EE4340 – Microgrids

Design Project

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1 Design a grid connected solar PV system to your home

1.1 Size the solar panel based on the available rooftop area

1.1.1 Rooftop area of the house

Figure 1 - Top view of the house from Google

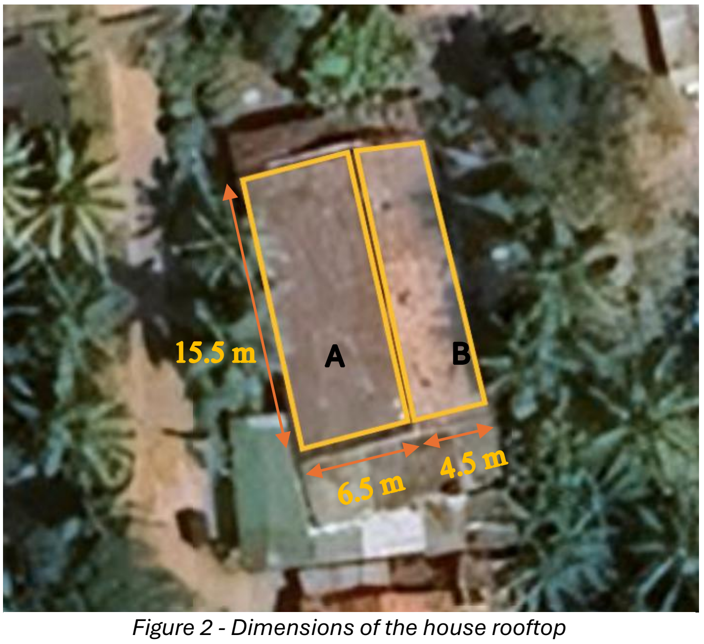


Figure 2 - Dimensions of the house rooftop

Figure 3 - Street View

The physical capacity of the solar PV array was evaluated based on the specific dimensions of the building's Gable type roof, which features two distinct slopes: Side A (15.5m x 6.5 m) and Side B (15.5 m x 4.5 m).

1.1.2 Select Cell module

Choose the **1664 x 998 x 7.6 mm with corner protector module**. It offers the highest durability and installation safety without reducing the number of panels we can fit.

1.1.3 Select orientation

There are two methods we can fit the module in the roof top.

- Method 1: Landscape Orientation

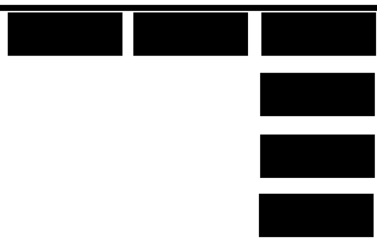
Side B

Rows: 4.5/ 0.998 = 4.509 → 4

Columns: 15.5/ 1.664 = 9.315 → 9

Total (Side B): 9 x 4 = 36

Side A



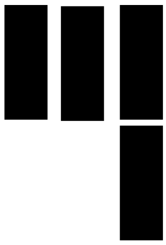
Rows: 6.5/ 0.998 = 6.513 → 6

Columns: 15.5/ 1.664 = 9.315 → 9

Total (Side A): 9 x 6 = 54

- Method 2: Portrait Orientation

Side B

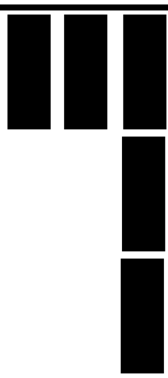


Rows: 4.5/ 1.664 = 2.704 → 2

Columns: 15.5/ 0.998 = 15.531 → 15

Total (Side B): 15 x 2 = 30

Side A



Rows: 6.5/ 1.664 = 3.906 → 3

Columns: 15.5/ 0.998 = 15.531 → 15

Total (Side A): 15 x 3 = 45

Therefore, total maximum physical limit: 54 + 36 = 90 panels (Method 1: Landscape Orientation)
While the rooftop geometrically allows for a maximum of 90 panels (4 from side B and 6 from side A) filling the roof edge-to-edge is often impractical for installation and maintenance. Therefore, one column of panels was removed from the design on both roof slopes. The adjusted number of panels are **80**.

