

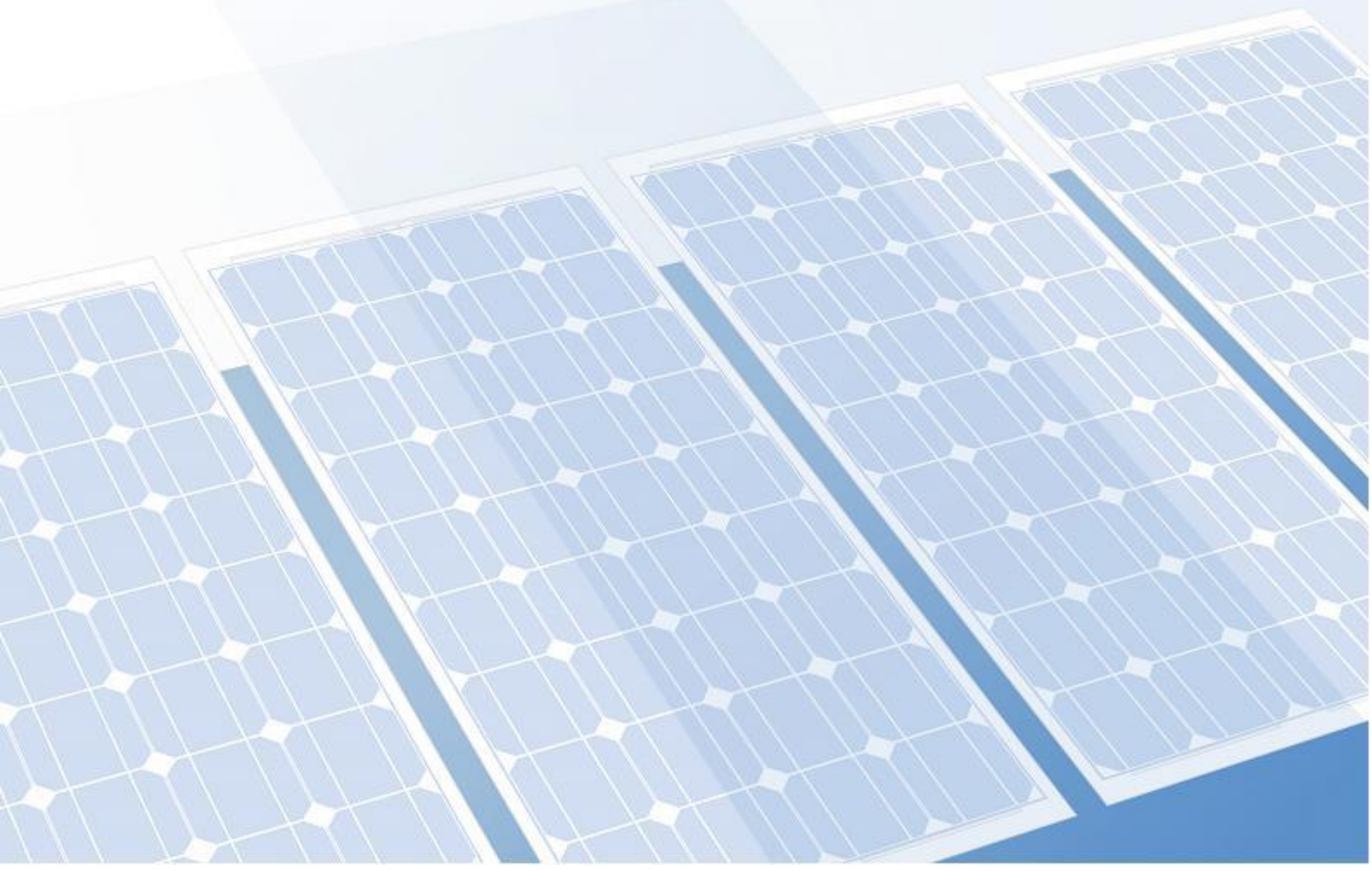
Company

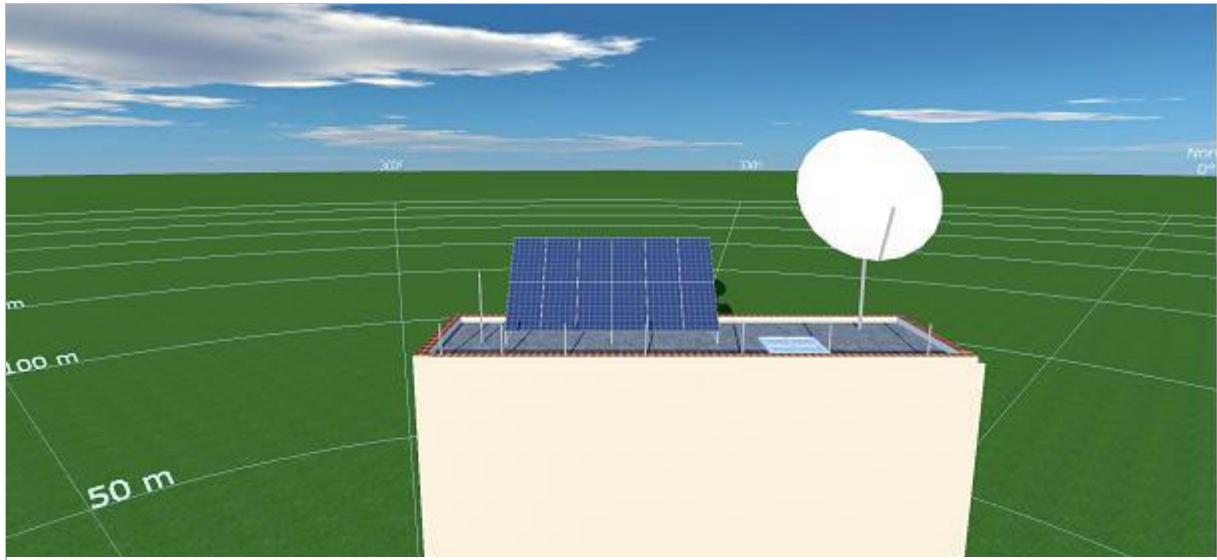
Universitatea Tehnica din Cluj Napoca

Client

Project

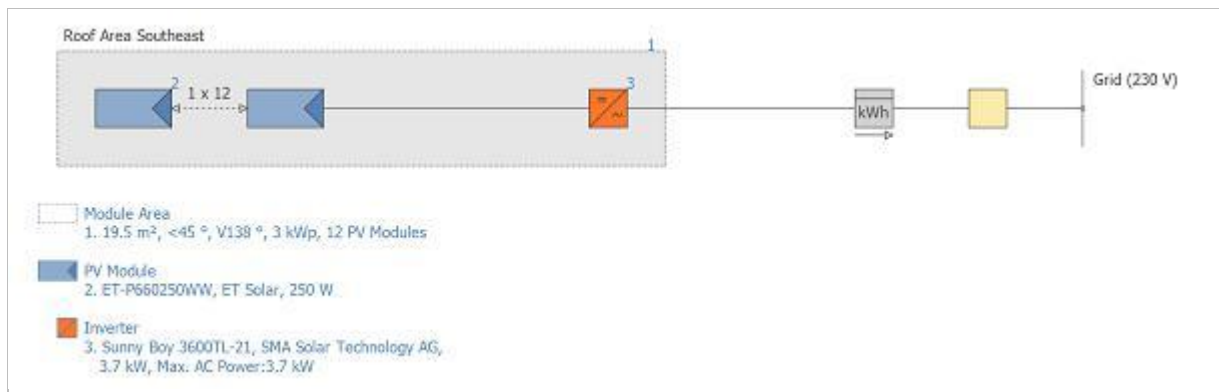
REMSIS





3D, Grid-connected PV System - Full Feed-in

City	Cluj Napoca
Climate Data	Cluj-Napoca
PV Generator Output	3 kWp
Generator Surface	19.5 m ²
Number of PV Modules	12
Number of Inverter	1



