

Regione
**EMILIA
ROMAGNA**

Progetto per la
realizzazione di un
impianto fotovoltaico,
denominato "**Fossatone**",
con potenza nominale di
64.674,48 kW da realizzarsi
nei Comuni di **Massa
Lombarda, Lugo, Conselice**

Comune di
**Massa
Lombarda**

Comune di
Lugo

Provincia di
Ravenna

Comune di
Conselice

P-r32

REV 00

**RELAZIONE DI CALCOLO
E STIMA DI PRODUCIBILITA'
DELL'IMPIANTO**

PROGETTO

data **APRILE 2026**

RICHIEDENTE

STM26 srl

Via Nenni 6E, Imola (BO)

COORDINAMENTO

STEMM
Sviluppo e Progettazione
www.stemm.solar

Via Nenni 6E, Imola (BO)

GRUPPO DI PROGETTAZIONE

Progetto agronomico



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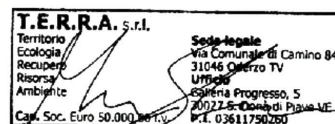
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1. Premessa

Il soggetto proponente è la Società STM26, avente sede in via Nenni 6E Imola (BO), la quale ha già la disponibilità delle aree come da contratto preliminare stipulato con atto notarile.

Essa intende realizzare un impianto per la produzione di energia elettrica da fonte solare fotovoltaica, di tipo grid connected, da collegare alla rete di distribuzione in alta tensione, tramite stazione di ricezione e POD dedicato.

L'impianto fotovoltaico sarà del tipo ad inseguimento automatico su un asse, per un numero complessivo di:

- n° 3.273 stringhe fotovoltaiche da 26 moduli;
- n° 85.098 moduli fotovoltaici da 760 Wp;

arrivando ad una potenza nominale di picco complessiva pari a 64.674,48 kWp e ad una potenza totale di immissione pari a 58.650 kW ac.

Le già menzionate stringhe, saranno posizionate su strutture ad inseguimento monoassiale, distanziate le une dalle altre, in direzione Est-Ovest, di circa 5,5 m (interasse strutture).

La conversione da continua in alternata, verrà effettuata per mezzo di inverter distribuiti in campo, disposti in modo da assicurare il miglior funzionamento relativo all'accoppiamento inverter-stringa e limitare le perdite.

Infine, verranno effettuate le connessioni degli inverter alle cabine di trasformazione e poi alla stazione di ricezione, che permette l'immissione dell'energia prodotta dall'impianto fotovoltaico sulla rete AT del distributore.

L'impianto in progetto sarà configurato per la cessione dell'energia elettrica in rete secondo cui l'energia prodotta dal gruppo di conversione della corrente continua in corrente alternata, verrà interamente immessa in rete al netto di quella necessaria per i servizi di centrale.

La progettazione dell'impianto fotovoltaico e delle opere connesse alla costruzione ed all'esercizio dell'impianto è stata condotta prevedendo in particolare l'attuazione di misure di mitigazione ambientale, per le quali si rimanda a relazioni specialistiche.



2. Ubicazione dell'impianto

L'area sede di intervento, avente estensione di circa 85,3 ha, è rappresentata da un lotto di terreno agricolo localizzato per la maggior parte all'interno del Comune di Massa Lombarda in Provincia di Ravenna (RA) e per una porzione minore all'interno dei confini comunali di Lugo (RA) e di Conselice (RA).

La località è denominata "Fossatone" con coordinate indicative del centro dell'appezzamento pari a 44°29'6.27" N, 11°51'9.01" E ed è caratterizzata da un terreno di superficie complessiva di circa 85,3 ha con qualità colturale prevalente a seminativo.

Essa è individuata al Catasto terreni del Comune di:

- Massa Lombarda ai fogli:
 - n. 7, mappali n. 17 e 18;
 - n. 8, mappali n. 11, 13, 79, 100, 101, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 133 e 134;
 - n.9, mappali n. 9, 23, 63, 135, 137, 143, 144, 151, 153, 154, 156, 157, 195, 196;
 - n. 60, mappale n. 4;
 - n. 61, mappale n. 54.
- Lugo ai fogli:
 - n. 61, mappali n. 11, 54 e 55.
- Conselice ai fogli:
 - n. 8, mappali n. 79, 101 e 112;
 - n. 60, mappali n. 4, 63, 64 e 65.

3. Relazione di calcolo con stime di resa

Il calcolo allegato con le stime di resa, al netto delle perdite, è stato redatto con software "PV SYST" Versione V8.1.0

PVsyst - Simulation report

Grid-Connected System

Project: Fossatone v4.0

Variant: MTN90H

Tracking system with backtracking

System power: 64.67 MWp

Zeppa - Italy

Client

STM26 srl

Author

Stemm srl (italy)

Imola

STEMMI

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20/04/26 07:18
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Project summary**Geographical Site**

Zeppa
Italy

Situation

Latitude 44.4848 °(N)
Longitude 11.8511 °(E)
Altitude 10 m
Time zone UTC+1

Project settings

Albedo 0.20

Weather data

Zeppa
Meteonorm 8.2 (1991-2012), Sat=100% - Synthetic

System summary**Grid-Connected System****Orientation #1****Tracking plane, horizontal N-S axis**

Axis azimuth 28.7 °
Phi min / max. -/+ 40 °
Diffuse shading all trackers

Tracking algorithm

Irradiance optimization
Backtracking activated

Near Shadings

Linear shadings : Slow (simul.)