Total DC Power of solar modules: 300W x 80 = **24 kW**

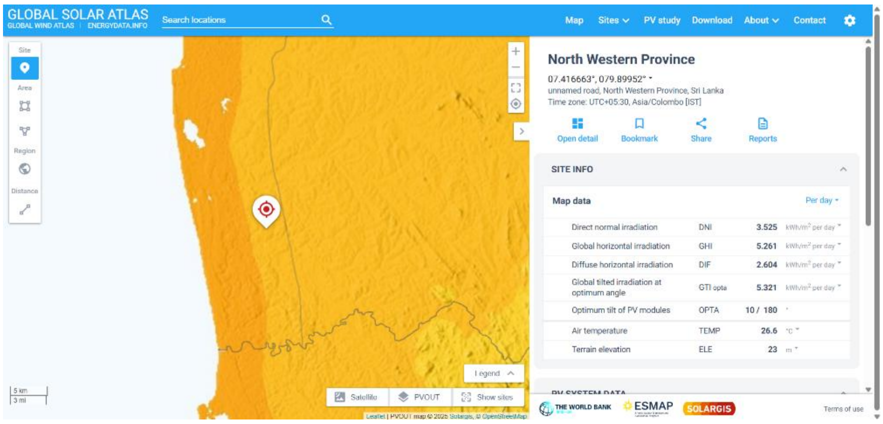


Figure 4 - Global Solar Atlas Data

$T_{a,day} = 26.6\ ^0C$
$G_T = 5.261\ kWh/m^2$ per day

1.2 Select and size the inverter

SUN2000-12/15/17/20/25KTL-M5
Technical Specification

Technical Specification	SUN2000 -12KTL-M5	SUN2000 -15KTL-M5	SUN2000 -17KTL-M5	SUN2000 -20KTL-M5	SUN2000 -25KTL-M5
Efficiency					
Max. efficiency	98.4%	98.4%	98.4%	98.4%	98.4%
European weighted efficiency	97.9%	98.0%	98.1%	98.1%	98.2%
Input					
Recommended max. PV power [1]	18,000 Wp	22,500 Wp	25,500 Wp	30,000 Wp	37,500 Wp
Max. input voltage [2]	1100 V				
Full-load MPPT voltage range	370V~800V	410V~800V	440V~800V	480V~800V	530~800V
MPPT Operating voltage range [3]	200 V ~ 1000 V				
Start-up voltage	200 V				
Rated input voltage	600 V				
Max. input current per MPPT	30 A (two string) / 20 A (single string)				
Max. short-circuit current	40 A				
Number of MPP trackers	2				
Max. number of inputs	4				

Figure 5 - Three-phase inverter data (Annex B)

Selected inverter: **SUN2000-20KTL-M5**
For a 24 kW DC PV array, the Huawei SUN2000-20KTL-M5 inverter was selected, as its 20 kW rated AC output gives a DC/AC ratio of 1.2, which is within the acceptable oversizing range and remains below the inverter's recommended maximum PV input power of 30 kW.

$T_{cell,eff} = T_{a,day} + T_r\ ,\quad T_r = 30\ ^0C$
$T_{cell,eff} = 56.6\ ^0C$

$V_{mp,\ eff} = V_{mp} - \Delta V_{mp}$, where $\Delta V_{oc} = V_{OC} \text{ x } \gamma \text{ x } (T_{cell,eff} - T_{STC})$
(V_{mp} temperature coefficient is not available, so P_{mp} temperature coefficient is used)
$V_{mp,\ eff} = 32.7 - 32.7 \text{ x } 0.0039 \text{ x } (56.6 - 25) = 28.67\ V$

Minimum number of modules in a string $= \dfrac{200 \times 1.1}{32.577} = 7.67 \rightarrow 8$

$V_{oc,\ eff} = V_{OC} - \Delta V_{oc}$, where $\Delta V_{oc} = V_{OC} \text{ x } \beta \text{ x } (15 - T_{STC})$
$V_{OC,eff} = 39.8 - 39.8 \text{ x } 0.0029 \text{ x } (15 - 25) = 40.95\ V$

Maximum number of modules in a string $= \dfrac{1100}{39.829} = 26.86 \rightarrow 26$

According to the manufacturer's datasheet, the Huawei SUN2000-20KTL-M5 inverter include 2 MPP trackers and 4 DC inputs. This configuration assigns two physical inputs to each MPPT. The datasheet specifies a Max. Input Current per MPPT of 30 A when two strings are connected. The Short Circuit Current (I_{sc}) of the selected Trina Solar panel is 9.81 A. Connecting two strings in parallel to a single MPPT with 1.25 safety margin gives a maximum total current of 24.525 A and it is below the inverter's 30 A limit. Therefore, it is safe to connect two parallel strings to each MPPT, allowing for a total of 4 strings.

Use **4 strings** with each have **20 cell modules in series**.

20 × 40.95 = **819 V** < 1100 V & 20 × 28.67 = **573 V** (within MPPT range)

1.3 Energy calculations

1.3.1 Derating factors

- Temperature Derating Factor (f_{temp})

  $T_{cell,eff} = 56.6\ ^0C$

$$\%P_{loss,temp} = \gamma(T_{cell,eff} - T_{STC})$$
$$\%P_{loss,temp} = 0.39(56.6 - 25)$$
$$\%P_{loss,temp} = 12.324\%$$

$f_{temp} = 1 - P_{loss,temp}$

$f_{temp} = 0.87676$

$\mathbf{f_{temp} = 0.877}$

- Manufacturer's output tolerance

ELECTRICAL DATA (STC)

Peak Power Watts-PMAX (Wp)*	280	285	290	295	300	305	310	315
Power Output Tolerance-PMAX (W)	0 ~ +5							
Maximum Power Voltage-VMPP (V)	31.7	31.8	32.2	32.5	32.7	32.9	33.1	33.3
Maximum Power Current-IMPP (A)	8.84	8.96	9.02	9.08	9.18	9.26	9.37	9.46
Open Circuit Voltage-Voc (V)	38.4	38.5	38.7	39.4	39.8	40.0	40.2	40.4
Short Circuit Current-Isc (A)	9.44	9.49	9.59	9.75	9.81	9.84	9.86	9.88
Module Efficiency ηm (%)	17.0	17.3	17.6	17.9	18.2	18.5	18.8	19.2

STC: Irradiance 1000W/m², Cell Temperature 25°C, Air Mass AM1.5.
*Measuring tolerance: ±3%.

