

**REGIONE SICILIA**  
Provincia di Catania  
COMUNI DI  
MILITELLO IN VAL DI CATANIA ,VIZZINI E MINEO

PROGETTO

**PARCO FOTOVOLTAICO DI MILITELLO**

**PROGETTO DEFINITIVO**

COMMITTENTE

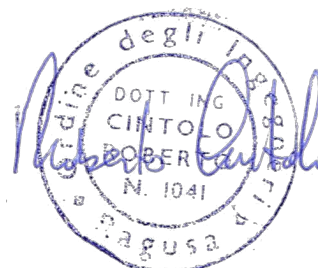
*ERG Solar Holding*



SOCIETA' DI PROGETTAZIONE



*Ing. Antonino Psaila*  
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OGGETTO DELL'ELABORATO

VALUTAZIONE RISORSA FOTOVOLTAICA E ANALISI DI  
PRODUCIBILITA' (PVsyst)

REV.	DATA	ATTIVITA'	REDATTO	VERIFICATO	APROVATO

CODICE PROGETTISTA	DATA	SCALA	FORMATO	FOGLIO	DOCUMENTO
	14/02/2022	--	A4	1	8975 - 7570 - RS - 025

# PVsyst - Simulation report

## Grid-Connected System

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Progetto: Militello

Layout definitivo

Tracking system with backtracking

System power: 31.82 MWp

Militello in Val di Catania CT - Italy



**PVsyst V7.3.2**

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**Project summary**

<b>Geographical Site</b>		<b>Situation</b>		<b>Project settings</b>	
Militello in Val di Catania CT		Latitude	37.28 °N	Albedo	0.20
Italy		Longitude	14.77 °E		
		Altitude	599 m		
		Time zone	UTC+1		
<b>Meteo data</b>					
Militello in Val di Catania CT					
SolarGISv2.2.32 - TMY					

**System summary**

<b>Grid-Connected System</b>		<b>Tracking system with backtracking</b>			
<b>PV Field Orientation</b>		<b>Tracking algorithm</b>		<b>Near Shadings</b>	
Orientation		Astronomic calculation		According to strings	
Tracking plane, tilted axis		Backtracking activated		Electrical effect	100 %
Avg axis tilt	-2.4 °			Diffuse shading	Automatic
Avg axis azim.	0 °				
<b>System information</b>					
<b>PV Array</b>					
Nb. of modules	47490 units	<b>Inverters</b>		Nb. of units	
Pnom total	31.82 MWp			8 units	
				Pnom total	
				33.47 MWac	
				Pnom ratio	
				0.951	
<b>User's needs</b>					
Unlimited load (grid)					

**Results summary**

Produced Energy	58031.33 MWh/year	Specific production	1824 kWh/kWp/year	Perf. Ratio PR	81.71 %
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**Table of contents**

Project and results summary	2
General parameters, PV Array Characteristics, System losses	3
Horizon definition	7
Near shading definition - Iso-shadings diagram	8
Main results	9
Loss diagram	10
Predef. graphs	11
Single-line diagram	12

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**General parameters****Grid-Connected System****PV Field Orientation****Orientation**

Tracking plane, tilted axis  
Avg axis tilt -2.4 °  
Avg axis azim. 0 °

**Models used**

Transposition Perez  
Diffuse Imported  
Circumsolar separate

**Horizon**

Average Height 0.7 °

**Tracking system with backtracking****Tracking algorithm**

Astronomic calculation  
Backtracking activated

**Near Shadings**

According to strings  
Electrical effect 100 %  
Diffuse shading Automatic

**Backtracking array**

Nb. of trackers 1743 units  
Identical arrays

**Sizes**

Tracker Spacing 5.50 m  
Collector width 2.38 m  
Ground Cov. Ratio (GCR) 43.3 %  
Phi min / max. -/+ 60.0 °

**Backtracking strategy**

Phi limits for BT -/+ 79.9 °  
Backtracking pitch 5.50 m  
Backtracking width 2.38 m

**User's needs**

Unlimited load (grid)

**PV Array Characteristics****PV module**

Manufacturer Trina Solar  
Model TSM-670DE21  
(Custom parameters definition)  
Unit Nom. Power 670 Wp  
Number of PV modules 43290 units  
Nominal (STC) 29.00 MWp

**Array #1 - Sottocampo #1**

Number of PV modules 6210 units  
Nominal (STC) 4161 kWp  
Modules 207 Strings x 30 In series

**At operating cond. (50°C)**

Pmpp 3808 kWp  
U mpp 1041 V  
I mpp 3658 A

**Array #2 - Sottocampo #2**

Number of PV modules 6210 units  
Nominal (STC) 4161 kWp  
Modules 207 Strings x 30 In series

**At operating cond. (50°C)**

Pmpp 3808 kWp  
U mpp 1041 V  
I mpp 3658 A

**Inverter**

Manufacturer SMA  
Model Sunny Central 4400 UP  
(Custom parameters definition)  
Unit Nom. Power 4400 kWac  
Number of inverters 7 units  
Total power 30800 kWac