The yield

Energy produced by PV System (AC)	3,292 kWh
Spec. Annual Yield	1,097.38 kWh/kWp
Performance Ratio (PR)	81.9 %
Yield Reduction due to Shading	3.8 %/year
CO ₂ Emissions avoided	1,967 kg / year

REMSIS

Your Gain	
Total investment costs	13,200.00 \$
Return on assets	1.84 %
Amortization Period	12.5 Years
Electricity Production Costs	\$0.49

The results have been calculated with a mathematical model calculation from Valentin Software GmbH (PV*SOL algorithms). The actual yields from the solar power system may differ as a result of weather variations, the efficiency of the modules and inverter, and other factors.

Set-up of the system

City	Cluj Napoca
Climate Data	Cluj-Napoka
Type of System	3D, Grid-connected PV System - Full Feed-in

Solar Generator

Module Area	Roof Area Southeast
Solar Modules*	12 x ET-P660250WW
Manufacturer	ET Solar
Inclination	45 °
Orientation	Southeast (138 °)
Installation Type	Mounted - Roof
Generator Surface	19.5 m ²

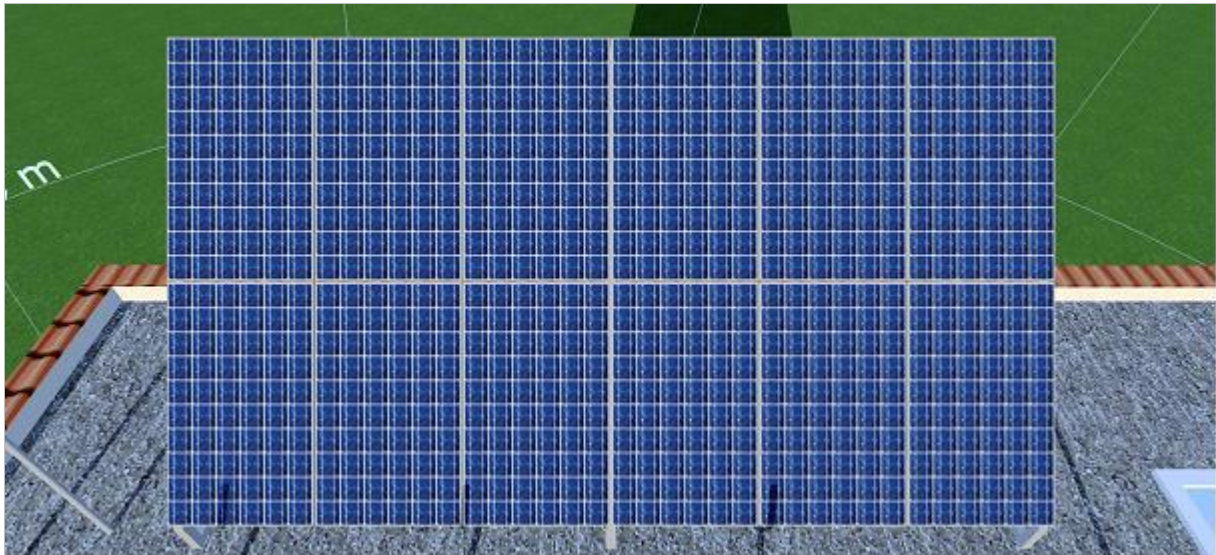


Figure: 3D Design for Roof Area Southeast

Losses

Remaining power after 20 Years	100 %
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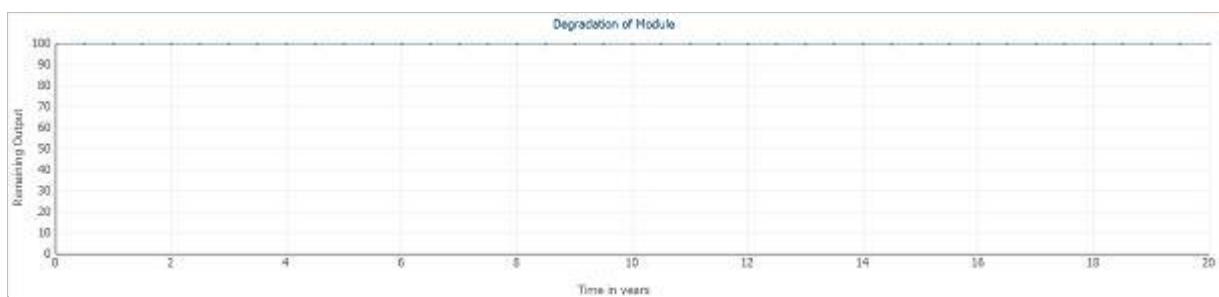


Figure: Degradation of Module of Roof Area Southeast

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Inverter	
Module Area	Roof Area Southeast
Inverter 1*	1 x Sunny Boy 3600TL-21
Manufacturer	SMA Solar Technology AG
Configuration	MPP 1: 1 x 12 MPP 2: free-standing

AC Mains	
Number of Phases	3
Mains Voltage (1-phase)	230 V
Displacement Power Factor (cos φ)	+/- 1

Cable	
Total Loss	0.97 %

* The guarantee provisions of the respective manufacturer apply

Simulation results

PV System

PV Generator Output	3 kWp
Spec. Annual Yield	1,097.38 kWh/kWp
Performance Ratio (PR)	81.9 %
Yield Reduction due to Shading	3.8 %/year
Annual Grid Feed-in	3,292 kWh/year
Annual Grid Feed-in incl. Degradation of Module	3,292 kWh/year
Stand-by Consumption	13 kWh/year
CO ₂ Emissions avoided	1,967 kg / year