System information**PV Array**

Nb. of modules 85098 units
Pnom total 64.67 MWp

Tracking system with backtracking**Orientation #2****Tracking plane, horizontal N-S axis**

Axis azimuth 18.4 °
Phi min / max. -/+ 40 °
Diffuse shading all trackers

Tracking algorithm

Irradiance optimization
Backtracking activated

User's needs

Unlimited load (grid)

Orientation #3**Tracking plane, horizontal N-S axis**

Avg axis azimuth 2 °
Phi min / max. -/+ 40 °
Diffuse shading all trackers

Tracking algorithm

Irradiance optimization
Backtracking activated

Inverters

Nb. of units 158 units
Total power 55300 kWac
Pnom ratio 1.17

Results summary

Simulation step Hourly

Produced Energy	98754008 kWh/year	Specific production	1527 kWh/kWp/year	Perf. Ratio PR	88.22 %
				Bifacial perf. ratio	83.76 %

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General parameters

Grid-Connected System

Simulation step

Hourly

Orientation #1

Tracking plane, horizontal N-S axis

Axis azimuth 28.7 °
Phi min / max. +/- 40 °
Diffuse shading all trackers

Tracking algorithm

Irradiance optimization
Backtracking activated

Orientation #2

Tracking plane, horizontal N-S axis

Axis azimuth 18.4 °
Phi min / max. +/- 40 °
Diffuse shading all trackers

Tracking algorithm

Irradiance optimization
Backtracking activated

Tracking system with backtracking

Field properties

Nb. of trackers 1483 units
Tracking plane, horizontal N-S axis

Sizes

Tracker Spacing 5.50 m
Sensitive width 2.38 m
GCR Shading 43.3 %

Backtracking limit angle

Phi limits +/- 64.3 °

Backtracking parameters

Backtracking pitch 5.49 m
Backtracking width 2.38 m
Left inactive band 0.00 m
Right inactive band 0.00 m
GCR Backtracking 43.4 %
Parameters choice Automatic

Models used

Transposition Perez
Diffuse Perez, Meteonom
Circumsolar separate

Horizon

Free Horizon

Field properties

Nb. of trackers 876 units
Tracking plane, horizontal N-S axis

Sizes

Tracker Spacing 5.50 m
Sensitive width 2.38 m
GCR Shading 43.3 %

Backtracking limit angle

Phi limits +/- 64.3 °

Backtracking parameters

Backtracking pitch 5.49 m
Backtracking width 2.38 m
Left inactive band 0.00 m
Right inactive band 0.00 m
GCR Backtracking 43.4 %
Parameters choice Automatic



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General parameters

Orientation #3

Tracking plane, horizontal N-S axis

Avg axis azim. 2 °
Phi min / max. +/- 40 °
Diffuse shading all trackers

Tracking algorithm

Irradiance optimization
Backtracking activated

Field properties

Nb. of trackers 1135 units
Tracking plane, horizontal N-S axis

Sizes

Tracker Spacing 5.50 m
Sensitive width 2.38 m
GCR Shading 43.3 %

Backtracking limit angle

Phi limits +/- 64.3 °

Backtracking parameters

Backtracking pitch 5.44 m
Backtracking width 2.38 m
Left inactive band 0.00 m
Right inactive band 0.00 m
GCR Backtracking 43.8 %
Parameters choice Automatic

Near Shadings

Linear shadings : Slow (simul.)

Bifacial system definition

Orientation #1

Bifacial system

Model Unlimited Trackers 2D model

Bifacial model geometry

Tracker Spacing 5.50 m
Tracker width 2.38 m
Axis height above ground 2.10 m
Nb. of sheds 237 units

Bifacial model definitions

Ground albedo 0.20
Bifaciality factor 80 %
Rear shading factor 5.0 %
Rear mismatch loss 10.0 %
Shed transparent fraction 0.0 %

Orientation #3

Bifacial system

Model Unlimited Trackers 2D model

Bifacial model geometry

Tracker Spacing 5.50 m
Tracker width 2.38 m
Axis height above ground 2.10 m
Nb. of sheds 389 units

Bifacial model definitions

Ground albedo 0.20
Bifaciality factor 80 %
Rear shading factor 5.0 %
Rear mismatch loss 10.0 %
Shed transparent fraction 0.0 %

User's needs

Unlimited load (grid)

Orientation #2

Bifacial system

Model Unlimited Trackers 2D model

Bifacial model geometry

Tracker Spacing 5.50 m
Tracker width 2.38 m
Axis height above ground 2.10 m
Nb. of sheds 170 units

Bifacial model definitions

Ground albedo 0.20
Bifaciality factor 80 %
Rear shading factor 5.0 %
Rear mismatch loss 10.0 %
Shed transparent fraction 0.0 %



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PV Array Characteristics

PV module

Manufacturer Sungi Solar
Model SNG-760W
(Custom parameters definition)
SNG-760W.PAN
Unit Nom. Power 760 Wp

Inverter

Manufacturer Sungrow
Model SG350-HX
(Original PVsyst database)
Unit Nom. Power 350 kWac

Array #1 - PV Array

Orientation 1
Tilt/Azimuth 0/119 °
Number of PV modules 35750 units
Nominal (STC) 27.17 MWp
Modules 1375 string x 26 In series

Number of inverters 68 units
Total power 23800 kWac

At operating cond. (50°C)

Pmpp 26.19 MWp
U mpp 1064 V
I mpp 24614 A

Operating voltage 500-1450 V
Pnom ratio (DC:AC) 1.14
Power sharing within this inverter

Array #2 - Sub-array #2 - Orientation #2

Orientation 2
Tilt/Azimuth 0/108 °
Number of PV modules 22308 units
Nominal (STC) 16.95 MWp
Modules 858 string x 26 In series

