Version 7.3.2

PVsyst - Simulation report

Grid-Connected System

Project: Essex-wit_finances

Variant: Simulation_with_finances

Building system

System power: 8.93 kWp

Black Notley - United Kingdom

Author

University of Edinburgh (United kingdom)

Project: Essex-wit_finances

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University of Edinburgh (United kingdom)

Project summary

Geographical Site
Black Notley
United Kingdom

Situation

Latitude	51.86 °N
Longitude	0.55 °E
Altitude	74 m
Time zone	UTC

Project settings
Albedo 0.20

Meteo data
Black Notley
Meteonorm 8.1 (2004-2013), Sat=91% - Synthetic

System summary

Grid-Connected System

Building system

PV Field Orientation

Fixed planes	2 orientations
Tilts/azimuths	40 / 88 °
	20 / -2 °

Near Shadings
According to strings
Electrical effect 100 %

User's needs
Unlimited load (grid)

System information

PV Array

Nb. of modules	21 units
Pnom total	8.93 kWp

Inverters

Nb. of units	1.6 units
Pnom total	6.70 kWac
Pnom ratio	1.332

Results summary

Produced Energy	8099.33 kWh/year	Specific production	907 kWh/kWp/year	Perf. Ratio PR	83.10 %

Table of contents

General parameters

Grid-Connected System

Building system

PV Field Orientation

Orientation		Sheds configuration	Models used	
Fixed planes	2 orientations		Transposition	Perez
Tilts/azimuths	40 / 88 °		Diffuse	Perez, Meteonorm
	20 / -2 °		Circumsolar	separate

Horizon
Free Horizon

Near Shadings
According to strings
Electrical effect 100 %

User's needs
Unlimited load (grid)

PV Array Characteristics

Array #1 - Area West

Orientation #1
Tilt/Azimuth 40/88 °

PV module

Manufacturer	Generic
Model	TSM-DE09R-08W-425wp
(Original PVsyst database)	
Unit Nom. Power	425 Wp
Number of PV modules	15 units
Nominal (STC)	6.38 kWp
Modules	1 String x 15 In series
At operating cond. (50°C)	
Pmpp	5.84 kWp
U mpp	575 V
I mpp	10 A

Inverter

Manufacturer	Generic
Model	Sunny Tripower 7000TL-20
(Original PVsyst database)	
Unit Nom. Power	7.00 kWac
Number of inverters	1 * MPPT 0.60 0.6 unit
Total power	4.2 kWac
Operating voltage	290-800 V
Pnom ratio (DC:AC)	1.52

Array #2 - Area 3 South

Orientation #2
Tilt/Azimuth 20/-2 °

PV module

Manufacturer	Generic
Model	TSM-DE09R-08W-425wp
(Original PVsyst database)	
Unit Nom. Power	425 Wp
Number of PV modules	6 units
Nominal (STC)	2550 Wp
Modules	1 String x 6 In series
At operating cond. (50°C)	
Pmpp	2335 Wp
U mpp	230 V
I mpp	10 A

Inverter

Manufacturer	Generic
Model	Sunny Boy 2500TLST-21
(Original PVsyst database)	
Unit Nom. Power	2.50 kWac
Number of inverters	1 unit
Total power	2.5 kWac
Operating voltage	180-500 V
Pnom ratio (DC:AC)	1.02

Total PV power

Nominal (STC)	9 kWp
Total	21 modules
Module area	42.0 m²

Total inverter power

Total power	6.7 kWac
Nb. of inverters	2 units
	0.4 unused
Pnom ratio	1.33

Array losses

Array Soiling Losses
Loss Fraction 3.0 %

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 29.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

IAM loss factor
Incidence effect (IAM): Fresnel, AR coating, n(glass)=1.526, n(AR)=1.290

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	0.999	0.987	0.962	0.892	0.816	0.681	0.440	0.000