Figure 6 - Cell module data (Annex A)

$f_{man} = (1 - \text{manufacturer's tolerance})$

$f_{man} = (1 - \frac{5}{300})$

$\mathbf{f_{man} = 0.9833}$

- Derating factor due to dirt

A dirt derating of 0.95 was selected since the system is assumed to be cleaned periodically,

$\mathbf{f_{dirt} = 0.95}$

- Derating factor due to wiring losses and mismatch

For a properly designed residential system, these losses are usually around 2%. Therefore,

$\mathbf{f_{mismatch,\ wire\ loss} = 0.98}$

- Derating factor due to inverter losses

According to the inverter data specifications maximum efficiency is 98.4%,

$\mathbf{f_{inv} = 0.984}$

1.3.2 Calculate energy production for a month

For a single solar cell module energy per day can be calculated using the following formula,

$$E_{sys} = \left(\frac{G_T}{G_{STC}}\right) \times P_{array_{STC}} \times f_{temp} \times f_{man} \times f_{dirt} \times f_{mismatch,wire\ loss} \times f_{inv}$$

where,

G_T = Average solar radiation incident on the PV array for the selected site
G_T = 5.261 kWh/m^2 per day (From Global Solar Atlas data)

$$E_{sys} = \left(\frac{5.261}{1}\right) \times 300 \times 0.877 \times 0.9833 \times 0.95 \times 0.98 \times 0.984$$

E_{sys} = 1246.867 Wh per module per day

Energy generated by the solar PV system during a single month,

$$E_{month} = \frac{1246.867 \times 80 \times 365}{12}$$

$$E_{month} = 3034043\ Wh$$

$$E_{month} = 3034\ kWh$$

1.3.3 Energy available to feed into the grid for a selected month

Table 1 - Monthly consumption for three months

Reading date	Units (kWh)
2025-08-19	112
2025-09-24	143
2025-10-26	126

Average monthly usage (From last 3 months period) = $\frac{126+143+112}{3}$ =127 kWh

Excess energy (E_{excess}) = 3034 – 127 = **2907 kWh**

2 Verify the design calculations using the PVSyst software

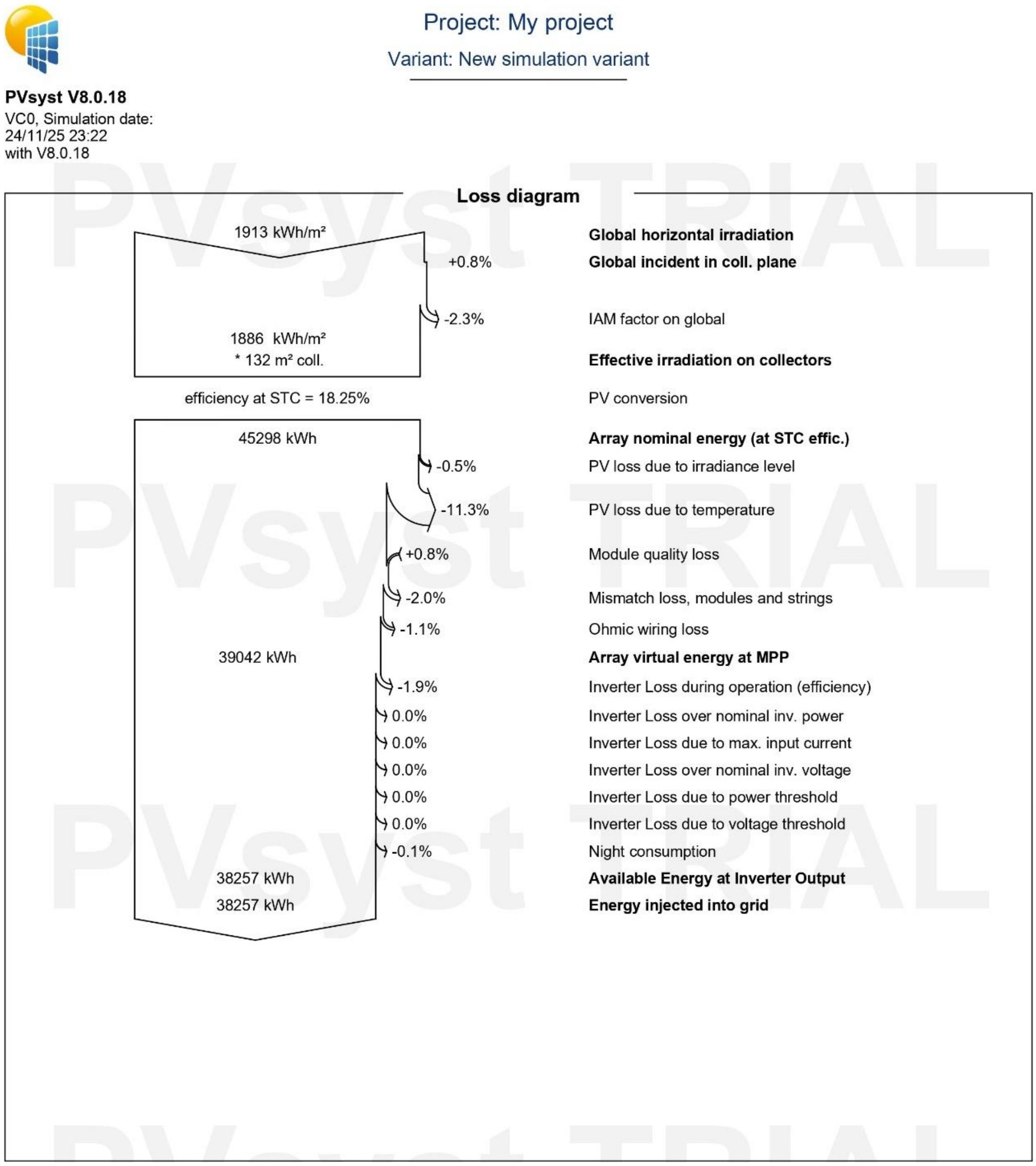


Figure 7 - Loss Diagram from PVsyst Report (Annex C)