Number of inverters 40 units
Total power 14000 kWac

At operating cond. (50°C)

Pmpp 16.34 MWp
U mpp 1064 V
I mpp 15359 A

Operating voltage 500-1450 V
Pnom ratio (DC:AC) 1.21
Power sharing within this inverter

Array #3 - Sub-array #3

Orientation 3
Tilt/Azimuth 0/92 °
Number of PV modules 27040 units
Nominal (STC) 20.55 MWp
Modules 1040 string x 26 In series

Number of inverters 50 units
Total power 17500 kWac

At operating cond. (50°C)

Pmpp 19.81 MWp
U mpp 1064 V
I mpp 18617 A

Operating voltage 500-1450 V
Pnom ratio (DC:AC) 1.17
Power sharing within this inverter

Total PV power

Nominal (STC) 64674 kWp
Total 85098 modules
Module area 264344 m²
Cell area 247686 m²

Total inverter power

Total power 55300 kWac
Number of inverters 158 units
Pnom ratio 1.17

Array losses

Array Soiling Losses

Loss Fraction 2.0 %

Thermal Loss factor

Module temperature according to irradiance
Uc (const) 29.0 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 1.50 %

Module Quality Loss

Loss Fraction -1.50 %

Module mismatch losses

Loss Fraction 1.30 % at MPP

Strings Mismatch loss

Loss Fraction 0.05 %



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Array losses

IAM loss factor

Incidence effect (IAM): Fresnel smooth glass, $n = 1.526$

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	0.998	0.981	0.948	0.862	0.776	0.636	0.402	0.000

DC wiring losses

Global wiring resistance 0.29 mΩ
Loss Fraction 1.50 % at STC

Array #1 - PV Array

Global array res. 0.69 mΩ
Loss Fraction 1.50 % at STC

Array #3 - Sub-array #3

Global array res. 0.92 mΩ
Loss Fraction 1.50 % at STC

Array #2 - Sub-array #2 - Orientation #2

Global array res. 1.1 mΩ
Loss Fraction 1.50 % at STC

System losses

Unavailability of the system

Time fraction 2.0 %
7.3 days,
3 periods

AC wiring losses

Inv. output line up to MV transfo

Inverter voltage 800 Vac tri
Loss Fraction 0.63 % at STC

Inverter: SG350-HX

Wire section (158 Inv.) Copper 158 x 3 x 150 mm²
Average wires length 83 m

MV line up to Injection

MV Voltage 30 kV
Average each transformer
Wires Copper 3 x 50 mm²
Length 4000 m
Loss Fraction 0.71 % at STC

AC losses in transformers

MV transfo

Medium voltage 30 kV

One transfo parameters

Nominal power at STC 4.28 MVA
Iron Loss (24/24 Connexion) 4.06 kVA
Iron loss fraction 0.09 % at STC
Copper loss 45.16 kVA
Copper loss fraction 1.06 % at STC
Coils equivalent resistance 3 x 1.58 mΩ

Operating losses at STC (full system)

Nb. identical MV transfos 15
Nominal power at STC 64.16 MVA
Iron loss (24/24 Connexion) 60.83 kVA
Copper loss 677.34 kVA



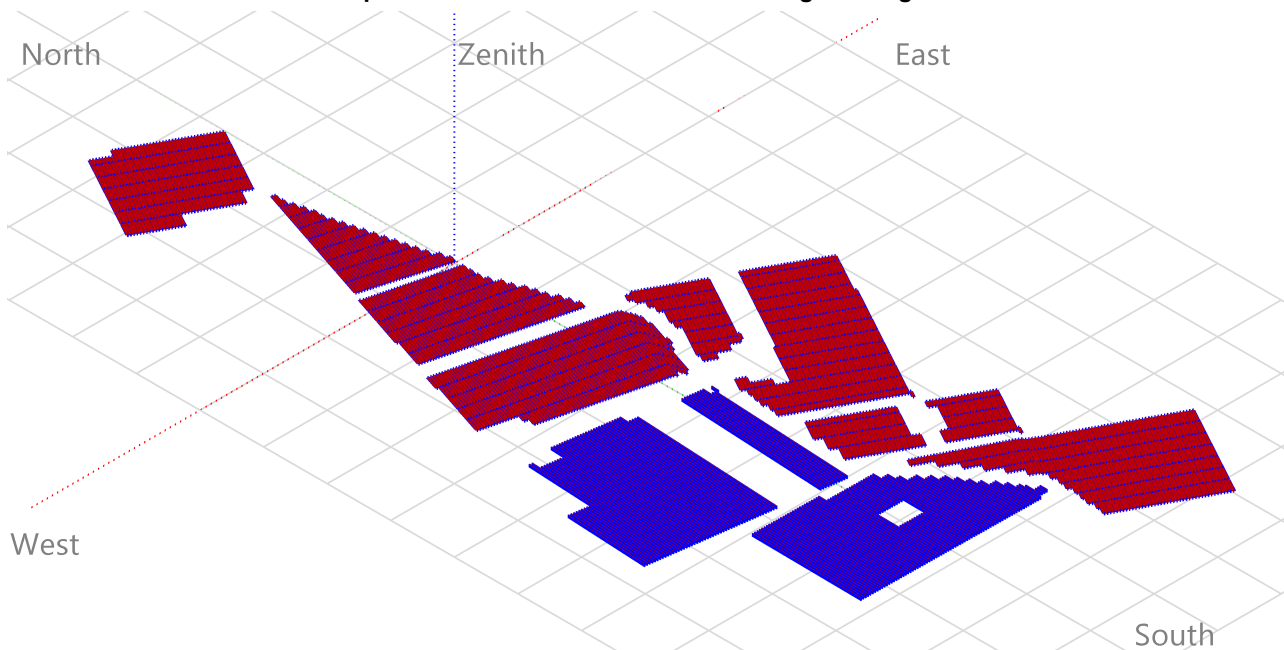
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Near shadings parameter