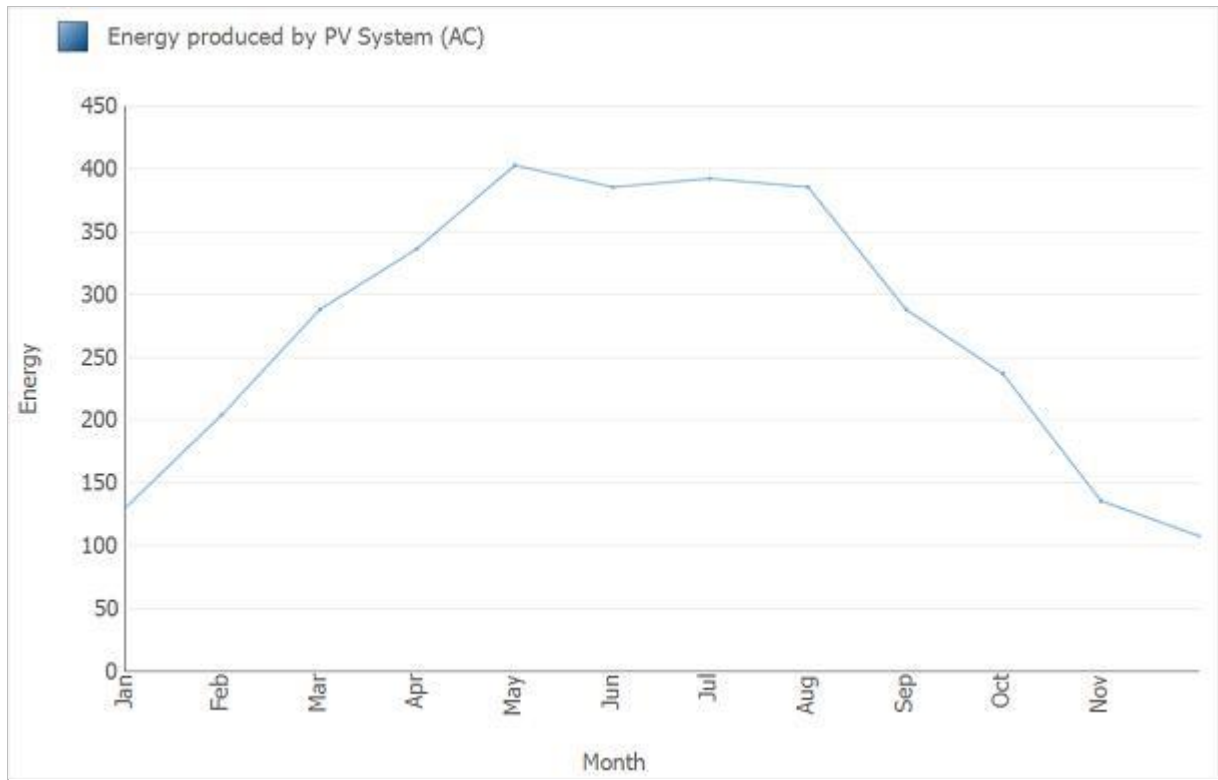


Figure: Production Forecast

PV System Energy Balance		
Global radiation - horizontal	1,277.6 kWh/m²	
Deviation from standard spectrum	-12.78 kWh/m ²	-1.00 %
Orientation and inclination of the module surface	80.98 kWh/m ²	6.40 %
Shading of diffuse radiation by horizon	0.00 kWh/m ²	0.00 %
Reflection on the Module Interface	-35.46 kWh/m ²	-2.63 %
Global Radiation at the Module	1,310.4 kWh/m²	
	1,310.4 kWh/m ²	
	x 19.52 m ²	
	= 25,581.8 kWh	
Global PV Radiation	25,581.8 kWh	
Soiling	0.00 kWh	0.00 %
STC Conversion (Rated Efficiency of Module 15.37%)	-21,650.67 kWh	-84.63 %
Rated PV Energy	3,931.1 kWh	
Module-specific Partial Shading	-21.57 kWh	-0.55 %
Part Load	-154.49 kWh	-3.95 %
Temperature	-107.19 kWh	-2.85 %
Diodes	-8.51 kWh	-0.23 %
Mismatch (Manufacturer Information)	-72.79 kWh	-2.00 %
Mismatch (Configuration/Shading)	-20.43 kWh	-0.57 %
String Cable	-13.88 kWh	-0.39 %
PV Energy (DC) without inverter regulation	3,532.3 kWh	
Regulation on account of the MPP Voltage Range	0.00 kWh	0.00 %
Regulation on account of the max. DC Current	0.00 kWh	0.00 %
Regulation on account of the max. DC Power	0.00 kWh	0.00 %
Regulation on account of the max. AC Power/cos phi	0.00 kWh	0.00 %