Number of inverters 1 unit  
Total power 4400 kWac

Operating voltage 962-1325 V  
Pnom ratio (DC:AC) 0.95

Number of inverters 1 unit  
Total power 4400 kWac

Operating voltage 962-1325 V  
Pnom ratio (DC:AC) 0.95

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**PV Array Characteristics****Array #3 - Sottocampo #3**

Number of PV modules	6210 units	Number of inverters	1 unit
Nominal (STC)	4161 kWp	Total power	4400 kWac
Modules	207 Strings x 30 In series		
<b>At operating cond. (50°C)</b>		Operating voltage	962-1325 V
Pmpp	3808 kWp	Pnom ratio (DC:AC)	0.95
U mpp	1041 V		
I mpp	3658 A		

**Array #4 - Sottocampo #4**

Number of PV modules	6210 units	Number of inverters	1 unit
Nominal (STC)	4161 kWp	Total power	4400 kWac
Modules	207 Strings x 30 In series		
<b>At operating cond. (50°C)</b>		Operating voltage	962-1325 V
Pmpp	3808 kWp	Pnom ratio (DC:AC)	0.95
U mpp	1041 V		
I mpp	3658 A		

**Array #5 - Sottocampo #5**

Number of PV modules	6210 units	Number of inverters	1 unit
Nominal (STC)	4161 kWp	Total power	4400 kWac
Modules	207 Strings x 30 In series		
<b>At operating cond. (50°C)</b>		Operating voltage	962-1325 V
Pmpp	3808 kWp	Pnom ratio (DC:AC)	0.95
U mpp	1041 V		
I mpp	3658 A		

**Array #6 - Sottocampo #6**

Number of PV modules	6210 units	Number of inverters	1 unit
Nominal (STC)	4161 kWp	Total power	4400 kWac
Modules	207 Strings x 30 In series		
<b>At operating cond. (50°C)</b>		Operating voltage	962-1325 V
Pmpp	3808 kWp	Pnom ratio (DC:AC)	0.95
U mpp	1041 V		
I mpp	3658 A		

**Array #7 - Sottocampo #7**

Number of PV modules	6030 units	Number of inverters	1 unit
Nominal (STC)	4040 kWp	Total power	4400 kWac
Modules	201 Strings x 30 In series		
<b>At operating cond. (50°C)</b>		Operating voltage	962-1325 V
Pmpp	3698 kWp	Pnom ratio (DC:AC)	0.92
U mpp	1041 V		
I mpp	3552 A		



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**PV Array Characteristics**

<b>Array #8 - Sottocampo #8</b>			
<b>PV module</b>		<b>Inverter</b>	
Manufacturer	Trina Solar	Manufacturer	SMA
Model	TSM-670DE21	Model	Sunny Central 2660 UP
(Custom parameters definition)		(Original PVsyst database)	
Unit Nom. Power	670 Wp	Unit Nom. Power	2667 kWac
Number of PV modules	4200 units	Number of inverters	1 unit
Nominal (STC)	2814 kWp	Total power	2667 kWac
Modules	140 Strings x 30 In series	Operating voltage	880-1325 V
<b>At operating cond. (50°C)</b>		Pnom ratio (DC:AC)	1.06
Pmpp	2576 kWp		
U mpp	1041 V		
I mpp	2474 A		
<b>Total PV power</b>		<b>Total inverter power</b>	
Nominal (STC)	31818 kWp	Total power	33467 kWac
Total	47490 modules	Number of inverters	8 units
Module area	147521 m <sup>2</sup>	Pnom ratio	0.95
Cell area	75851 m <sup>2</sup>		

**Array losses**

<b>Array Soiling Losses</b>		<b>Thermal Loss factor</b>		<b>LID - Light Induced Degradation</b>				
Loss Fraction	1.5 %	Module temperature according to irradiance		Loss Fraction	2.0 %			
		Uc (const)	29.0 W/m <sup>2</sup> K					
		Uv (wind)	0.0 W/m <sup>2</sup> K/m/s					
<b>Module Quality Loss</b>		<b>Module mismatch losses</b>		<b>Strings Mismatch loss</b>				
Loss Fraction	-0.7 %	Loss Fraction	2.0 % at MPP	Loss Fraction	0.1 %			
<b>IAM loss factor</b>								
Incidence effect (IAM): User defined profile								
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	0.61 mΩ		
Loss Fraction	1.5 % at STC		
<b>Array #1 - Sottocampo #1</b>		<b>Array #2 - Sottocampo #2</b>	
Global array res.	4.7 mΩ	Global array res.	4.7 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
<b>Array #3 - Sottocampo #3</b>		<b>Array #4 - Sottocampo #4</b>	
Global array res.	4.7 mΩ	Global array res.	4.7 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
<b>Array #5 - Sottocampo #5</b>		<b>Array #6 - Sottocampo #6</b>	
Global array res.	4.7 mΩ	Global array res.	4.7 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
<b>Array #7 - Sottocampo #7</b>		<b>Array #8 - Sottocampo #8</b>	
Global array res.	4.8 mΩ	Global array res.	6.9 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC



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**System losses**

**Auxiliaries loss**

constant (fans) 16.00 kW  
0.0 kW from Power thresh.