Perspective of the PV-field and surrounding shading scene



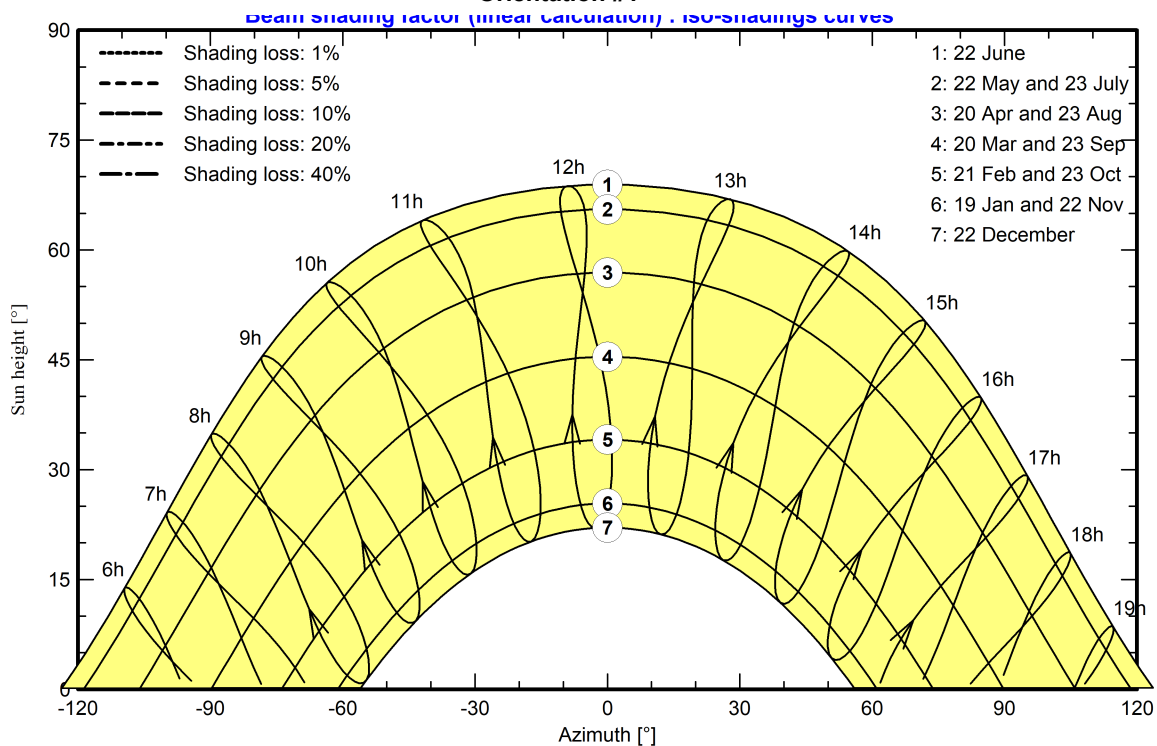


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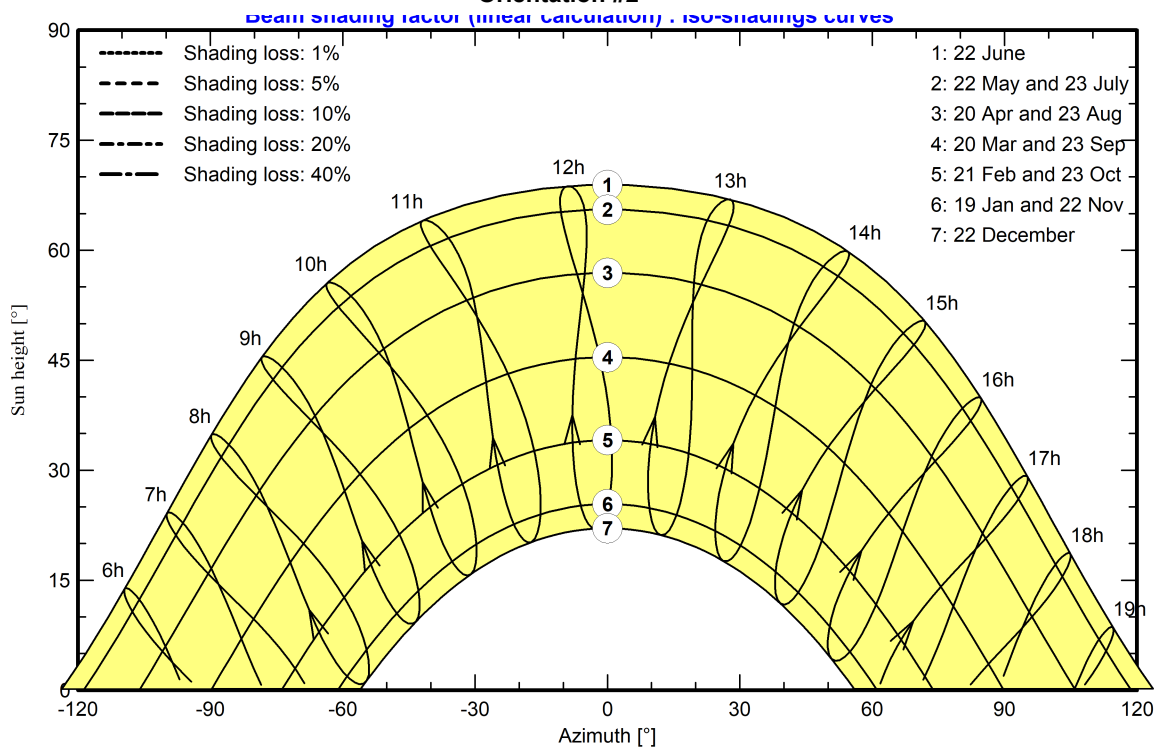
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Iso-shadings diagram