DC wiring losses

Global wiring resistance 10 mΩ
Loss Fraction 1.5 % at STC

Array #1 - Area West
Global array res. 936 mΩ
Loss Fraction 1.5 % at STC

Array #2 - Area 3 South
Global array res. 374 mΩ
Loss Fraction 1.5 % at STC

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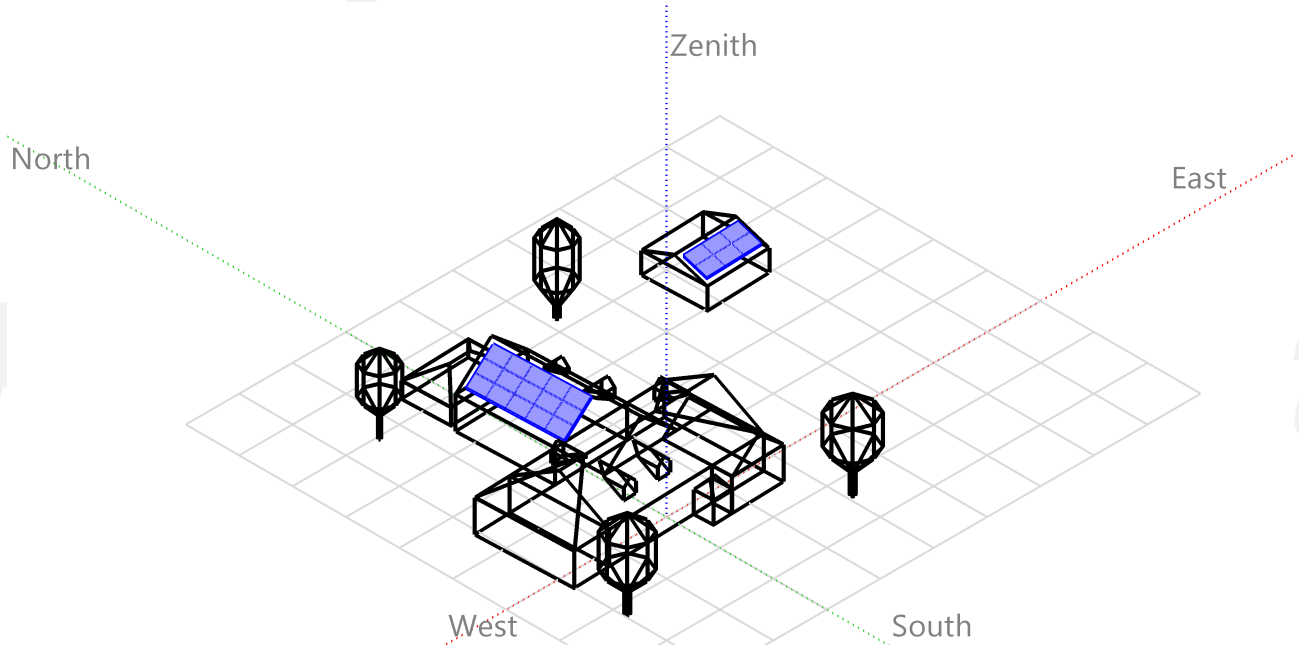
Near shadings parameter

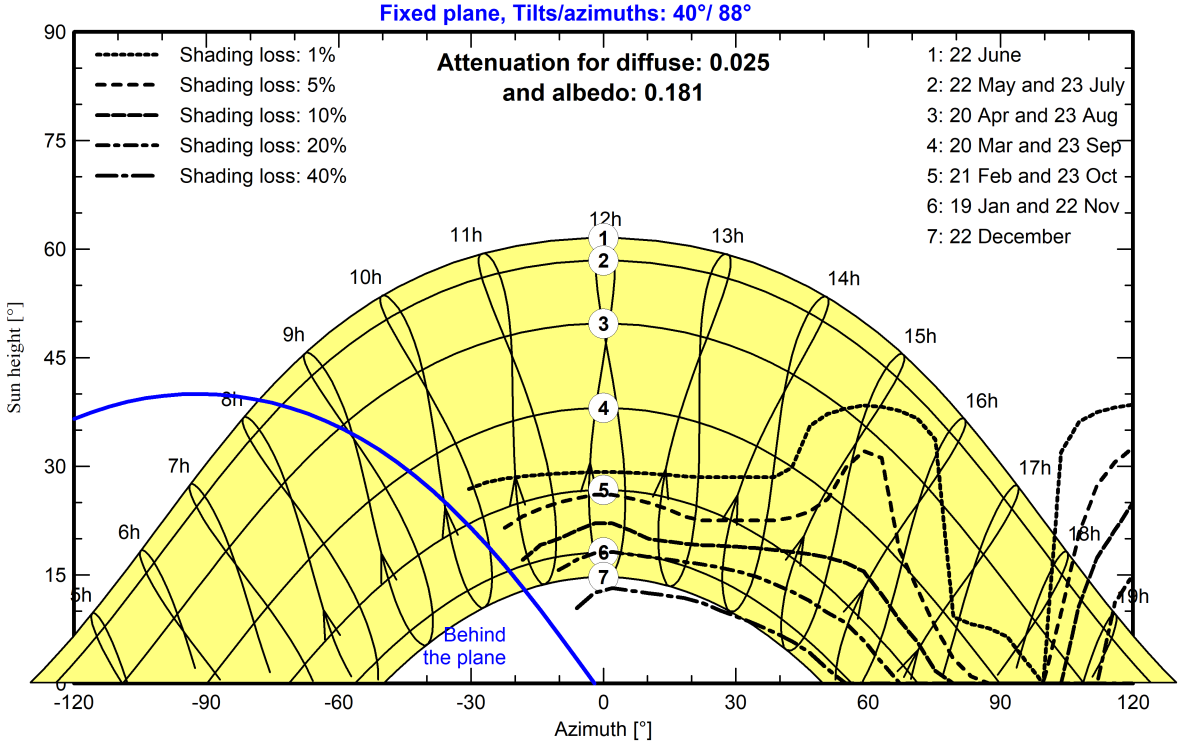
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