**AC wiring losses**

**Inv. output line up to MV transfo**

Inverter voltage 660 Vac tri  
Loss Fraction 0.01 % at STC

**Inverters: Sunny Central 4400 UP, Sunny Central 2660 UP**

Wire section (8 Inv.) Copper 8 x 3 x 2500 mm<sup>2</sup>  
Average wires length 1 m

**MV line up to Injection**

MV Voltage 36 kV  
Average each inverter  
Wires Alu 3 x 185 mm<sup>2</sup>  
Length 2663 m  
Loss Fraction 0.27 % at STC

**AC losses in transformers**

**MV transfo**

Medium voltage 36 kV

**One transfo parameters**

Nominal power at STC 7.82 MVA  
Iron Loss (night disconnect) 0.00 kVA  
Iron loss fraction 0.00 % at STC  
Copper loss 0.00 kVA  
Copper loss fraction 0.00 % at STC  
Coils equivalent resistance 3 x 0.00 mΩ

**Operating losses at STC (full system)**

Nb. identical MV transfos 4  
Nominal power at STC 31.28 MVA  
Iron loss (night disconnect) 0.00 kVA  
Copper loss 0.00 kVA



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Horizon definition

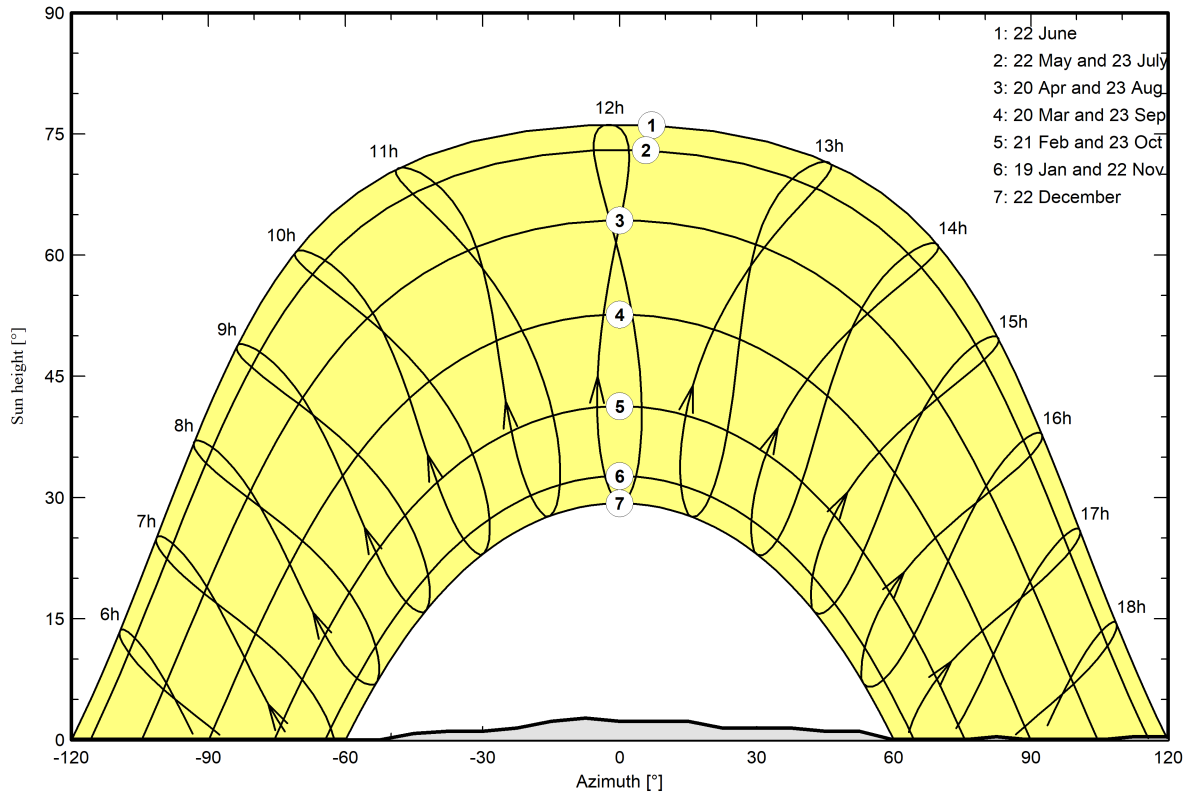
Horizon from PVGIS website API, Lat=37°17'24', Long=14°46'12', Alt=543m

Average Height	0.7 °	Albedo Factor	0.98
Diffuse Factor	0.99	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-173	-165	-158	-150	-143	-53	-45	-38	-30	-23
Height [°]	0.4	0.4	1.1	2.3	0.8	0.0	0.0	0.8	1.1	1.1	1.5
Azimuth [°]	-15	-8	0	15	23	38	45	53	60	75	83
Height [°]	2.3	2.7	2.3	2.3	1.5	1.5	1.1	1.1	0.0	0.0	0.4
Azimuth [°]	90	105	113	120	128	135	143	150	180		
Height [°]	0.0	0.0	0.4	0.4	0.0	0.4	0.0	0.4	0.4		