Orientation #1 -



Orientation #2 -





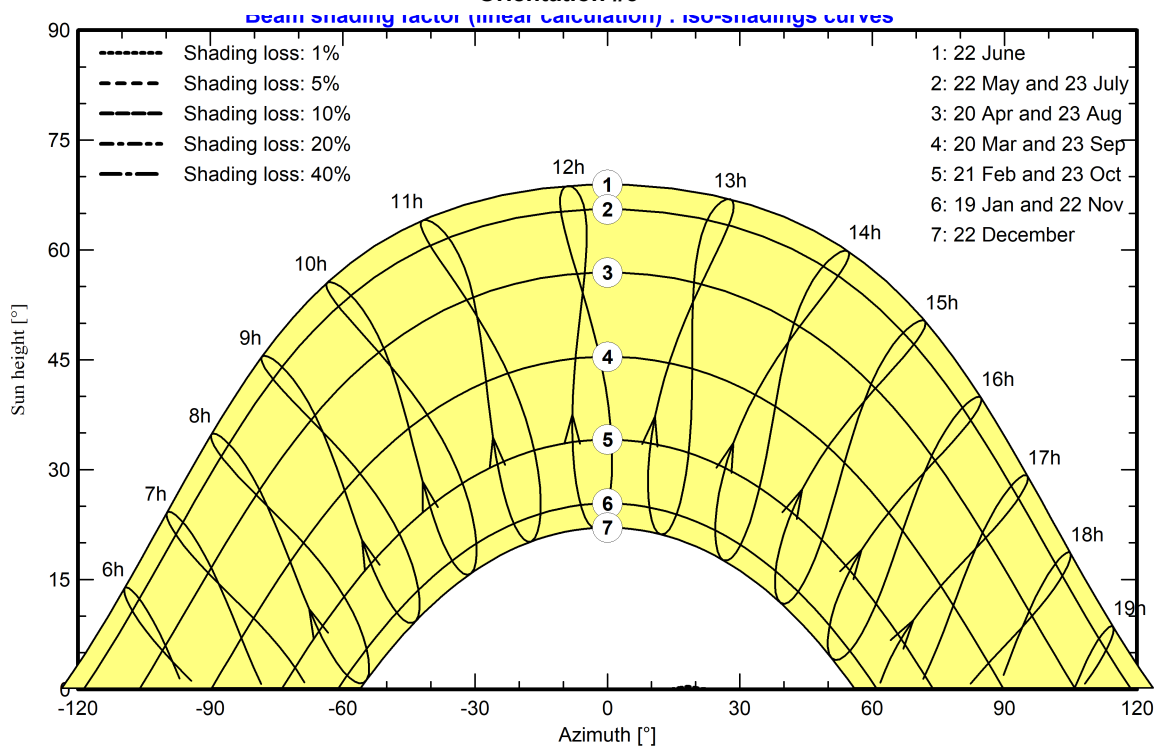
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Iso-shadings diagram

Orientation #3 -





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Stemm srl (italy)