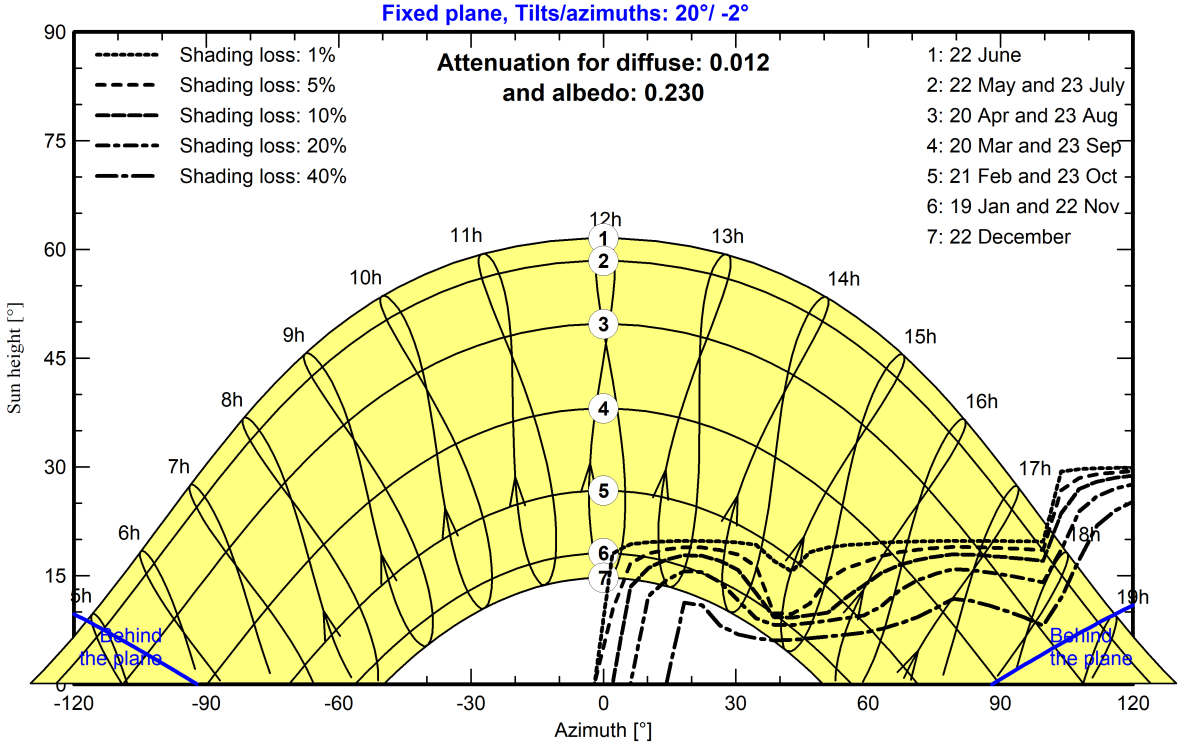
Orientation #1

Fixed plane, Tilts/azimuths: 40°/ 88°



Orientation #2

Fixed plane, Tilts/azimuths: 20°/ -2°



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Main results

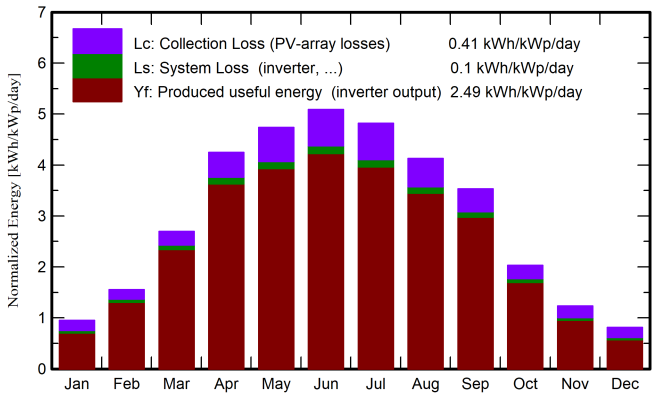
System Production

Produced Energy	8099.33 kWh/year	Specific production	907 kWh/kWp/year
		Performance Ratio PR	83.10 %

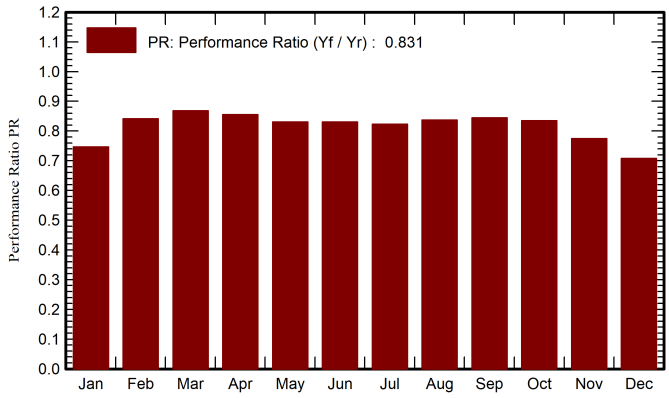
Economic evaluation

Investment		Yearly cost		LCOE	
Global	8,376.54 GBP	Annuities	0.00 GBP/yr	Energy cost	0.05 GBP/kWh
Specific	0.94 GBP/Wp	Run. costs	109.96 GBP/yr		
		Payback period	7.4 years		