Sun Paths (Height / Azimuth diagram)



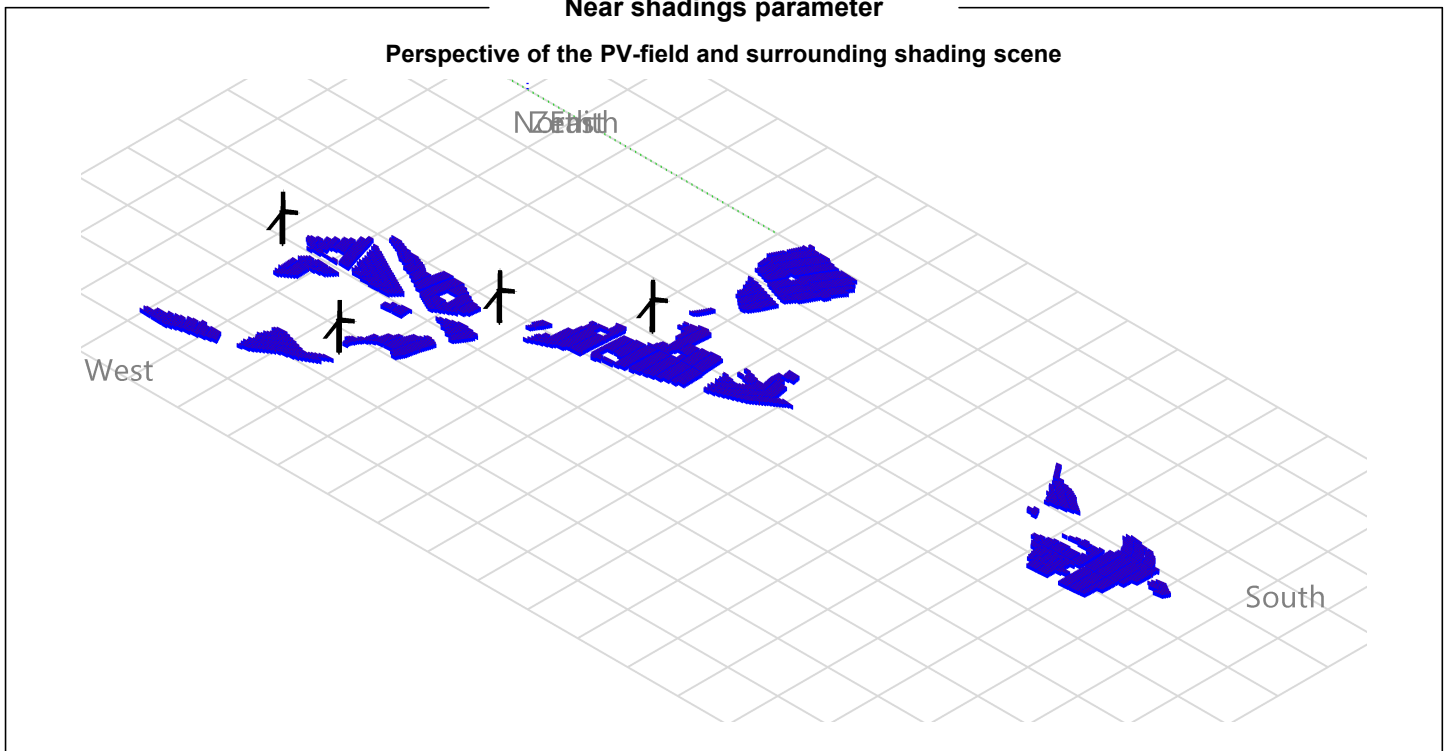




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