Main results

Simulation step

Hourly

System Production

Produced Energy 98754008 kWh/year

Specific production

1527 kWh/kWp/year

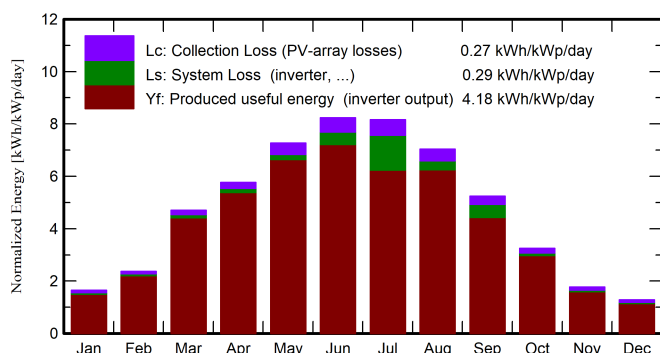
Perf. Ratio PR

88.22 %

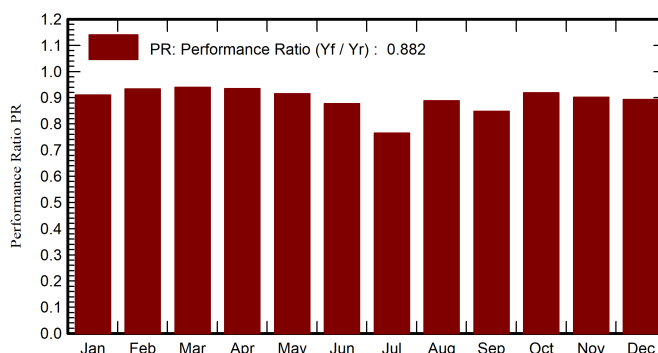
Bifacial perf. ratio

83.76 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

	GlobHor	DiffHor	T_Amb	GlobInc	GlobEff	EArray	E_Grid	PR	PRBifi
	kWh/m ²	kWh/m ²	°C	kWh/m ²	kWh/m ²	kWh	kWh	ratio	ratio
January	40.9	25.92	3.19	51.3	46.5	3134118	3018974	0.911	0.863
February	54.3	33.91	5.24	66.3	61.3	4131006	4001774	0.933	0.882
March	112.5	47.77	10.06	145.8	137.8	9120911	8861715	0.940	0.895
April	139.6	73.47	14.21	173.1	164.0	10765173	10468091	0.935	0.886
May	181.4	83.50	19.28	225.3	214.5	13722677	13338730	0.916	0.868
June	197.9	84.46	23.89	247.0	235.8	14946871	14010682	0.877	0.832
July	200.8	85.13	26.45	252.9	241.3	15190333	12518053	0.765	0.727
August	173.4	76.64	25.86	218.2	207.8	13221001	12532171	0.888	0.843
September	120.9	52.77	20.18	157.2	148.7	9574256	8618771	0.848	0.807
October	78.8	39.88	15.66	100.7	94.2	6166052	5984404	0.919	0.873
November	41.6	24.29	9.95	53.2	48.7	3220548	3102761	0.901	0.856
December	31.1	19.39	4.48	39.8	36.0	2402555	2297883	0.893	0.848
Year	1373.3	647.14	14.92	1730.8	1636.7	105595502	98754008	0.882	0.838

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
PRBifi Bifacial Performance Ratio