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

	GlobHor	DiffHor	T_Amb	GlobInc	GlobEff	EArray	E_Grid	PR
	kWh/m²	kWh/m²	°C	kWh/m²	kWh/m²	kWh	kWh	ratio
January	23.6	13.24	4.41	29.5	24.9	210	196	0.746
February	38.1	22.00	4.50	43.5	39.7	343	326	0.842
March	78.7	43.53	6.21	83.6	77.5	674	648	0.868
April	128.3	56.77	8.75	127.5	119.2	1007	973	0.855
May	155.8	74.24	11.97	146.9	137.2	1127	1088	0.830
June	167.3	81.91	14.94	152.6	142.0	1172	1132	0.831
July	159.6	75.46	17.51	149.5	139.6	1137	1098	0.823
August	130.8	71.75	17.14	127.9	119.4	990	955	0.837
September	98.9	43.38	14.32	105.9	98.8	827	798	0.845
October	57.9	31.60	11.24	63.1	58.0	490	470	0.835
November	30.1	16.12	7.12	37.0	32.2	270	256	0.774
December	19.9	11.11	5.18	25.1	20.5	171	159	0.707
Year	1089.1	541.11	10.31	1092.1	1009.0	8418	8099	0.831

Legends

GlobHor	Global horizontal irradiation
DiffHor	Horizontal diffuse 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
PR	Performance Ratio

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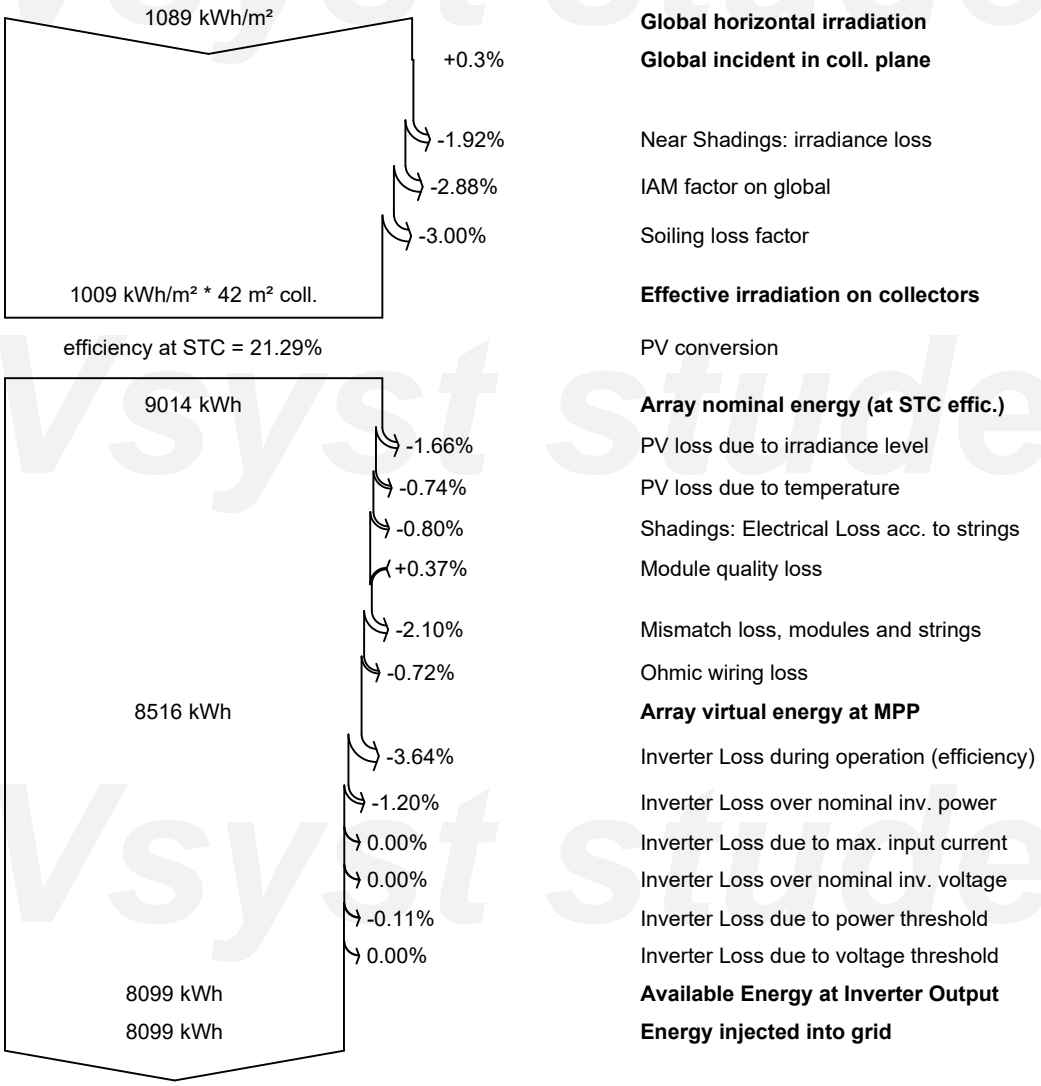
Loss diagram