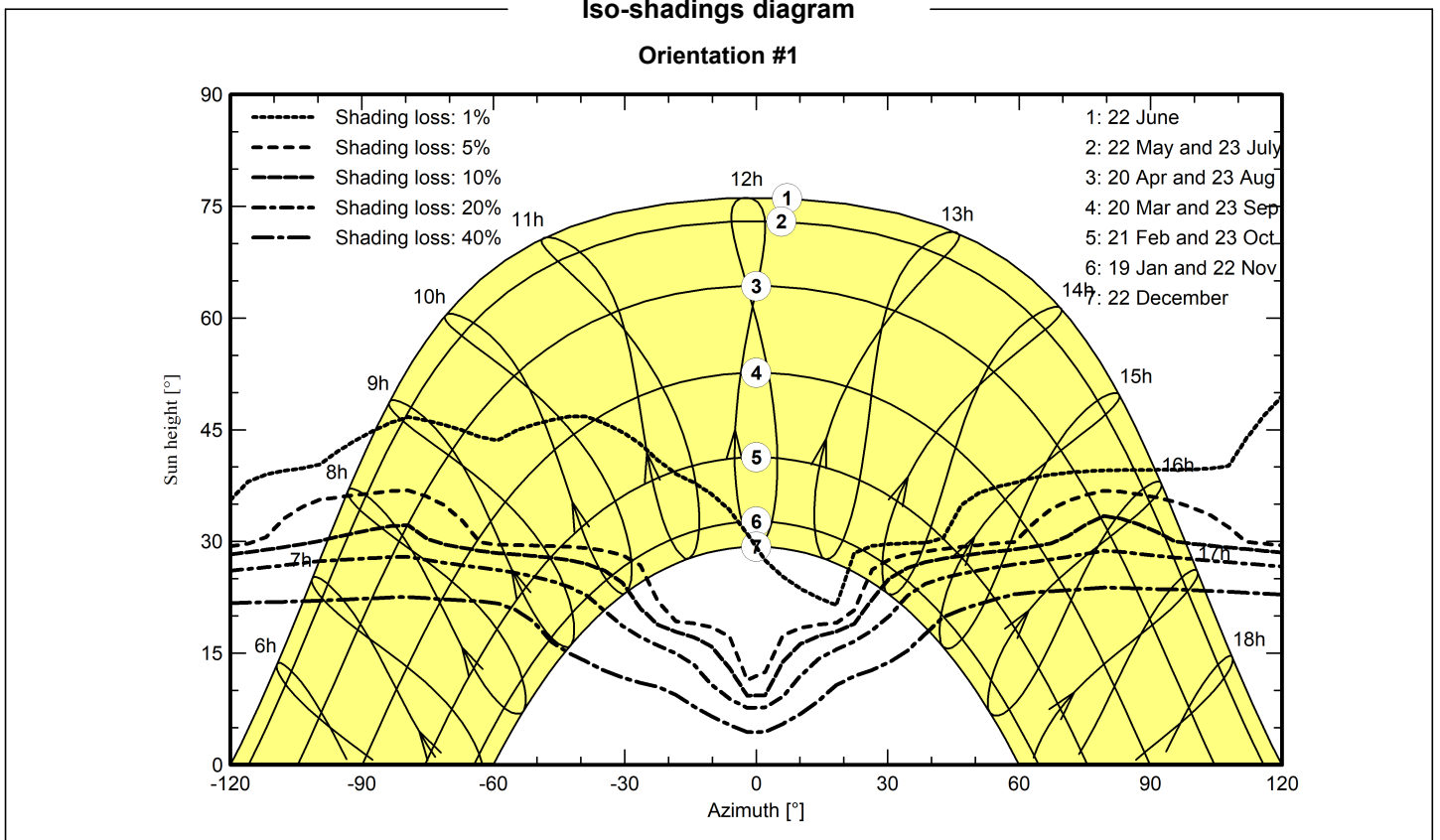
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### Near shadings parameter