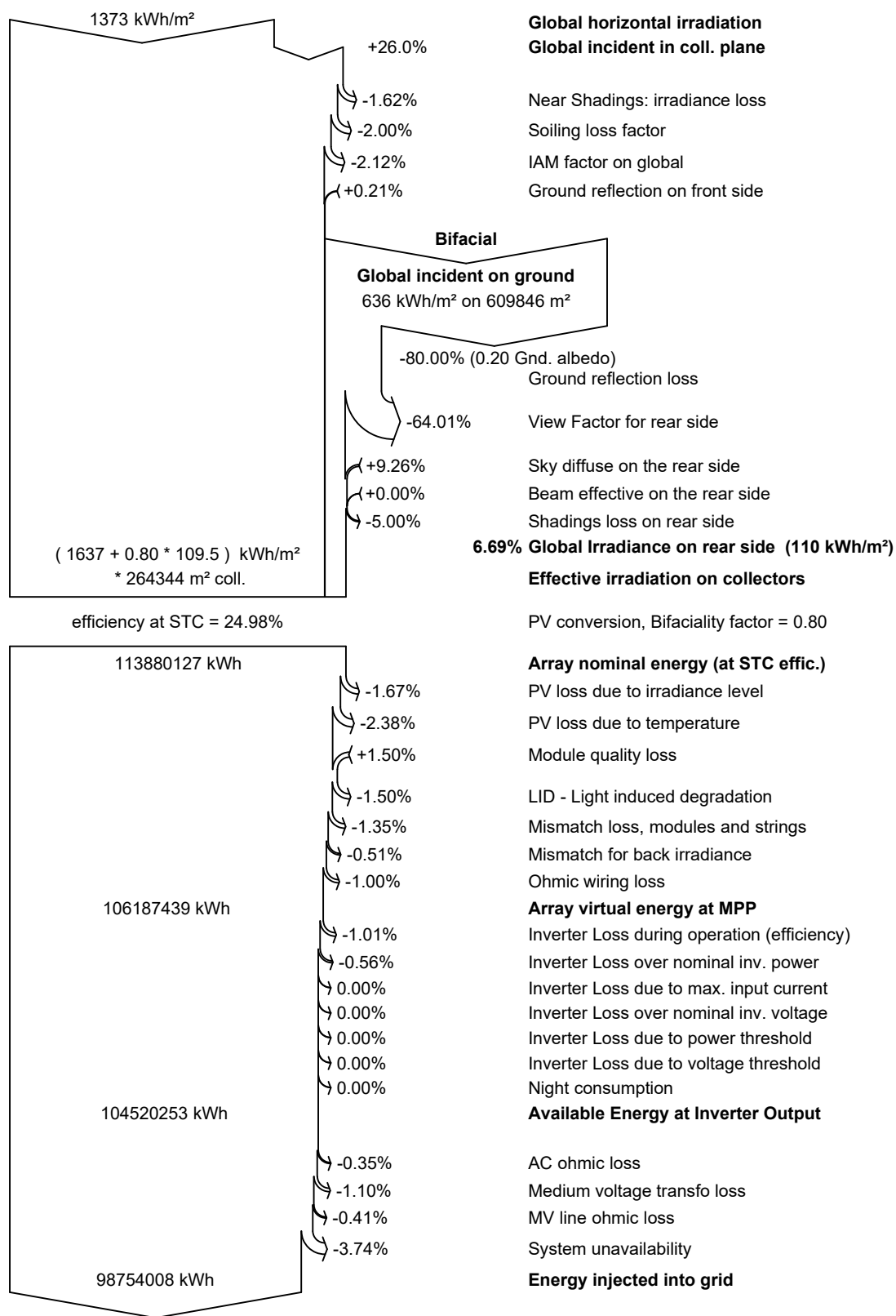


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Loss diagram





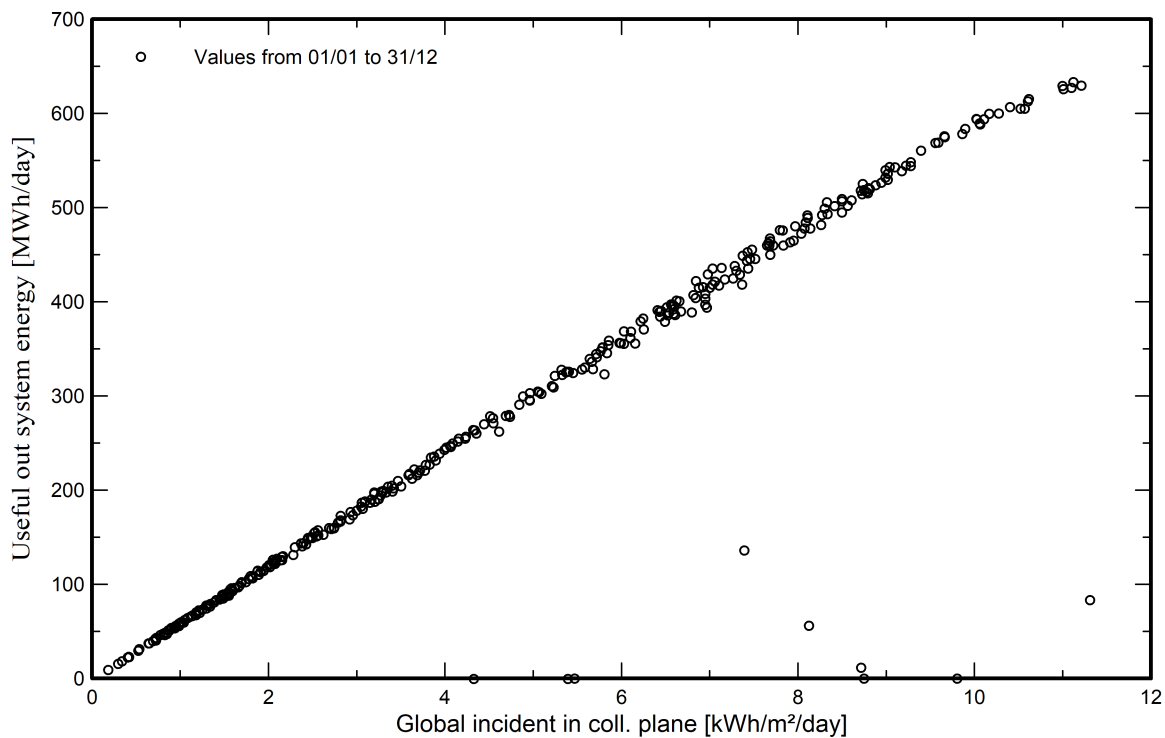
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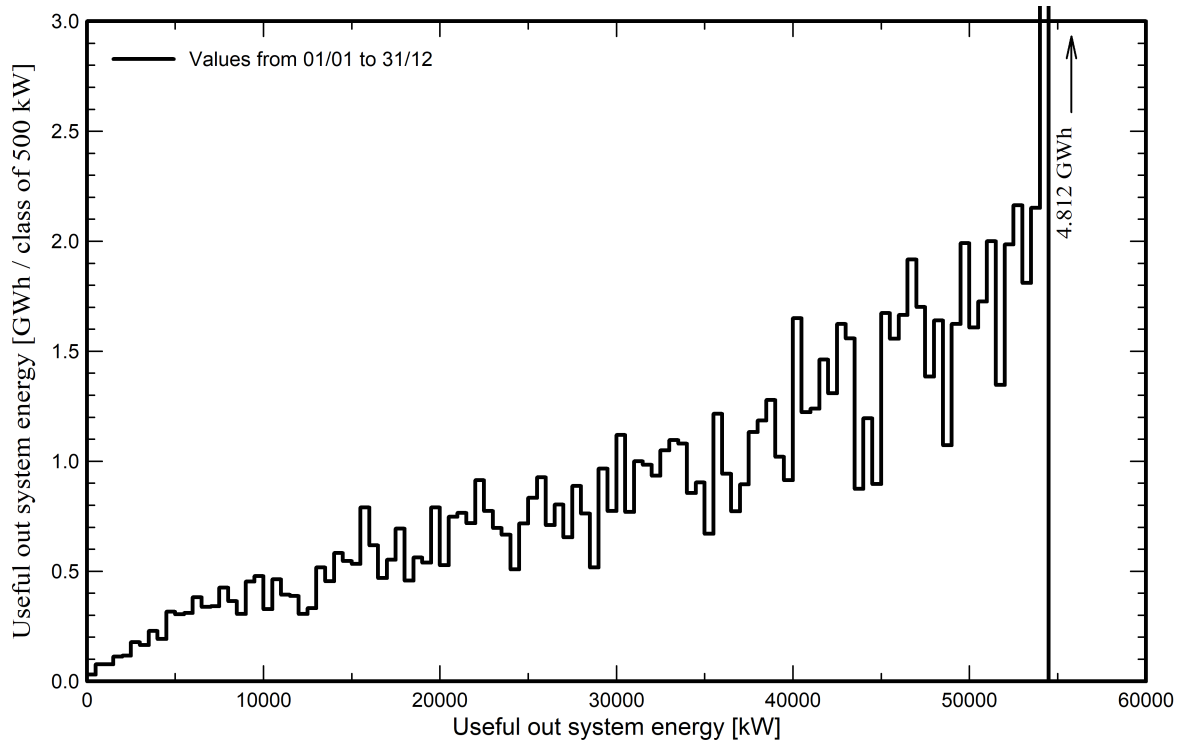
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Predef. graphs