MPP Matching	-43.06 kWh	-1.22 %
PV energy (DC)	3,489.2 kWh	
Energy at the Inverter Input	3,489.2 kWh	
Input voltage deviates from rated voltage	-21.15 kWh	-0.61 %

Financial Analysis

System Data

Annual Grid Feed-in incl. Degradation of Module	3,292 kWh
PV Generator Output	3 kWp
Start of Operation of the System	4/25/2016
Assessment Period	20 Years

Economic Parameters

Return on assets	1.84 %
Accrued Cash Flow (Cash Balance)	5,089.07 \$
Amortization Period	12.5 Years

Payment overview

Total investment costs	13,200.00 \$
Total investment costs	4,400.00 \$/kWp
Incoming Subsidies	0.00 \$
One-off Payments	0.00 \$
Annual Costs	92.40 \$/year
Other revenue or savings	0.00 \$/year

Remuneration and savings

Total Payment from Utility in First Year	1,646.07 \$
Solar - Solar	
Validity	4/25/2016 - 4/25/2036
Specific feed-in / export Remuneration	0.5 \$/kWh
Feed-in / export tariff	1,646.07 \$/year

PV Module: ET-P660250WW

Manufacturer	ET Solar
Available	Yes

Electrical Data

Cell Type	Si polycrystalline
Only Transformer Inverters suitable	No
Number of Cells	60
Number of Bypass Diodes	3

Mechanical Data

Width	992 mm
Height	1640 mm
Depth	40 mm
Frame Width	11 mm
Weight	18.8 kg
Framed	No