### Iso-shadings diagram

#### Orientation #1





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**Main results**

**System Production**

Produced Energy 58031.33 MWh/year

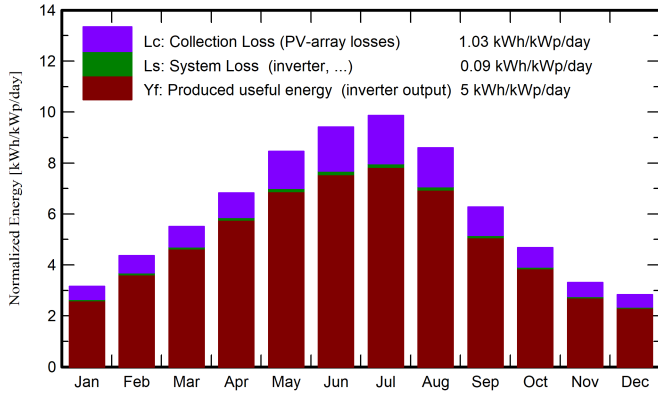
Specific production

1824 kWh/kWp/year

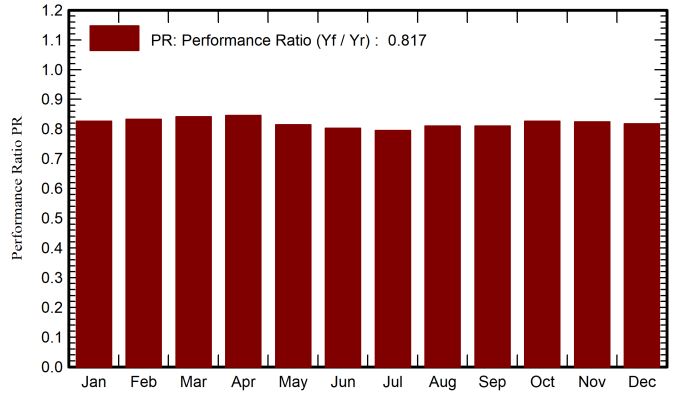
Performance Ratio PR

81.71 %

**Normalized productions (per installed kWp)**



**Performance Ratio PR**



**Balances and main results**

	<b>GlobHor</b> kWh/m <sup>2</sup>	<b>DiffHor</b> kWh/m <sup>2</sup>	<b>T_Amb</b> °C	<b>GlobInc</b> kWh/m <sup>2</sup>	<b>GlobEff</b> kWh/m <sup>2</sup>	<b>EArray</b> MWh	<b>E_Grid</b> MWh	<b>PR</b> ratio
<b>January</b>	77.4	31.36	6.79	97.8	89.5	2617	2570	0.826
<b>February</b>	94.9	37.73	7.21	122.0	113.1	3292	3233	0.833
<b>March</b>	136.0	53.51	8.73	170.8	160.6	4656	4573	0.842
<b>April</b>	163.8	67.78	12.18	204.6	193.9	5604	5504	0.845
<b>May</b>	207.3	77.00	19.84	262.4	249.6	6920	6799	0.814
<b>June</b>	221.6	75.97	22.87	282.4	269.6	7338	7211	0.802
<b>July</b>	237.2	72.77	25.50	305.9	292.0	7869	7735	0.795
<b>August</b>	206.3	71.19	25.52	266.4	253.6	6980	6863	0.810
<b>September</b>	148.6	56.90	22.03	188.1	178.1	4936	4852	0.810
<b>October</b>	114.6	49.32	14.49	144.9	135.0	3875	3808	0.826
<b>November</b>	79.6	36.21	12.18	99.1	90.8	2647	2600	0.824
<b>December</b>	68.9	30.21	8.62	87.7	79.3	2325	2283	0.818
<b>Year</b>	1756.3	659.95	15.55	2232.1	2105.3	59059	58031	0.817

**Legends**

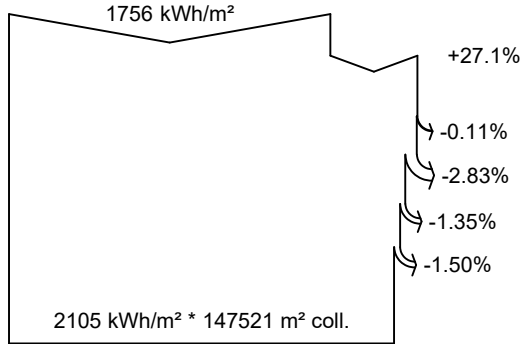
- GlobHor Global horizontal irradiation
- DiffHor Horizontal diffuse irradiation
- T\_Amb Ambient Temperature
- GlobInc Global incident in coll. plane
- GlobEff Effective Global, corr. for IAM and shadings
- EArray Effective energy at the output of the array
- E\_Grid Energy injected into grid
- PR Performance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



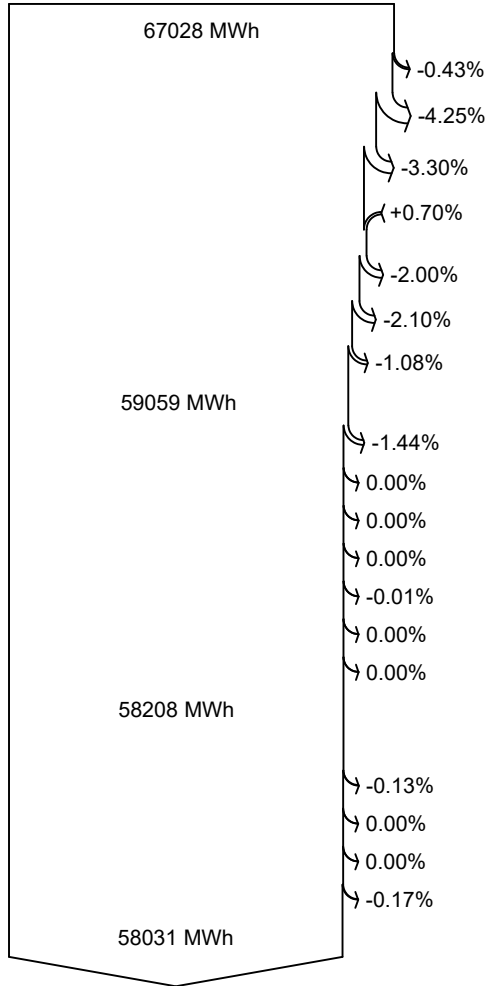
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Loss diagram



efficiency at STC = 21.58%



**Global horizontal irradiation**

**Global incident in coll. plane**

Far Shadings / Horizon

Near Shadings: irradiance loss

IAM factor on global

Soiling loss factor

**Effective irradiation on collectors**

PV conversion

**Array nominal energy (at STC effic.)**

PV loss due to irradiance level

PV loss due to temperature

Shadings: Electrical Loss acc. to strings

Module quality loss

LID - Light induced degradation

Mismatch loss, modules and strings

Ohmic wiring loss

**Array virtual energy at MPP**

Inverter Loss during operation (efficiency)

Inverter Loss over nominal inv. power

Inverter Loss due to max. input current

Inverter Loss over nominal inv. voltage

Inverter Loss due to power threshold

Inverter Loss due to voltage threshold

Night consumption

**Available Energy at Inverter Output**

Auxiliaries (fans, other)