From calculations,

E_{excess} (Per month) = 2907 kWh

E_{excess} (Per year) = 2907 x 12 kWh = 34884 kWh

From PVSyst software,

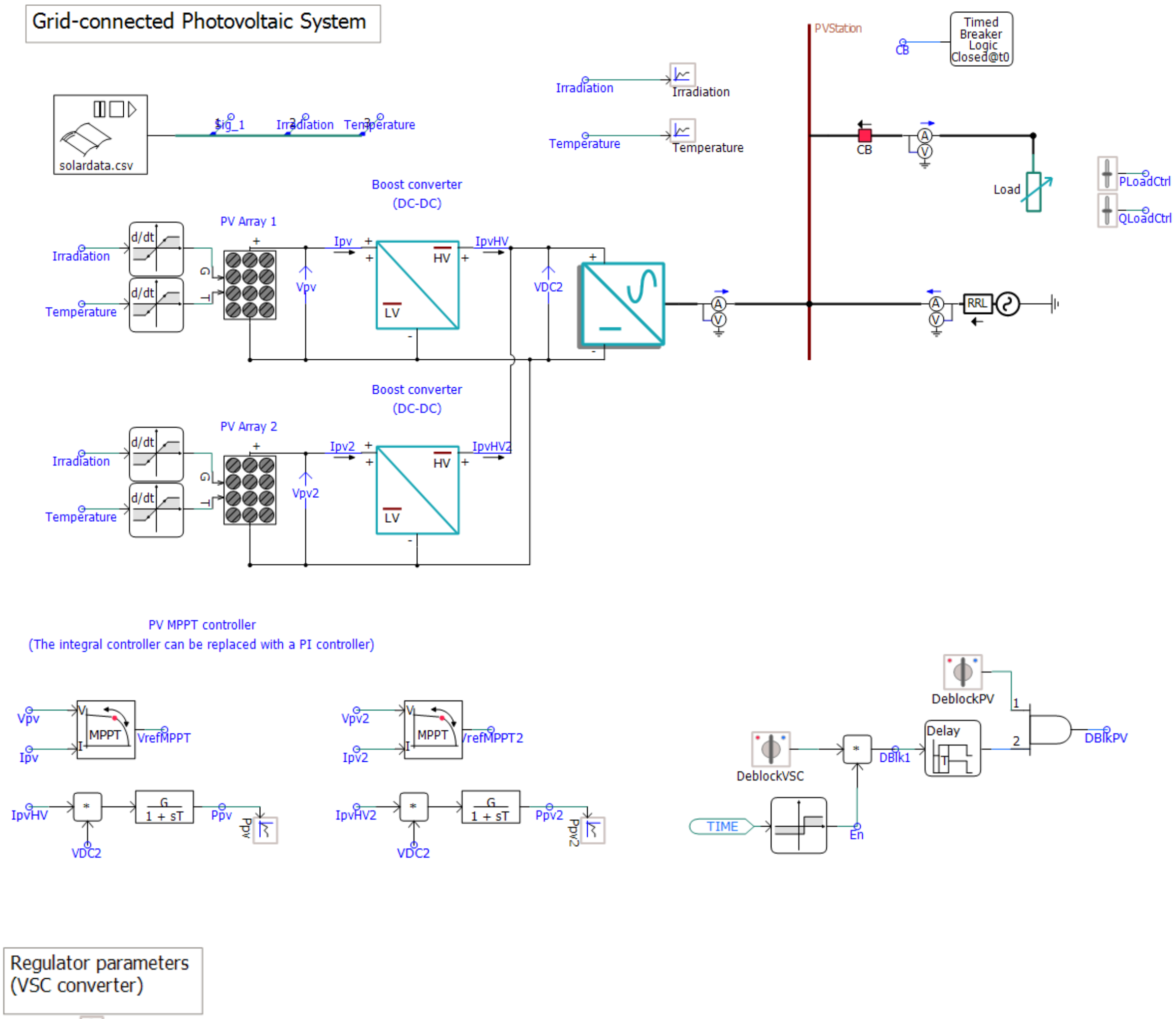
E_{excess} (Per year) = 38257 kWh

Percentage Difference: $\frac{38257 - 34884}{38257} \times 100\ \% = 8.82\ \%$

This deviation is acceptable. The higher output in PVSyst indicates that the manual sizing assumptions were conservative. Since the simulation confirms the system can meet and exceed the generation targets, the **design is validated**.