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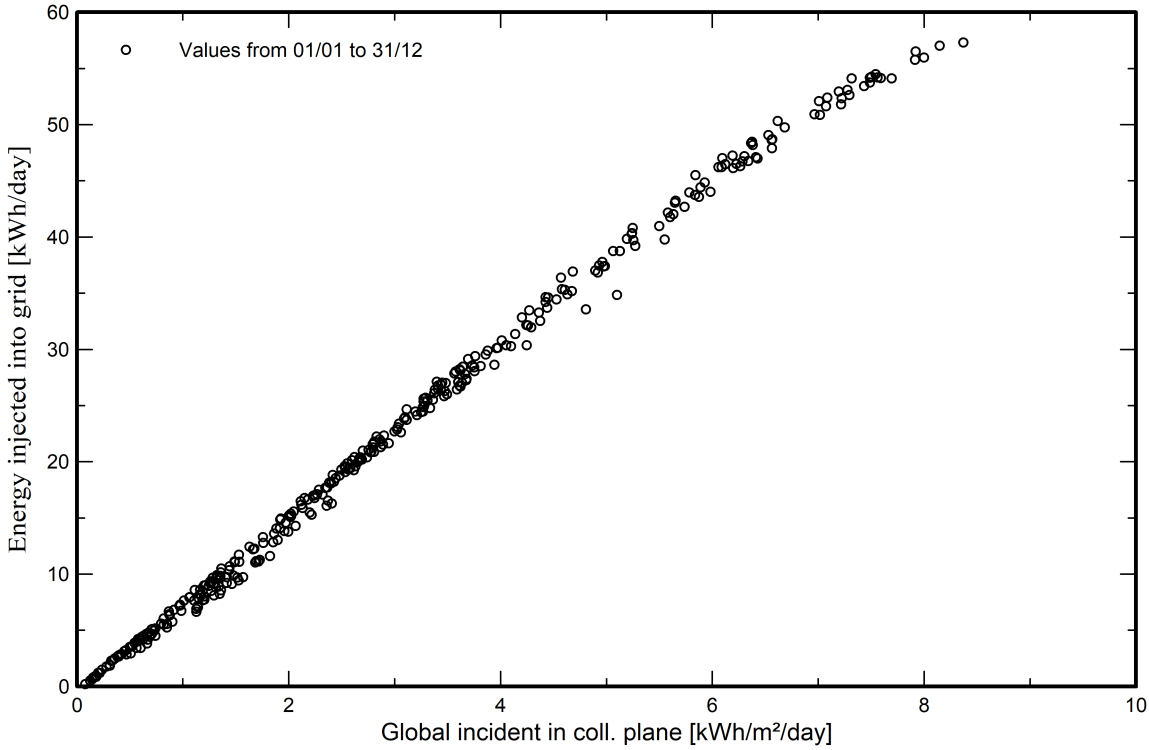
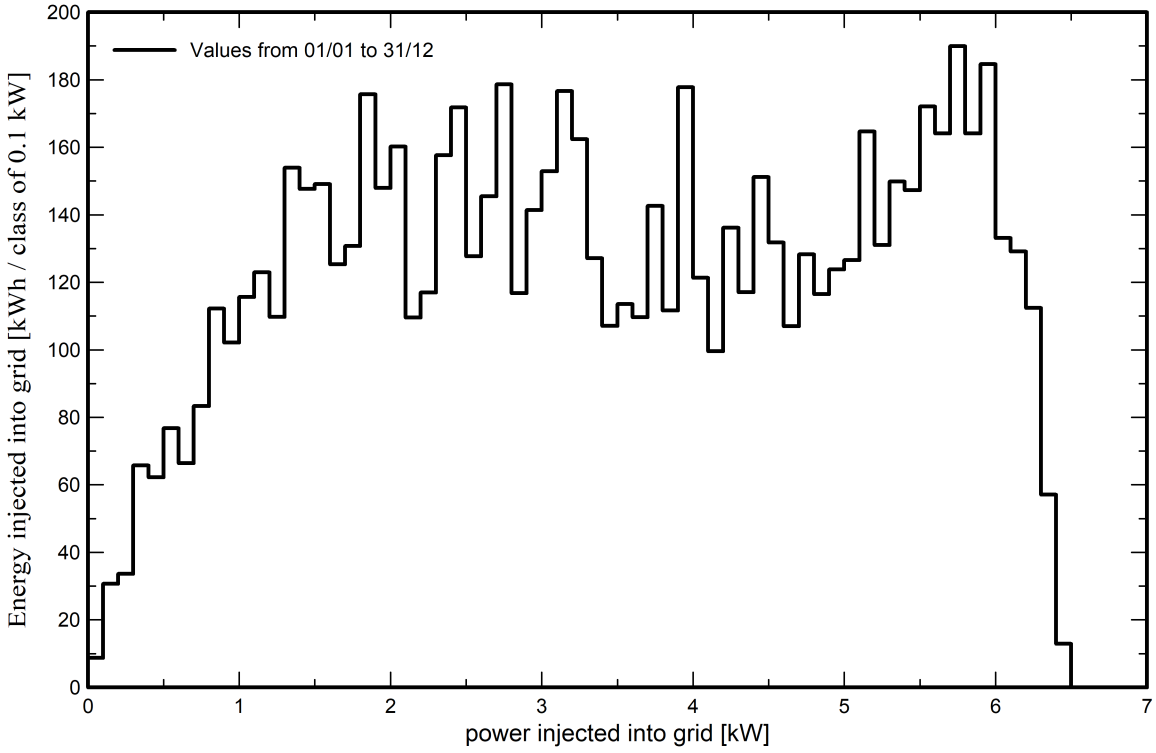
Predef. graphs