AC ohmic loss

Medium voltage transfo loss

MV line ohmic loss

**Energy injected into grid**

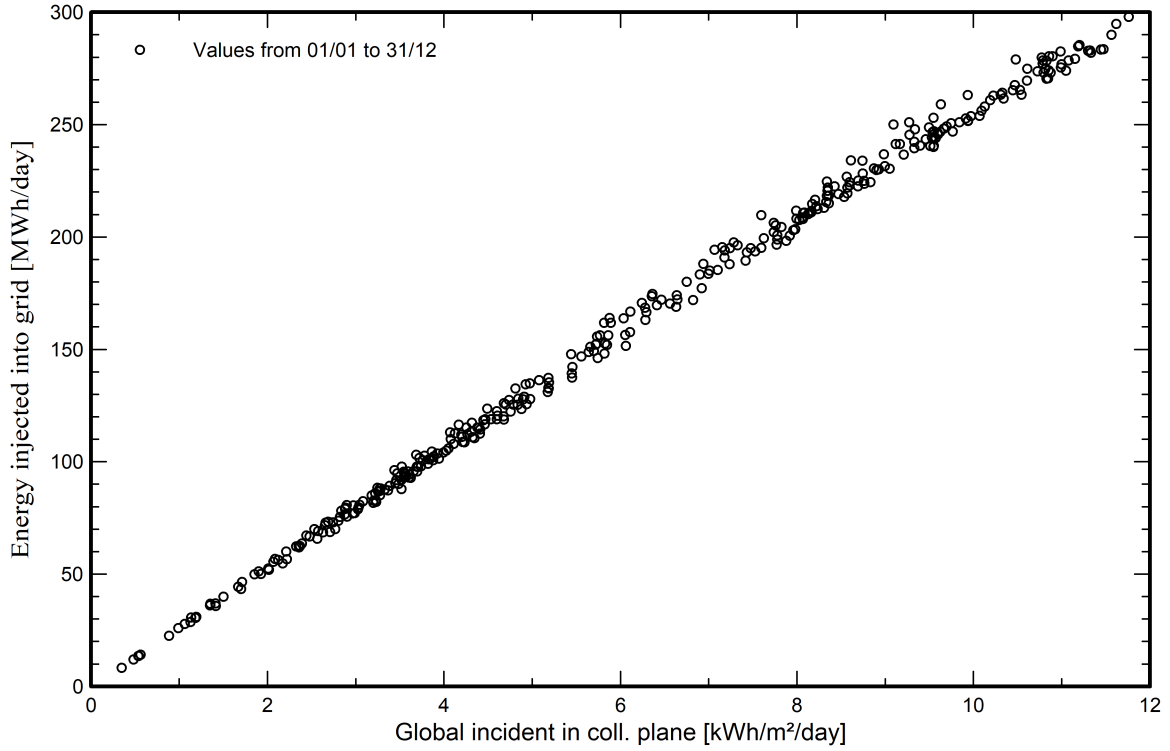


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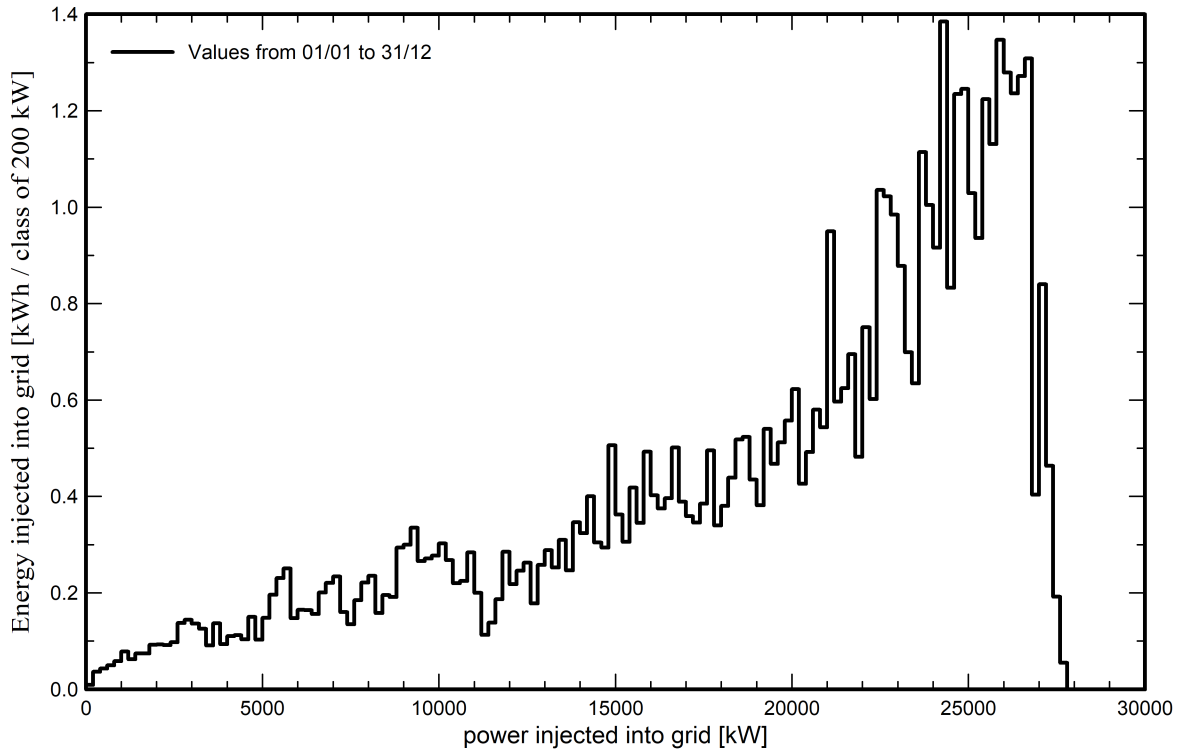
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**Predef. graphs**