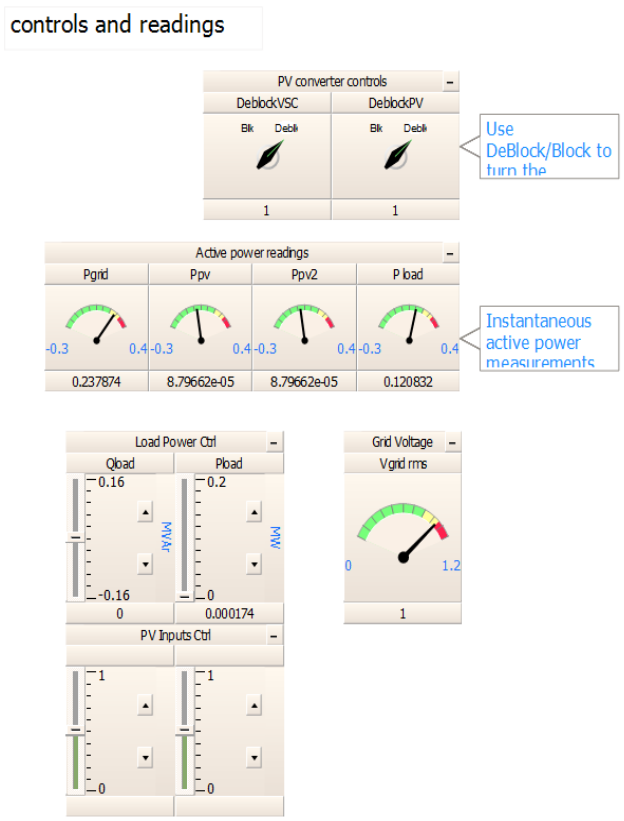
3 Model the designed roof-top Solar PV system as a grid feeding source using PSCAD

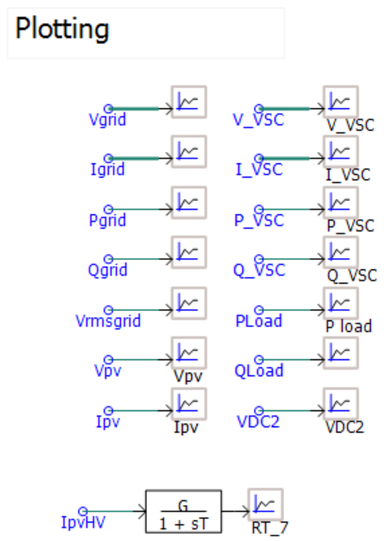
3.1 PSCAD Layout



PV Converter							
Kp_DC	Ti_DC	Kp_Q	Ti_Q	Kpd	Tid	Kpq	Tiq
200	100	20	100	200	10	200	10
0	0	0	0	0	0	0	0
1	0.02	1	0.02	0.15	0.001	1	0.001

VSC power loops			
Kp_DC	Ti_DC	Kp_Q	Ti_Q
200	100	20	100
0	0	0	0
1	0.02	1	0.02





3.2 PSCAD Configuration

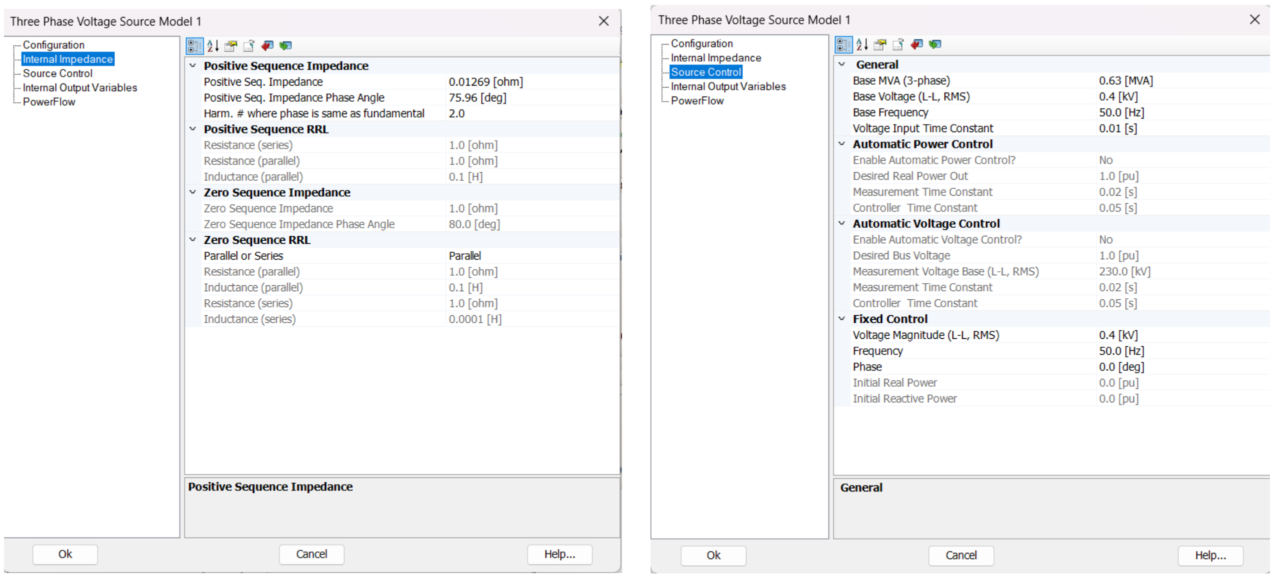


Figure 8 - Three Phase Voltage Source settings (630 kVA, 33/0.4 kV distribution transformer)

