

PVsyst - Simulation report

Grid-Connected System

Project: Bhadla MiniGrid Solar 1

Variant: New simulation variant

Sheds, single array

System power: 17.74 MWp

Ghator - India

Author

AVENGERS RAYS SOLAR PRIVATE LIMITED (India)



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Project summary

Geographical Site

Ghator

India

Situation

Latitude 27.40 °N

Longitude 72.28 °E

Altitude 183 m

Time zone UTC+5.5

Project settings

Albedo 0.20

Weather data

Ghator

SolarGIS Monthly aver. , period not spec. - Synthetic

System summary

Grid-Connected System

PV Field Orientation

Fixed plane

Tilt/Azimuth 22 / 0 °

Sheds, single array

Near Shadings

Linear shadings : Fast (table)

User's needs

Unlimited load (grid)

System information

PV Array

Nb. of modules

30856 units

Pnom total

17.74 MWp

Inverters

Nb. of units

8 units

Pnom total

19.45 MWac

Pnom ratio

0.912

Results summary

Produced Energy	32751369 kWh/year	Specific production	1846 kWh/kWp/year	Perf. Ratio PR	82.96 %
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General parameters

Grid-Connected System

PV Field Orientation

Orientation

Fixed plane
Tilt/Azimuth 22 / 0 °

Horizon

Free Horizon

Bifacial system

Model 2D Calculation
unlimited sheds

Bifacial model geometry

Sheds spacing 7.75 m
Sheds width 4.62 m
Limit profile angle 26.3 °
GCR 59.6 %
Height above ground 0.75 m

Sheds, single array

Sheds configuration

Nb. of sheds 150 units
Single array

Sizes

Sheds spacing 7.75 m
Collector width 4.58 m
Ground Cov. Ratio (GCR) 59.0 %
Top inactive band 0.02 m
Bottom inactive band 0.02 m

Shading limit angle

Limit profile angle 26.3 °

Near Shadings

Linear shadings : Fast (table)

Models used

Transposition Perez
Diffuse Perez, Meteonorm
Circumsolar separate

User's needs

Unlimited load (grid)

PV Array Characteristics

PV module

Manufacturer Waaree Energies Ltd.
Model BiN-08-575
(Custom parameters definition)

Unit Nom. Power 575 Wp
Number of PV modules 6216 units
Nominal (STC) 3574 kWp

Array #1 - PV Array

Number of PV modules 4928 units
Nominal (STC) 2834 kWp
Modules 176 string x 28 In series

At operating cond. (50°C)

Pmpp 2619 kWp
U mpp 1097 V
I mpp 2387 A

Array #5 - Sub-array #5

Number of PV modules 1288 units
Nominal (STC) 741 kWp
Modules 46 string x 28 In series

At operating cond. (50°C)

Pmpp 685 kWp
U mpp 1097 V
I mpp 624 A

Inverter

Manufacturer FIMER
Model PVS980-58-1250-L prelim rev. A
(Custom parameters definition)

Unit Nom. Power 1215 kWac
Number of inverters 3 units
Total power 3645 kWac

Number of inverters 2 units
Total power 2430 kWac

Operating voltage 978-1500 V
Max. power (=>25°C) 1250 kWac
Pnom ratio (DC:AC) 1.17

Number of inverters 1 unit
Total power 1215 kWac

Operating voltage 978-1500 V
Max. power (=>25°C) 1250 kWac
Pnom ratio (DC:AC) 0.61



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PV Array Characteristics

Array #2 - Sub-array #2

PV module

Manufacturer Waaree Energies Ltd.
Model BiN-08-575

(Custom parameters definition)

Unit Nom. Power 575 Wp
Number of PV modules 6160 units
Nominal (STC) 3542 kWp
Modules 220 string x 28 In series

At operating cond. (50°C)

Pmpp 3274 kWp
U mpp 1097 V
I mpp 2984 A

PV module

Manufacturer Waaree Energies Ltd.
Model BiN-08-575

(Custom parameters definition)

Unit Nom. Power 575 Wp
Number of PV modules 18480 units
Nominal (STC) 10.63 MWp

Array #3 - Sub-array #3

Number of PV modules 12320 units
Nominal (STC) 7084 kWp
Modules 440 string x 28 In series

At operating cond. (50°C)