Daily Input/Output diagram



System Output Power Distribution





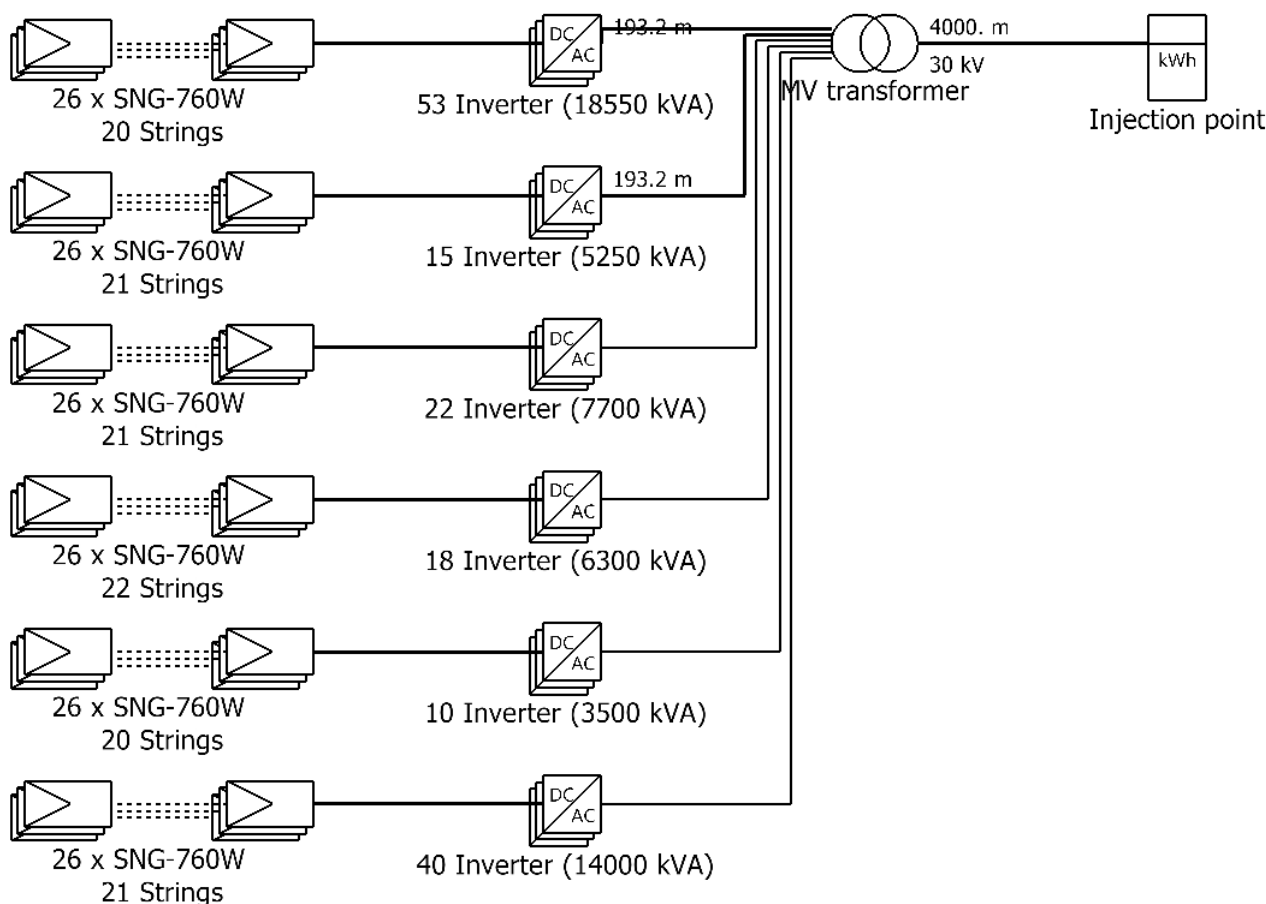
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Single-line diagram



PV module	SNG-760W
Inverter	SG350-HX
String	26 x SNG-760W

STEMMI

Fossatone v4

Stemm srl (italy)

VC1 : MTN90H

23/04/26



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CO₂ Emission Balance

Total: 970359.9 tCO₂

Generated emissions

Total: 116988.29 tCO₂

Source: Detailed calculation from table below

Replaced Emissions

Total: 1253188.4 tCO₂

System production: 98754.01 MWh/yr

Grid Lifecycle Emissions: 423 gCO₂/kWh

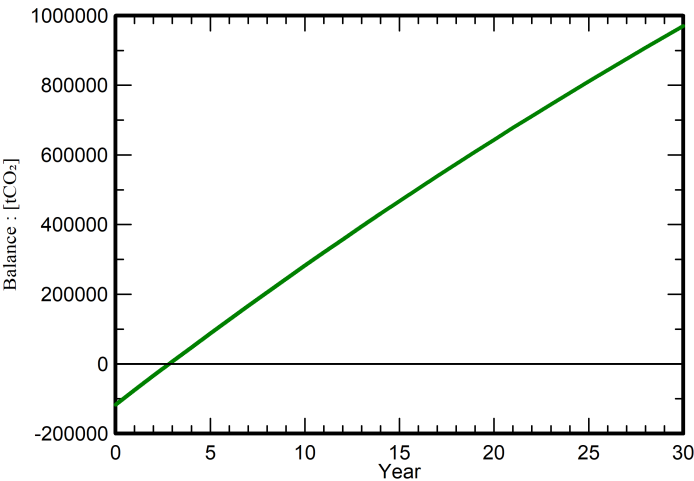
Source: IEA List

Country: Italy

Lifetime: 30 years

Annual degradation: 1.0 %

Saved CO₂ Emission vs. Time



System Lifecycle Emissions Details

Item	LCE	Quantity	Subtotal
			[kgCO ₂]
Modules	1623 kgCO ₂ /kWp	64674 kWp	104939314
Supports	2.82 kgCO ₂ /kg	4254900 kg	12004817
Inverters	280 kgCO ₂ /	158	44164