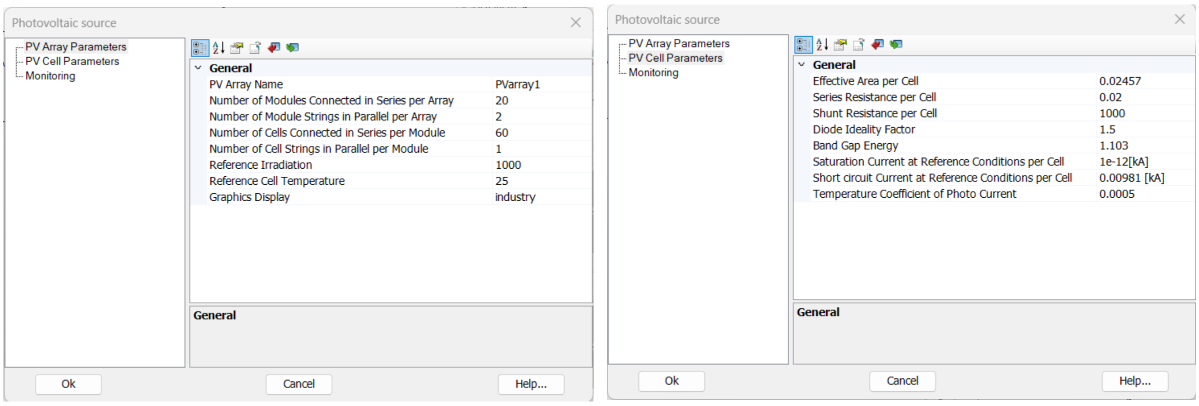


Figure 9 - PV Array settings (PV Array 1 is given as an example)

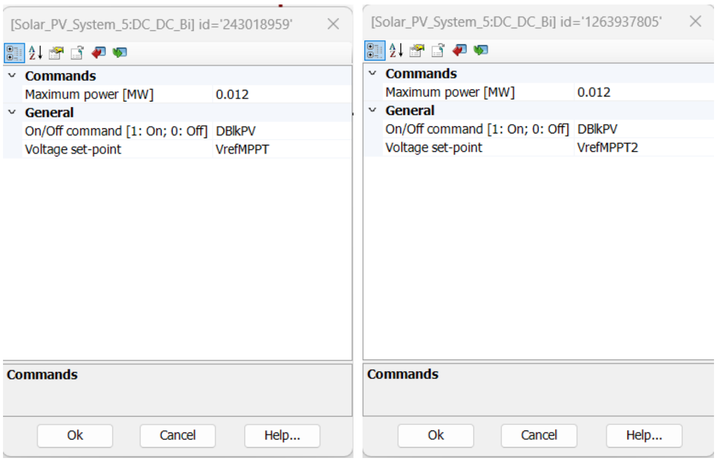


Figure 10 - Boost converter settings

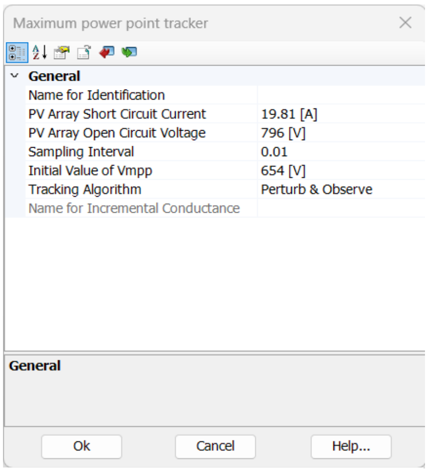


Figure 11 - MPPT settings

For load calculations, P_{load} = (127 kWh)/ (24 x 30 hours) = 0. 174 kW = 0.000174 MW
Assume Q_{load} as 0, since for house load reactive power consumption is very low.