Pmpp 6548 kWp
U mpp 1097 V
I mpp 5967 A

Array #4 - Sub-array #4

Number of PV modules 6160 units
Nominal (STC) 3542 kWp
Modules 220 string x 28 In series

At operating cond. (50°C)

Pmpp 3274 kWp
U mpp 1097 V
I mpp 2984 A

Total PV power

Nominal (STC) 17742 kWp
Total 30856 modules
Module area 79709 m²

Inverter

Manufacturer FIMER
Model PVS980-58-2500-L prelim rev. A

(Custom parameters definition)

Unit Nom. Power 2431 kWac
Number of inverters 2 units
Total power 4862 kWac
Operating voltage 978-1500 V
Max. power (=>25°C) 2500 kWac
Pnom ratio (DC:AC) 0.73

Inverter

Manufacturer FIMER
Model PVS980-58-3750-L prelim rev. A

(Custom parameters definition)

Unit Nom. Power 3647 kWac
Number of inverters 3 units
Total power 10941 kWac

Number of inverters 2 units
Total power 7294 kWac

Operating voltage 978-1500 V
Max. power (=>25°C) 3750 kWac
Pnom ratio (DC:AC) 0.97

Number of inverters 1 unit
Total power 3647 kWac

Operating voltage 978-1500 V
Max. power (=>25°C) 3750 kWac
Pnom ratio (DC:AC) 0.97

Total inverter power

Total power 19448 kWac
Max. power 20000 kWac
Number of inverters 8 units
Pnom ratio 0.91

Array losses

Array Soiling Losses

Loss Fraction 1.0 %

Thermal Loss factor

Module temperature according to irradiance
Uc (const) 20.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

Serie Diode Loss

Voltage drop 0.7 V
Loss Fraction 0.1 % at STC

LID - Light Induced Degradation

Loss Fraction 0.3 %

Module Quality Loss

Loss Fraction 0.5 %

Module mismatch losses

Loss Fraction 2.0 % at MPP

Strings Mismatch loss

Loss Fraction 0.2 %



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Array losses

IAM loss factor

Incidence effect (IAM): User defined profile

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	1.000	0.999	0.993	0.979	0.946	0.855	0.615	0.000

DC wiring losses

Global wiring resistance 1.2 mΩ
Loss Fraction 1.5 % at STC

Array #1 - PV Array

Global array res. 7.5 mΩ
Loss Fraction 1.5 % at STC

Array #3 - Sub-array #3

Global array res. 3.0 mΩ
Loss Fraction 1.5 % at STC

Array #5 - Sub-array #5

Global array res. 29 mΩ
Loss Fraction 1.5 % at STC

Array #2 - Sub-array #2

Global array res. 6.0 mΩ
Loss Fraction 1.5 % at STC

Array #4 - Sub-array #4

Global array res. 6.0 mΩ
Loss Fraction 1.5 % at STC

System losses

Unavailability of the system

Time fraction 1.0 %
3.7 days,
3 periods

Auxiliaries loss

Proportionnal to Power 5.0 W/kW
0.0 kW from Power thresh.
Night aux. cons. 5.00 kW

AC wiring losses

Inv. output line up to MV transfo

Inverter voltage 690 Vac tri
Loss Fraction 0.36 % at STC

Inverters: PVS980-58-1250-L prelim rev. A, PVS980-58-2500-L prelim rev. A, PVS980-58-3750-L prelim rev. A

Wire section (7 Inv.) Alu 7 x 3 x 1000 mm²
Average wires length 25 m

Inverter: PVS980-58-1250-L prelim rev. A

Wire section (1 Inv.) Alu 1 x 3 x 500 mm²
Wires length 0 m

MV line up to HV Transfo

MV Voltage 20 kV
Wires Alu 3 x 500 mm²
Length 900 m
Loss Fraction 0.25 % at STC

HV line up to Injection

HV line voltage 33 kV
Wires Alu 3 x 240 mm²
Length 500 m
Loss Fraction 0.10 % at STC

AC losses in transformers



AC losses in transformers

MV transfo

Medium voltage 20 kV

Transformer parameters

Nominal power at STC	17.39 MVA
Iron Loss (24/24 Connexion)	17.39 kVA
Iron loss fraction	0.10 % at STC
Copper loss	156.52 kVA
Copper loss fraction	0.90 % at STC
Coils equivalent resistance	3 x 0.25 mΩ