Daily Input/Output diagram



System Output Power Distribution



P50 - P90 evaluation

Meteo data

Source	Meteonorm 8.1 (2004-2013), Sat=91%
Kind	Not defined
Year-to-year variability(Variance)	-1.0 %
Specified Deviation	

Simulation and parameters uncertainties

PV module modelling/parameters	1.0 %
Inverter efficiency uncertainty	0.5 %
Soiling and mismatch uncertainties	1.0 %
Degradation uncertainty	0.6 %

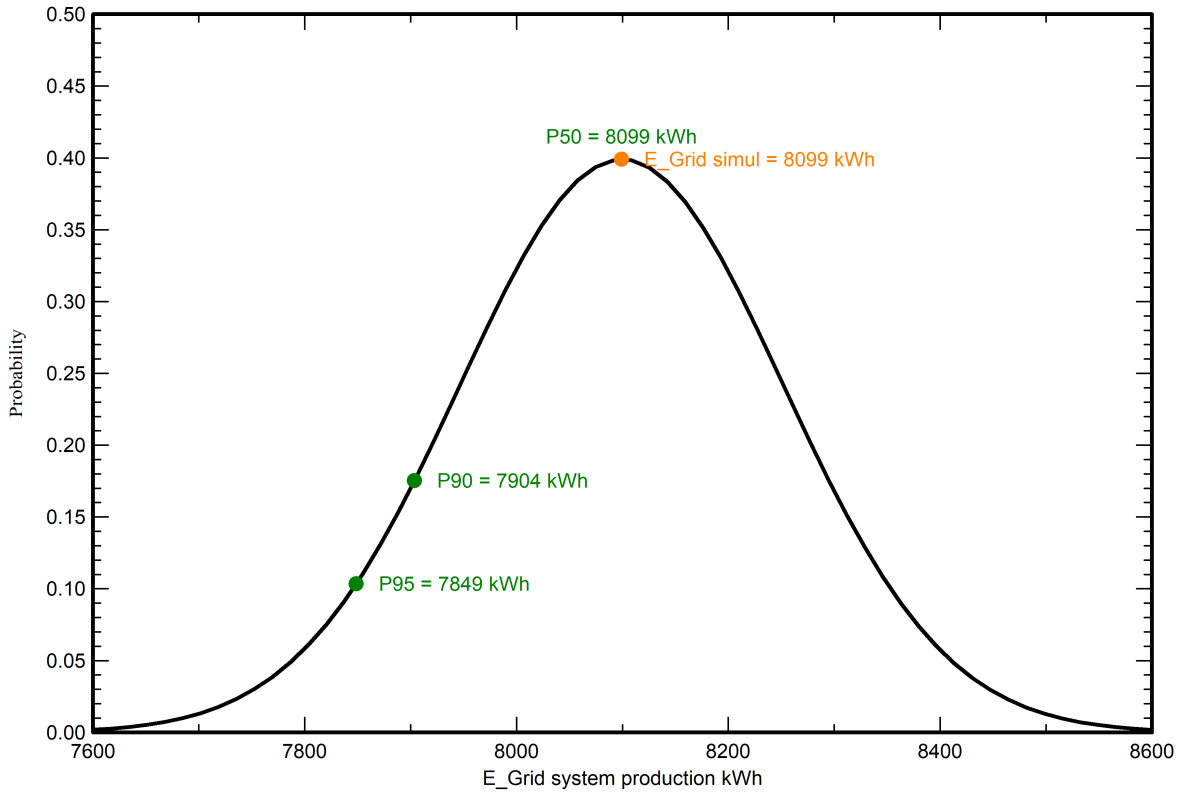
Global variability (meteo + system)

Variability (Quadratic sum)	1.9 %

Annual production probability

Variability	153 kWh
P50	8099 kWh
P90	7904 kWh
P95	7849 kWh

Probability distribution



Cost of the system

Installation costs

Item	Quantity units	Cost GBP	Total GBP
PV modules			
TSM-DE09R-08W-425wp	21	142.00	2,982.00
Supports for modules	21	25.00	525.00
Inverters			
Sunny Tripower 7000TL-20	1	1,536.33	921.80
Sunny Boy 2500TLST-21	1	397.74	397.74
Other components			
Wiring	300	1.00	300.00
Combiner box	200	1.00	200.00
Monitoring system, display screen	300	1.00	300.00
Measurement system, pyranometer	300	1.00	300.00
Surge arrester	150	1.00	150.00
Installation			
Global installation cost per module	21	95.24	2,000.00
Grid connection	300	1.00	300.00
		Total	8,376.54
		Depreciable asset	4,826.54

Operating costs

Item	Total GBP/year
Maintenance	
Provision for inverter replacement	109.96
Total (OPEX)	109.96

System summary

Total installation cost	8,376.54	GBP
Operating costs	109.96	GBP/year
Produced Energy	8099	kWh/year
Cost of produced energy (LCOE)	0.051	GBP/kWh

Financial analysis

Simulation period

Project lifetime	25 years	Start year	2023

Income variation over time

Inflation	0.00 %/year
Production variation (aging)	0.55 %/year
Discount rate	0.00 %/year