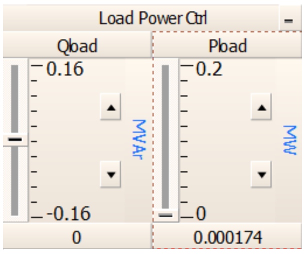


Figure 12 - Load power control

3.3 PSCAD Results

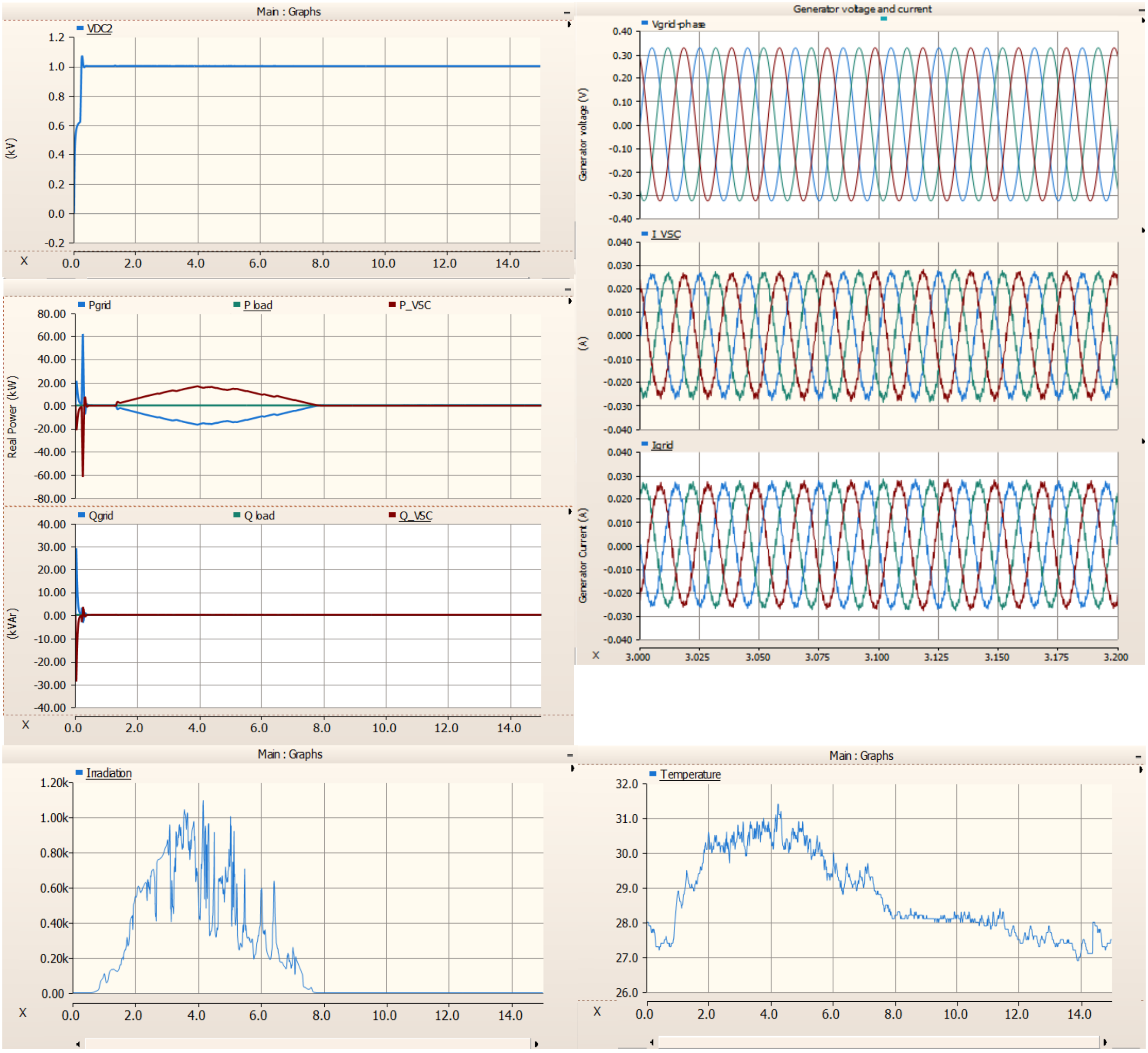


Figure 13 - System response to ramping irradiance. Note: Time axis '1.0' represents 100 minutes (1 hour 40 mins) into the day

Note: In the PSCAD simulation results, a negative value for P_{grid} denotes power flow from the PV system into the grid (Export), while a positive value would indicate power drawn from the grid (Import).

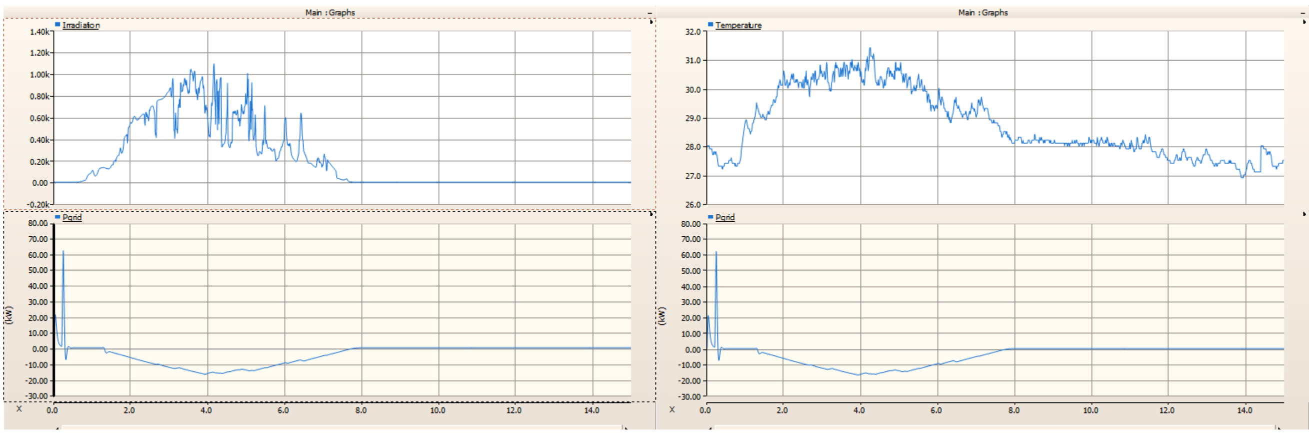


Figure 14 - System behavior with varying irradiance and temperature

3.3.1 Scenario 1: Solar Irradiance Ramping Up (Morning)

Time period: 1:50 am - 4:10 am

During this period, the solar irradiance gradually increases from a low value to a moderate level. As the sunlight increases, the PV system starts generating power, and the MPPT controller begins tracking the maximum power point. The grid power output increases smoothly, showing that the inverter responds correctly to the rising solar input.

Figure 15 - Scenario 1

3.3.2 Scenario 2: Solar Maximum Periods (Peak Generation)

Time period: 5:55 am - 7:15 am

In this scenario, the solar irradiance is at its highest level of the day. As a result, the PV system operates near its rated maximum power. The grid power remains steady and negative, indicating continuous export of power to the grid. This confirms that the inverter can safely operate at full load without instability.