HV transfo

Grid voltage 33 kV

Transformer from Datasheets

Nominal power	17390 kVA
Iron Loss (24/24 Connexion)	17.00 kVA
Iron loss fraction	0.10 % of PNom
Copper loss	170.00 kVA
Copper loss fraction	0.98 % at PNom
Coils equivalent resistance	3 x 224.86 mΩ



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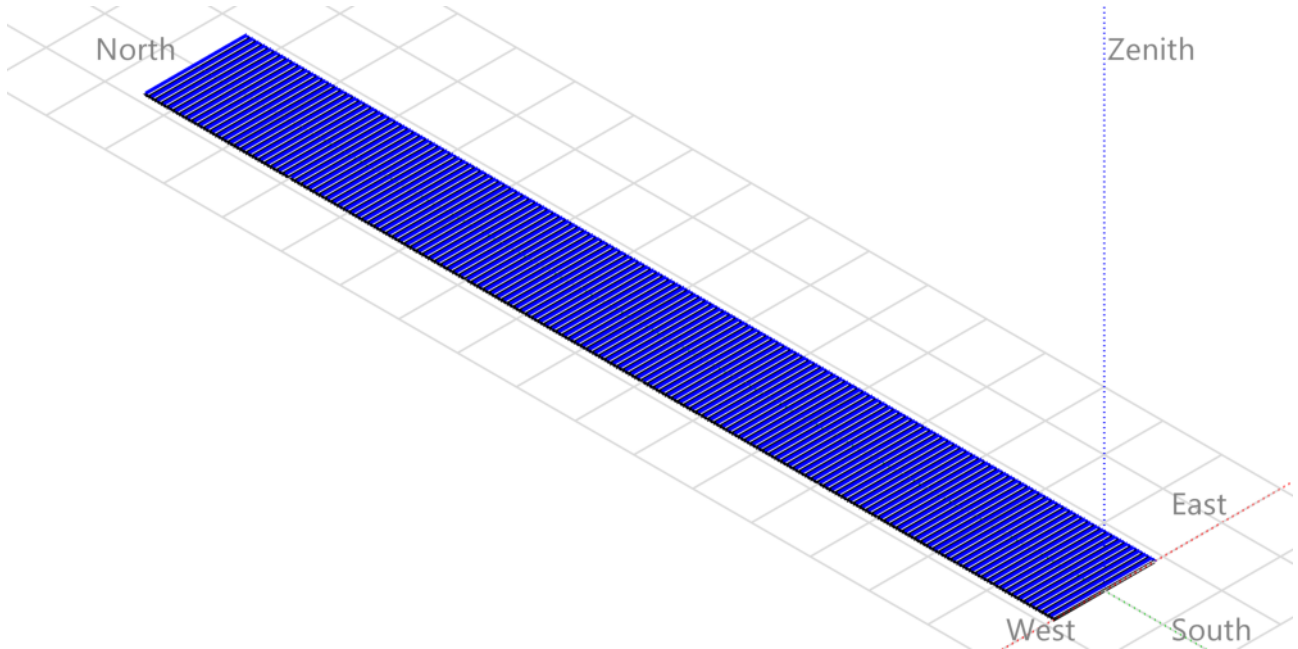
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Near shadings parameter

