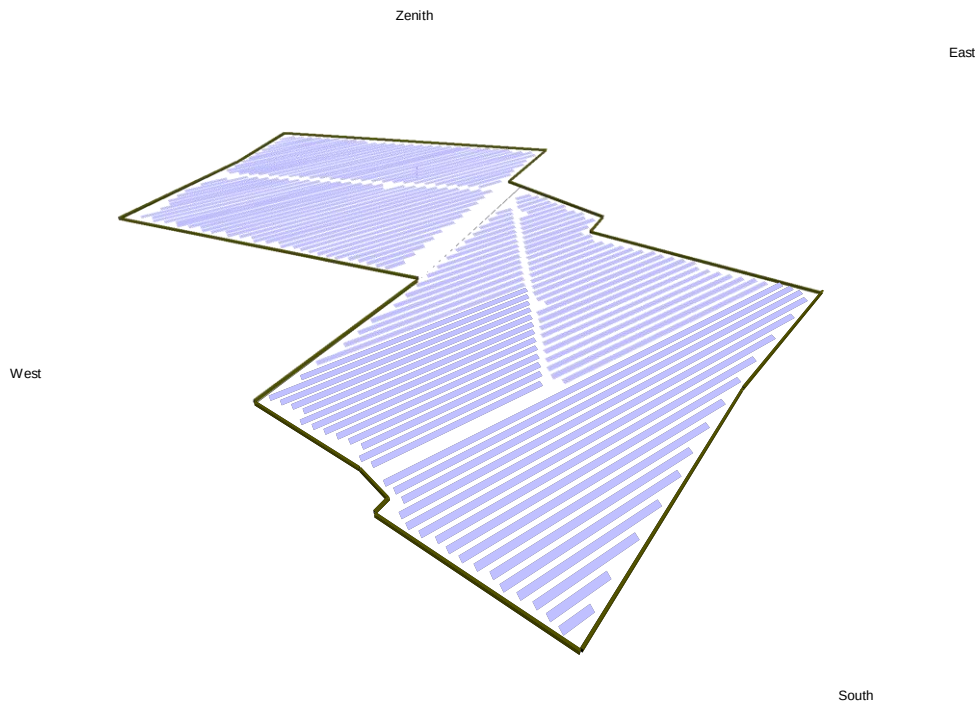
Unlimited load (grid)

Grid-Connected System: Near shading definition

Project : Grange solar farm 250-255W 27.5KW
Simulation variant : Grange Farm 250W255W 27.5kW - Purchase Order

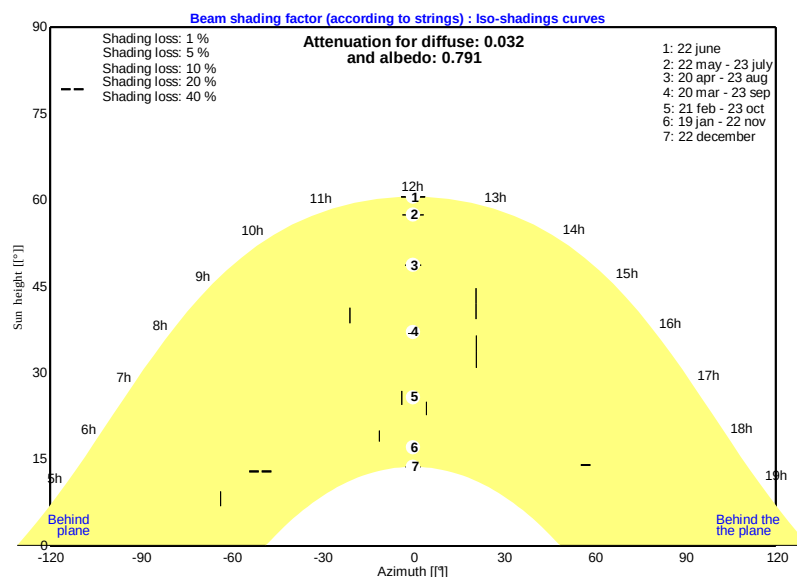
Main system parameters	System type	Grid-Connected		
Near Shadings	According to strings		Electrical effect	80 %
	Shadings of thin objects		Electrical effect	20 %
PV Field Orientation	tilt	20°	azimuth	0°
PV modules	Model	STP 255-20/Wd	Pnom	255 Wp
PV modules	Model	STP 250-20/Wd	Pnom	250 Wp
PV Array	Nb. of modules	51552	Pnom total	13054 kWp
Inverter	Model	SUN2000-28k TL	Pnom	27.50 kW ac
Inverter pack	Nb. of units	359.0	Pnom total	9873 kW ac
User's needs	Unlimited load (grid)			

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Grange solar farm 250-255W 27.5KW



Grid-Connected System: Main results

Project :