I/V Characteristics at STC

MPP Voltage	30.34 V
MPP Current	8.24 A
Output	250 W
Open Circuit Voltage	37.47 V
Short-Circuit Current	8.76 A
Increase open circuit voltage before stabilisation	0 %

I/V Part Load Characteristics

Values source	Manufacturer/user-created
Irradiance	200 W/m ²
Voltage in MPP at Part Load	29.6661 V
Current in MPP at Part Load	1.6181 A
Open Circuit Voltage (Part Load)	34.6704 V
Short Circuit Current at Part Load	1.7201 A

Further

Voltage Coefficient	-116.5 mV/K
Electricity Coefficient	3.59 mA/K
Output Coefficient	-0.44 %/K
Incident Angle Modifier	97 %
Maximum System Voltage	1000 V
Spec. Heat Capacity	920 J/(kg*K)
Absorption Coefficient	70 %
Emissions Coefficient	85 %

Inverter: Sunny Boy 3600TL-21

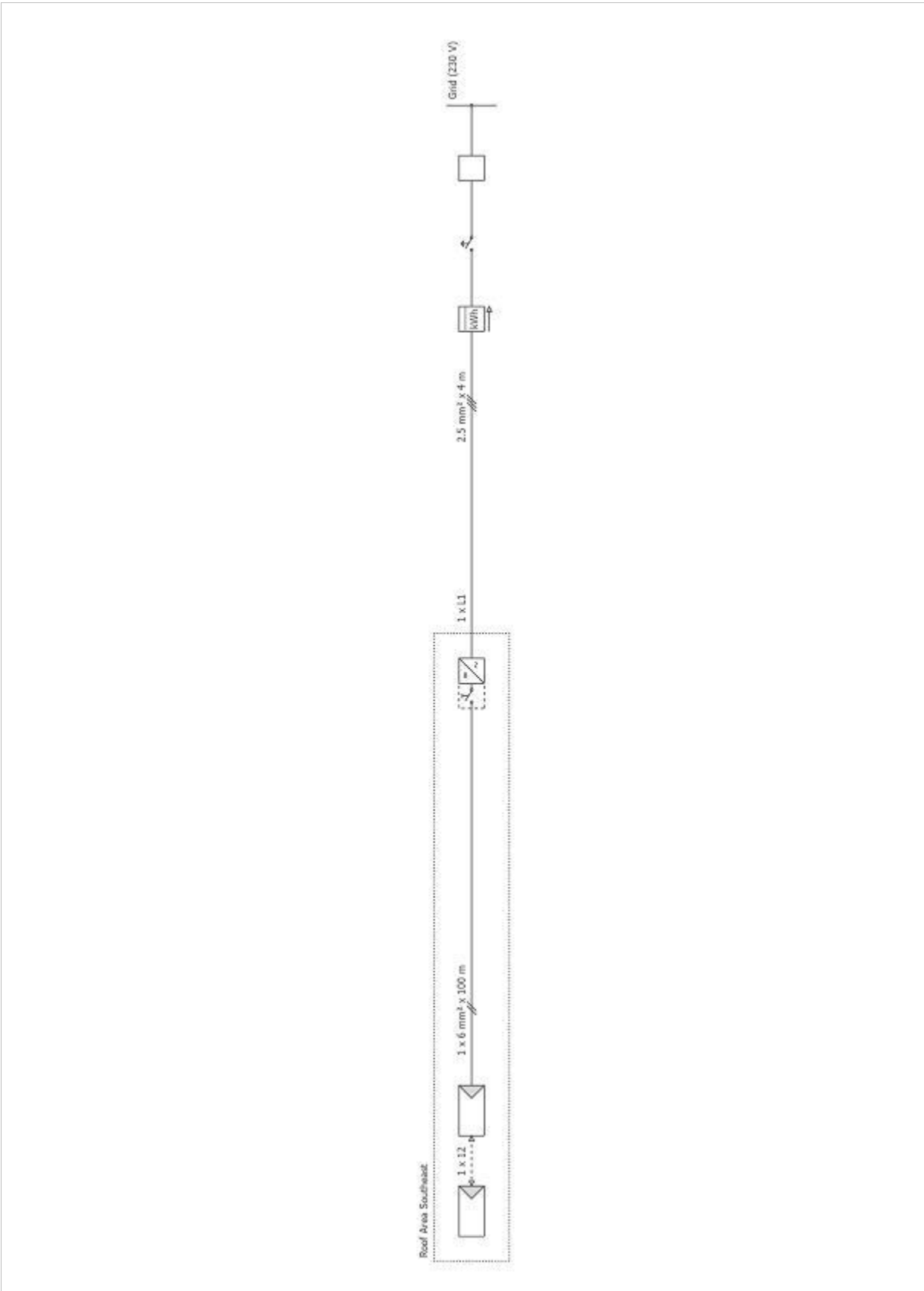
Manufacturer	SMA Solar Technology AG
Available	Yes