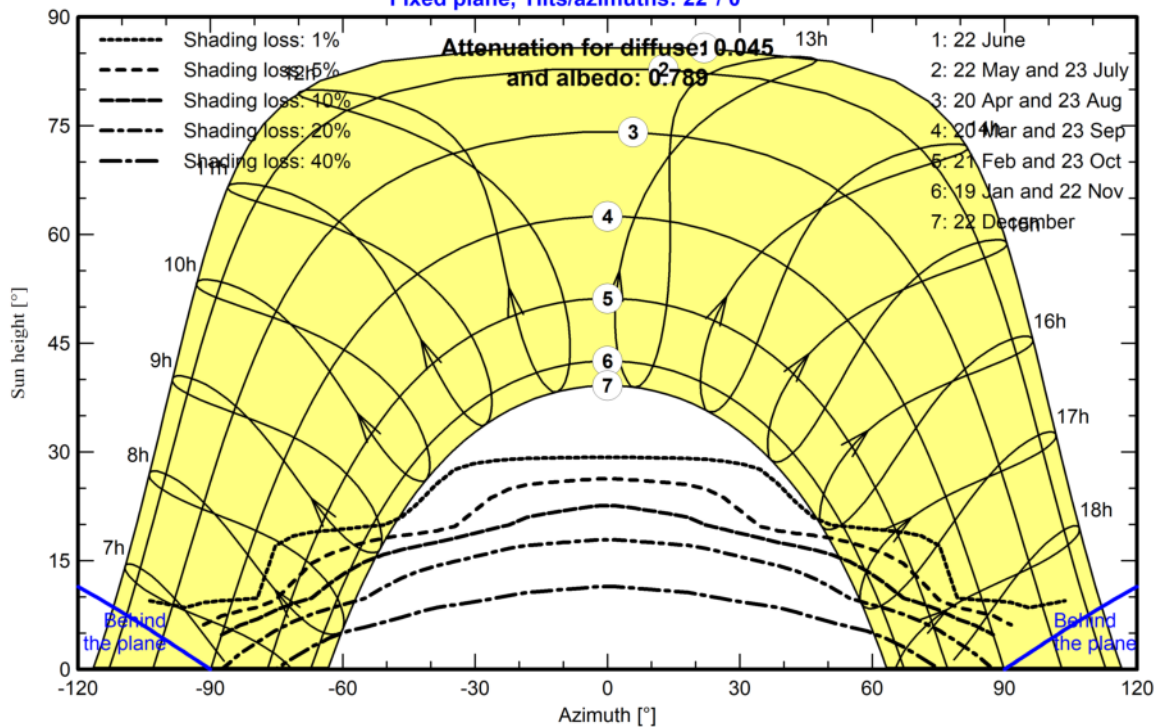
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1

Fixed plane, Tilts/azimuths: 22°/ 0°





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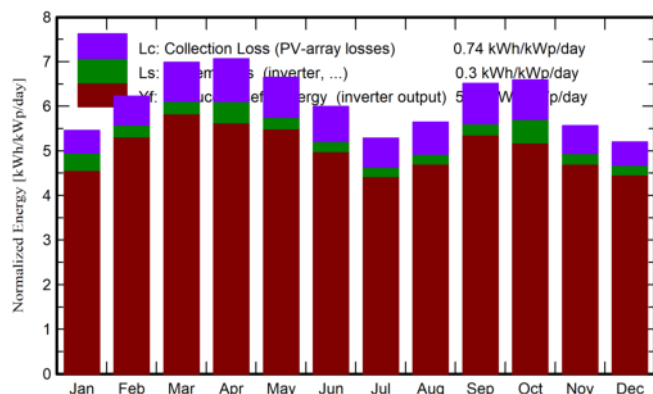
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Main results

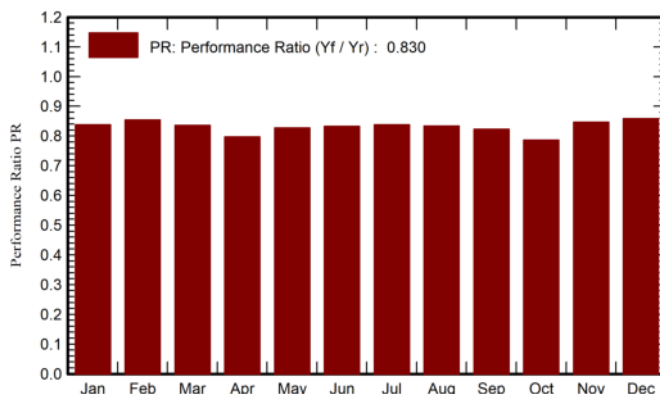
System Production

Produced Energy (P50) 32751369 kWh/year	Specific production (P50) 1846 kWh/kWp/year	Perf. Ratio PR	82.96 %
Produced Energy (P90) 31994262 kWh/year	Specific production (P90) 1803 kWh/kWp/year		
Produced Energy (P95) 31781242 kWh/year	Specific production (P95) 1791 kWh/kWp/year		