Grange solar farm 250-255W 27.5KW

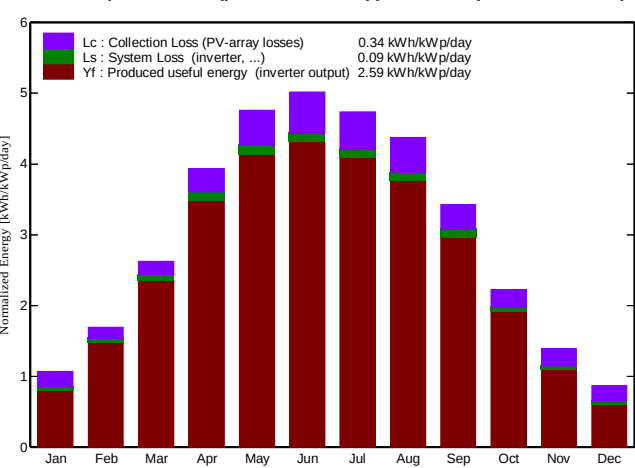
Simulation variant :

Grange Farm 250W255W 27.5kW - Purchase Order

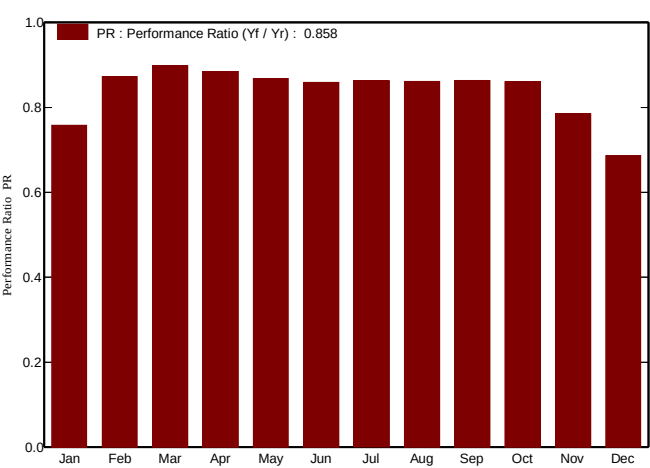
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PV Field Orientation	tilt	azimuth	0°
PV modules	Model	Pnom	255 Wp
PV modules	Model	Pnom	250 Wp
PV Array	Nb. of modules	Pnom total	13054 kWp
Inverter	Model	Pnom	27.50 kW ac
Inverter pack	Nb. of units	Pnom total	9873 kW ac
User's needs	Unlimited load (grid)		

Main simulation results			
System Production	Produced Energy	12338 MWh/year	Specific prod. 945 kWh/kWp/year
	Performance Ratio PR	85.8 %	

Normalized productions (per installed kWp): Nominal power 13054 kWp



Performance Ratio PR



Grange Farm 250W255W 27.5kW - Purchase Order

Balances and main results

	GlobHor	T Amb	GlobInc	GlobEff	EArray	E_Grid	EffArrR	EffSysR
	kWh/m²	℃	kWh/m²	kWh/m²	MWh	MWh	%	%
January	21.2	3.40	33.2	28.0	347	328	12.45	11.80
February	35.5	4.40	47.5	43.8	561	541	14.10	13.58
March	68.8	6.69	81.5	76.5	986	955	14.42	13.98
April	106.5	9.18	118.2	111.7	1412	1365	14.25	13.77
May	142.1	12.29	147.6	139.2	1726	1673	13.94	13.51
June	148.4	15.38	150.6	142.1	1735	1689	13.74	13.37
July	143.1	16.69	147.0	138.5	1702	1656	13.81	13.44
August	122.9	16.99	135.7	128.6	1569	1526	13.79	13.41
September	85.8	14.00	102.8	97.1	1207	1159	14.00	13.44
October	51.2	10.40	69.0	64.4	802	775	13.87	13.40
November	26.8	6.39	41.8	36.4	448	429	12.78	12.22
December	16.4	3.70	27.1	21.6	264	243	11.61	10.69
Year	968.6	9.99	1101.8	1027.7	12759	12338	13.81	13.35

Legends:

GlobHor

Horizontal global irradiation

T Amb

Ambient Temperature

GlobInc

Global incident in coll. plane

GlobEff

Effective Global, corr. for IAM and shadings

EArray

Effective energy at the output of the array

E_Grid

Energy injected into grid

EffArrR

Effic. Eout array / rough area

EffSysR

Effic. Eout system / rough area

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Grid-Connected System: Loss diagram			
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PV Field Orientation	tilt	azimuth	0°
PV modules	Model	Pnom	255 Wp
PV modules	Model	Pnom	250 Wp
PV Array	Nb. of modules	Pnom total	13054 kWp
Inverter	Model	Pnom	27.50 kW ac
Inverter pack	Nb. of units	Pnom total	9873 kW ac
User's needs	Unlimited load (grid)		

Loss diagram over the whole year