**Daily Input/Output diagram**



**Distribuzione potenza in uscita sistema**

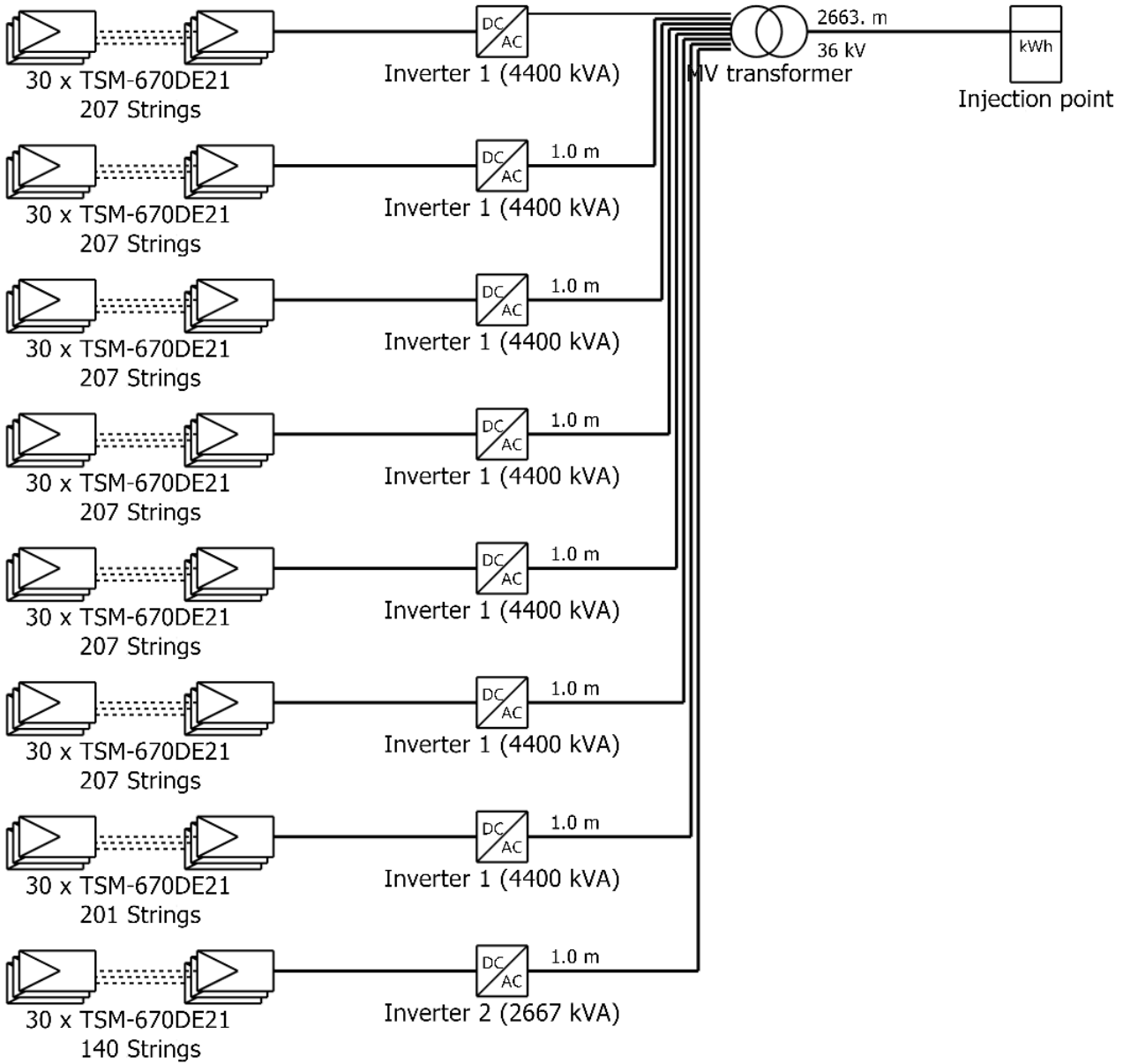




# Single-line diagram

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PV module	TSM-670DE21
Inverter 1	Sunny Central 4400 UP
Inverter 2	Sunny Central 2660 UP
String	30 x TSM-670DE21

Militello def\_Solargis

ERG (Italy)

VCA : Simulazione\_Solargis\_turbine\_D  
EFINITIVO\_1

02/03/23