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

	GlobHor kWh/m ²	DiffHor kWh/m ²	T_Amb °C	GlobInc kWh/m ²	GlobEff kWh/m ²	EArray kWh	E_Grid kWh	PR ratio
January	127.0	48.0	13.90	169.1	163.6	2724748	2514295	0.838
February	141.0	50.0	17.70	174.3	169.7	2774789	2643266	0.855
March	192.0	69.0	24.00	216.5	211.0	3367792	3209582	0.835
April	205.0	86.0	29.90	212.0	206.1	3257324	3000230	0.798
May	213.0	108.0	34.40	206.1	199.6	3166088	3027007	0.828
June	191.0	104.0	36.00	179.8	173.6	2778320	2657552	0.833
July	172.0	103.0	34.50	163.9	157.8	2550616	2436530	0.838
August	175.0	92.0	33.40	175.0	169.2	2712225	2590349	0.834
September	180.0	74.0	32.20	195.5	190.1	2990937	2855934	0.823
October	171.0	60.0	27.10	204.3	199.0	3145181	2850819	0.786
November	130.0	53.0	20.20	167.0	161.9	2635789	2509427	0.847
December	119.0	46.0	15.09	161.3	155.8	2580791	2456378	0.859
Year	2016.0	893.0	26.57	2225.0	2157.4	34684599	32751369	0.830

Legends

GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_Grid	Energy injected into grid
T_Amb	Ambient Temperature	PR	Performance Ratio
GlobInc	Global incident in coll. plane		
GlobEff	Effective Global, corr. for IAM and shadings		



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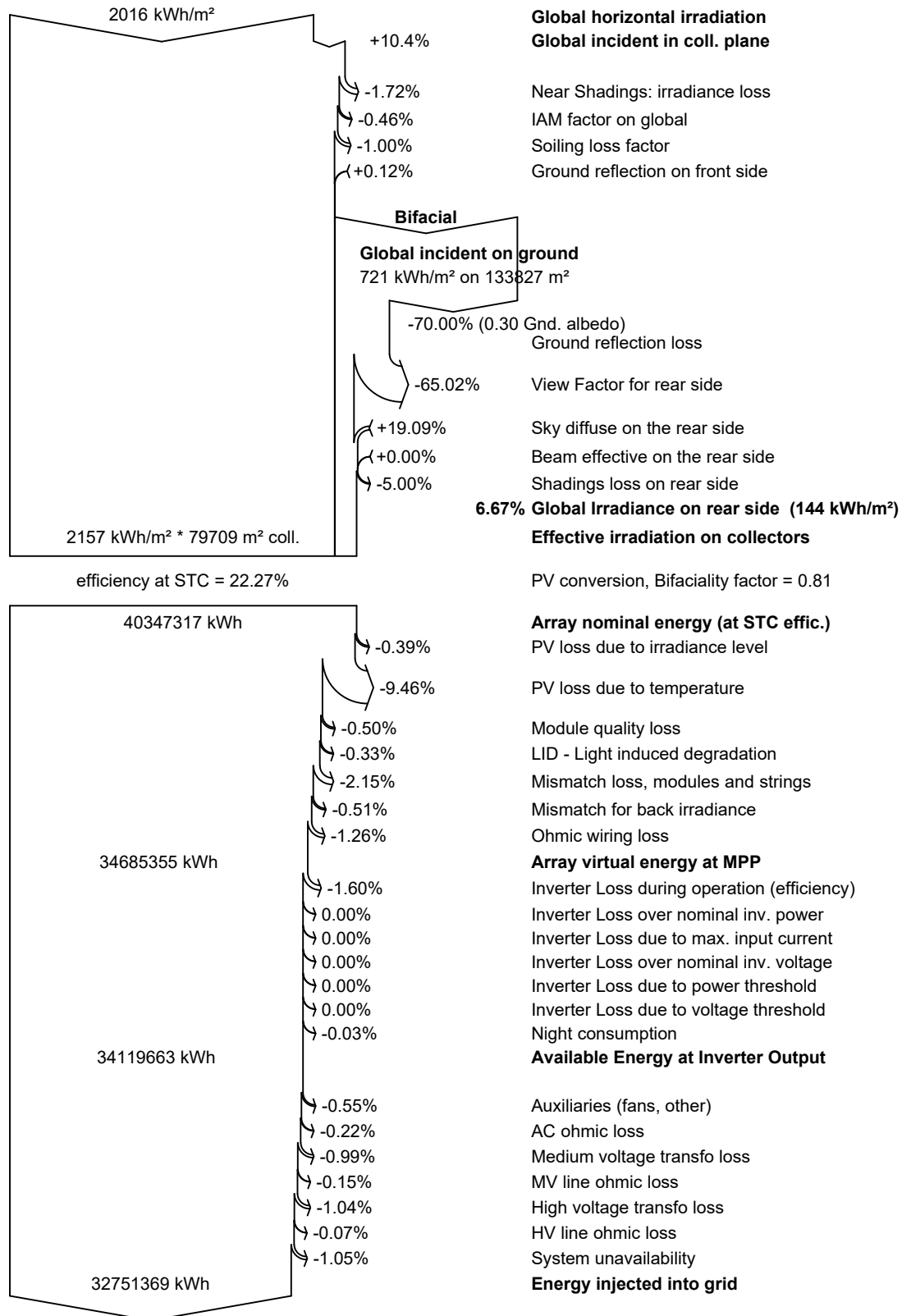
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Loss diagram