Income dependent expenses

Income tax rate	0.00 %/year
Other income tax	0.00 %/year
Dividends	0.00 %/year

Depreciable assets

Asset	Depreciation method	Depreciation period (years)	Salvage value (GBP)	Depreciable (GBP)
PV modules				
TSM-DE09R-08W-425wp	Straight-line	25	0.00	2,982.00
Supports for modules	Straight-line	25	0.00	525.00
Inverters				
Sunny Tripower 7000TL-20	Straight-line	25	0.00	921.80
Sunny Boy 2500TLST-21	Straight-line	25	0.00	397.74
		Total	0.00	4,826.54

Financing

Own funds	8,376.54 GBP

Electricity sale

Feed-in tariff	0.1500 GBP/kWh
Duration of tariff warranty	20 years
Annual connection tax	0.00 GBP/kWh
Annual tariff variation	0.0 %/year
Feed-in tariff decrease after warranty	0.00 %

Return on investment

Payback period	7.4 years
Net present value (NPV)	21,338.64 GBP
Internal rate of return (IRR)	13.09 %
Return on investment (ROI)	254.7 %

Financial analysis

Detailed economic results (GBP)

Year	Electricity sale	Own funds	Run. costs	Deprec. allow.	Taxable income	Taxes	After-tax profit	Cumul. profit	% amorti.
0	0	8,377	0	0	0	0	0	-8,377	0.0%
1	1,215	0	110	193	912	0	1,105	-7,272	13.2%
2	1,222	0	110	193	919	0	1,112	-6,160	26.5%
3	1,228	0	110	193	925	0	1,118	-5,042	39.8%
4	1,235	0	110	193	932	0	1,125	-3,917	53.2%
5	1,242	0	110	193	939	0	1,132	-2,785	66.8%
6	1,249	0	110	193	946	0	1,139	-1,646	80.4%
7	1,256	0	110	193	953	0	1,146	-500	94.0%
8	1,262	0	110	193	959	0	1,152	652	107.8%
9	1,269	0	110	193	966	0	1,159	1,812	121.6%
10	1,276	0	110	193	973	0	1,166	2,978	135.6%
11	1,283	0	110	193	980	0	1,173	4,151	149.6%
12	1,290	0	110	193	987	0	1,180	5,332	163.7%
13	1,298	0	110	193	995	0	1,188	6,520	177.8%
14	1,305	0	110	193	1,002	0	1,195	7,714	192.1%
15	1,312	0	110	193	1,009	0	1,202	8,916	206.4%
16	1,319	0	110	193	1,016	0	1,209	10,125	220.9%
17	1,326	0	110	193	1,023	0	1,216	11,342	235.4%
18	1,334	0	110	193	1,031	0	1,224	12,565	250.0%
19	1,341	0	110	193	1,038	0	1,231	13,796	264.7%
20	1,348	0	110	193	1,045	0	1,238	15,035	279.5%
21	1,356	0	110	193	1,053	0	1,246	16,280	294.4%
22	1,363	0	110	193	1,060	0	1,253	17,534	309.3%
23	1,371	0	110	193	1,068	0	1,261	18,794	324.4%
24	1,378	0	110	193	1,075	0	1,268	20,063	339.5%
25	1,386	0	110	193	1,083	0	1,276	21,339	354.7%
Total	**32,464**	**8,377**	**2,749**	**4,827**	**24,889**	**0**	**29,715**	**21,339**	**354.7%**