Electrical Data

DC Power Rating	3.88 kW
AC Power Rating	3.68 kW
Max. DC Power	3.88 kW
Max. AC Power	3.68 kW
Stand-by Consumption	10 W
Night Consumption	1 W
Feed-in from	32 W
Max. Input Current	30 A
Max. Input Voltage	750 V
Nom. DC Voltage	400 V
Number of Feed-in Phases	1
Number of DC Inlets	4
With Transformer	No
Change in Efficiency when Input Voltage deviates from Rated Voltage	0.99 %/100V

MPP Tracker

Output Range < 20% of Power Rating	97 %
Output Range > 20% of Power Rating	98.9 %
No. of MPP Trackers	2
Max. Input Current per MPP Tracker	15 A
Max. recommended Input Power per MPP Tracker	3.68 kW
Min. MPP Voltage	125 V
Max. MPP Voltage	500 V



Configuration

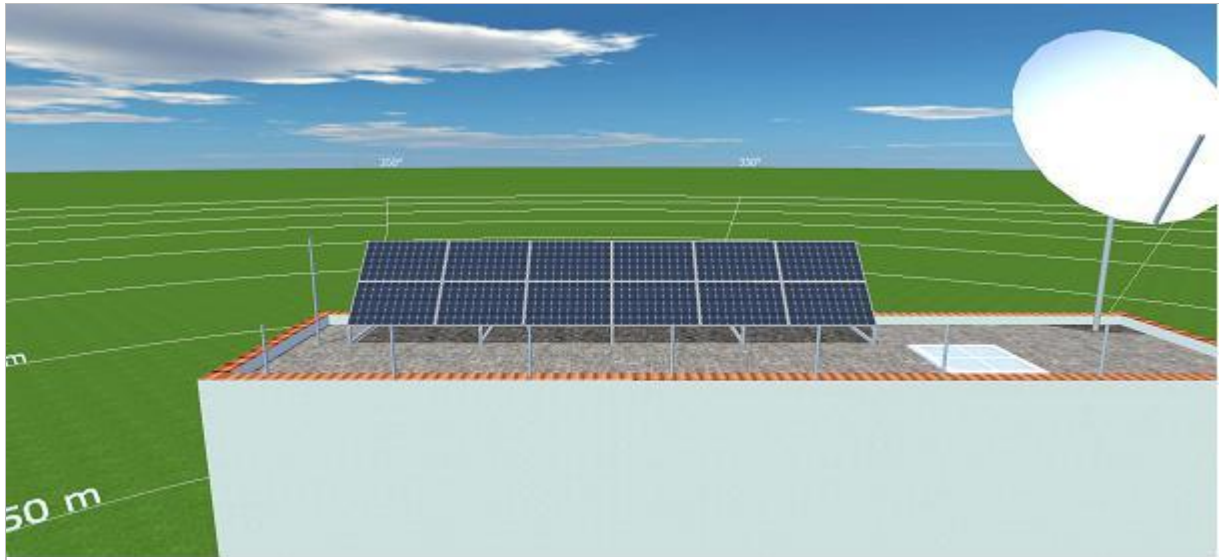


Figure: Screenshot01