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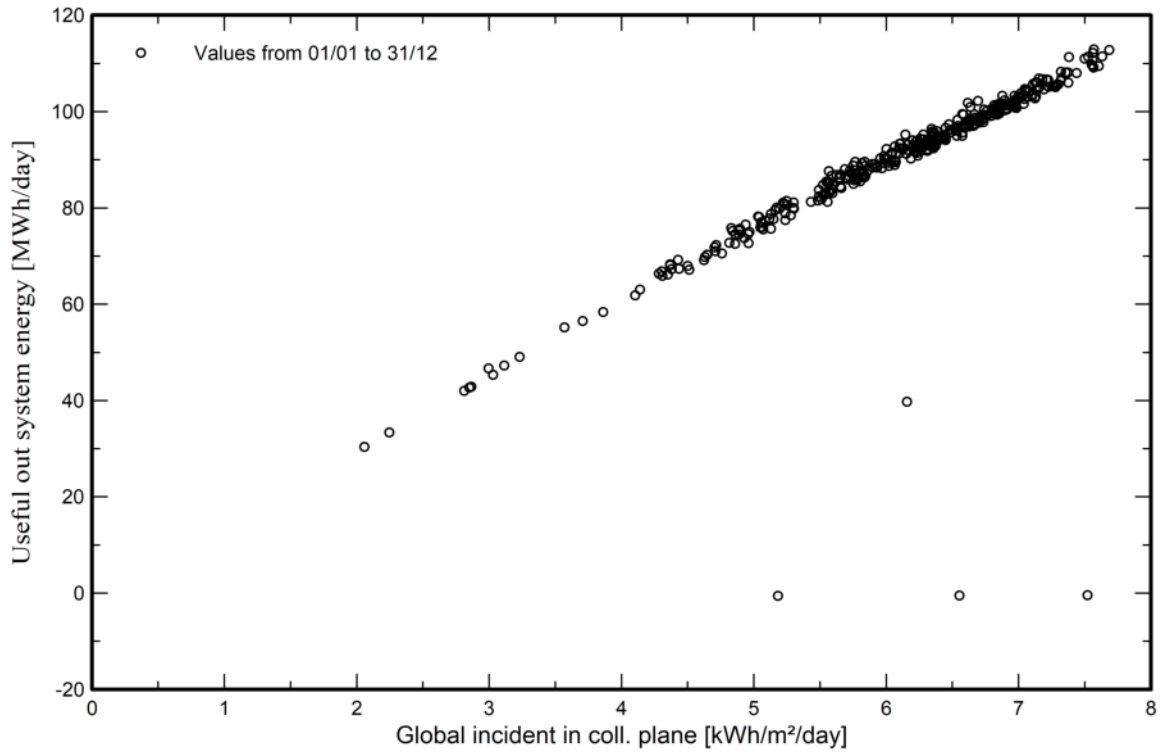
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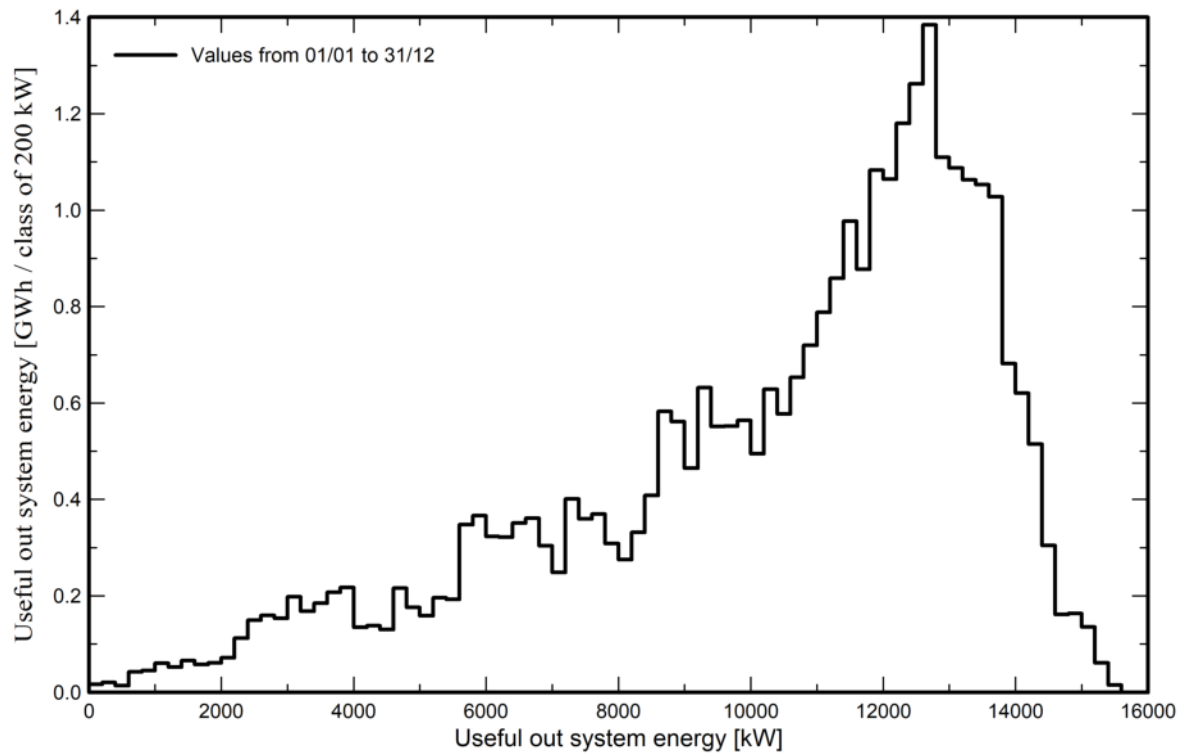
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Predef. graphs