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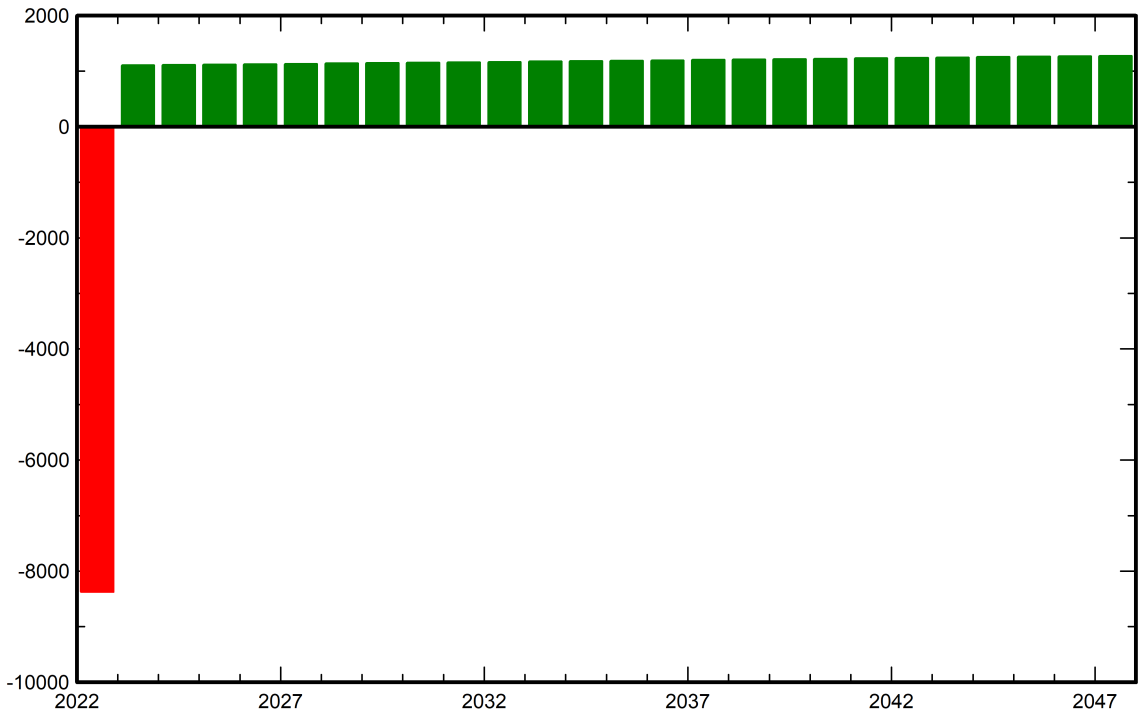
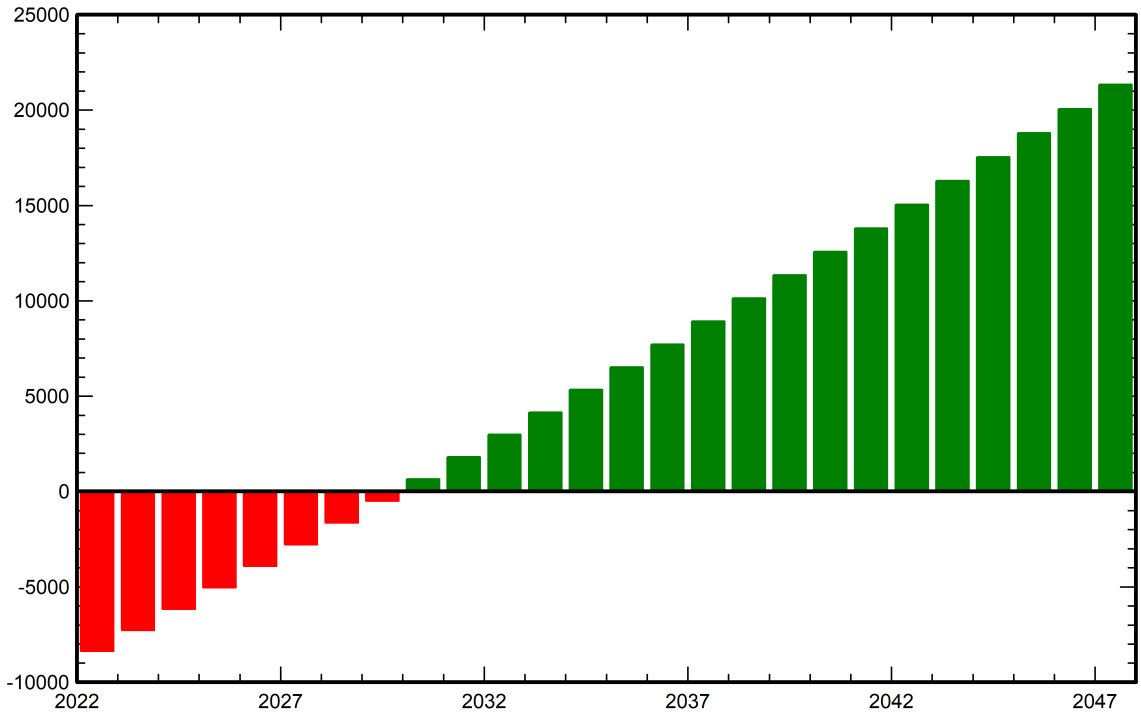
Financial analysis

Yearly net profit (GBP)



Cumulative cashflow (GBP)



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CO_2 Emission Balance

Total: 98.2 tCO_2

Generated emissions

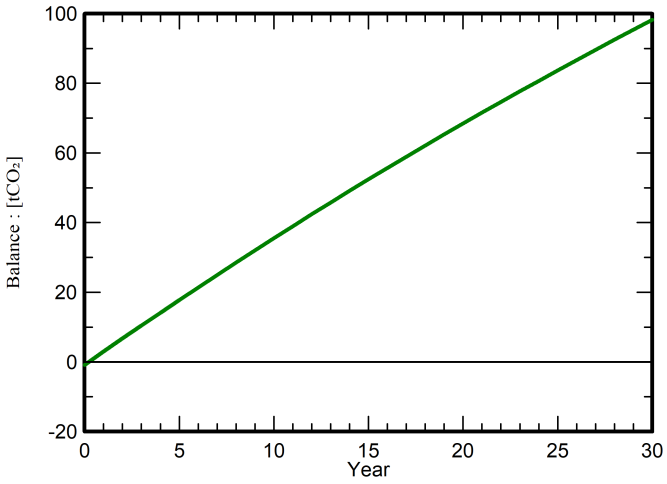
Total: 0.86 tCO_2

Source: Detailed calculation from table below

Replaced Emissions

Total: 114.2 tCO_2
System production: 8099.33 kWh/yr
Grid Lifecycle Emissions: 470 gCO_2/kWh
Source: IEA List
Country: United Kingdom
Lifetime: 30 years
Annual degradation: 1.0 %

Saved CO_2 Emission vs. Time



System Lifecycle Emissions Details

Item	LCE	Quantity	Subtotal
			[$kgCO_2$]
Modules	1209 kgCO2/kWp	0.43 kWp	514
Supports	3.13 kgCO2/kg	10.00 kg	31.3
Inverters	311 kgCO2/units	1.00 units	311