Daily Input/Output diagram



System Output Power Distribution





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P50 - P90 evaluation

Weather data

Source SolarGIS Monthly aver. , period not spec.
Kind Not defined
Year-to-year variability(Variance) 0.0 %

Specified Deviation

Global variability (weather data + system)

Variability (Quadratic sum) 1.8 %

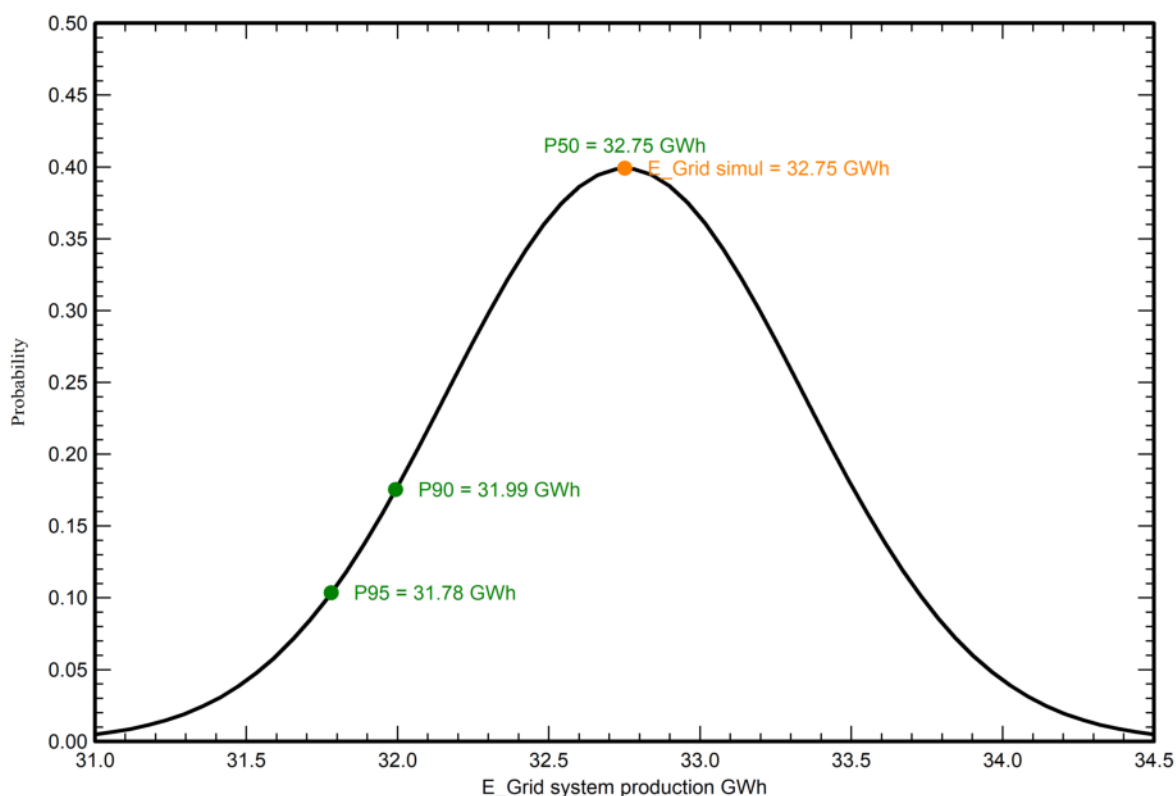
Simulation and parameters uncertainties

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

Annual production probability

Variability	0.59 GWh
P50	32.75 GWh
P90	31.99 GWh
P95	31.78 GWh

Probability distribution





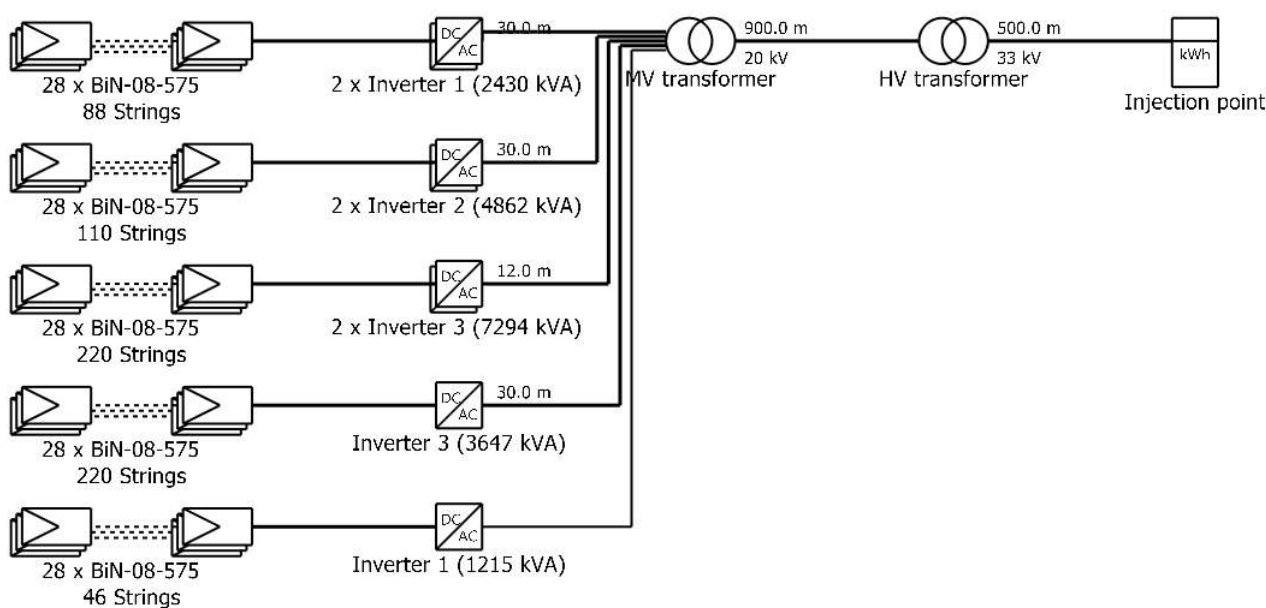
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Single-line diagram



PV module	BiN-08-575
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Inverter 1	PVS980-58-1250-L prelim rev. A
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Inverter 2	PVS980-58-2500-L prelim rev. A
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Inverter 3	PVS980-58-3750-L prelim rev. A
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String	28 x BiN-08-575
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