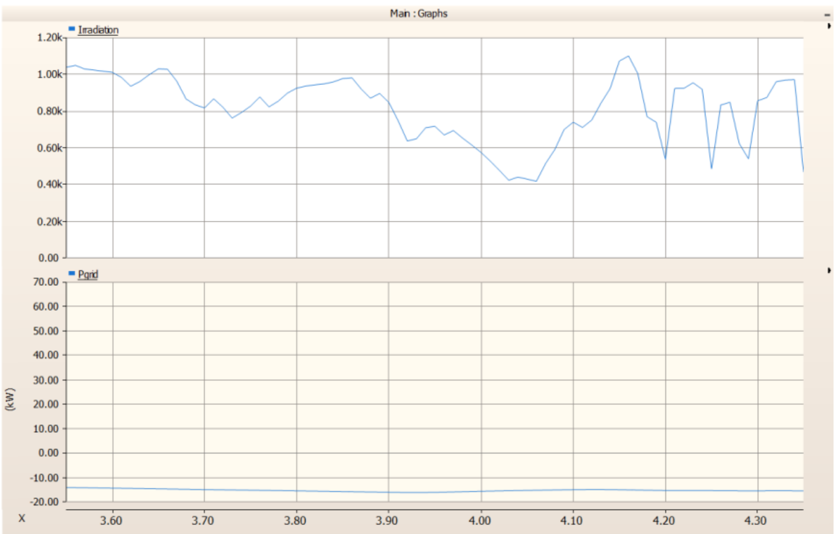


Figure 16 - Scenario 2

3.3.3 Scenario 3: Intermittency (Cloud Cover)

Time period: 7:30 am - 9:10 am

Here, the solar irradiance fluctuates rapidly due to moving cloud cover. These fast changes cause sudden variations in PV output power. The simulation shows that the MPPT controller quickly adjusts to these changes and the inverter remains stable without disconnecting from the grid. This proves that the system can handle intermittent solar conditions effectively.

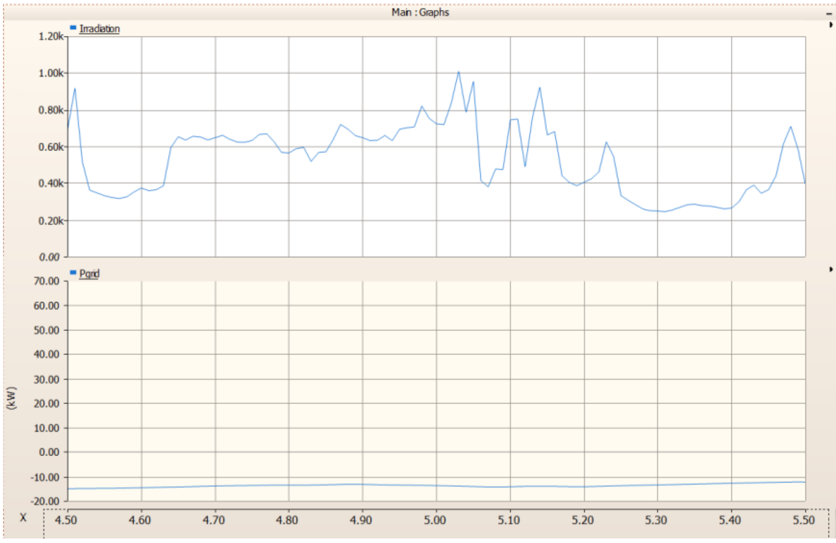


Figure 17 - Scenario 3

3.3.4 Scenario 4: Solar Irradiance Ramping Down (Evening)

Time period: 10:50 am - 1:20 pm

During this period, the solar irradiance gradually decreases as the sun sets. The PV output power reduces smoothly and eventually drops to zero. The inverter shuts down its power injection to the grid without causing voltage or current disturbances. This shows proper and safe inverter shutdown operation.

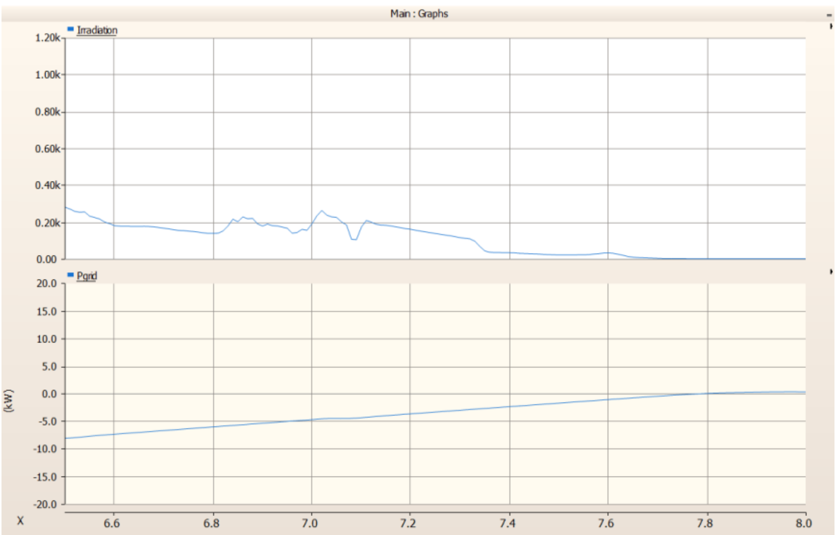


Figure 18 - Scenario 4

3.3.5 Power Quality Verification

The voltage and current waveforms at the grid connection point are sinusoidal and properly synchronized. The current is in phase with the voltage, indicating near unity power factor operation. The Phase Locked Loop (PLL) maintains accurate synchronization with the 50 Hz grid. These results confirm that the injected power has good quality and does not introduce much harmonic distortion or instability into the grid.

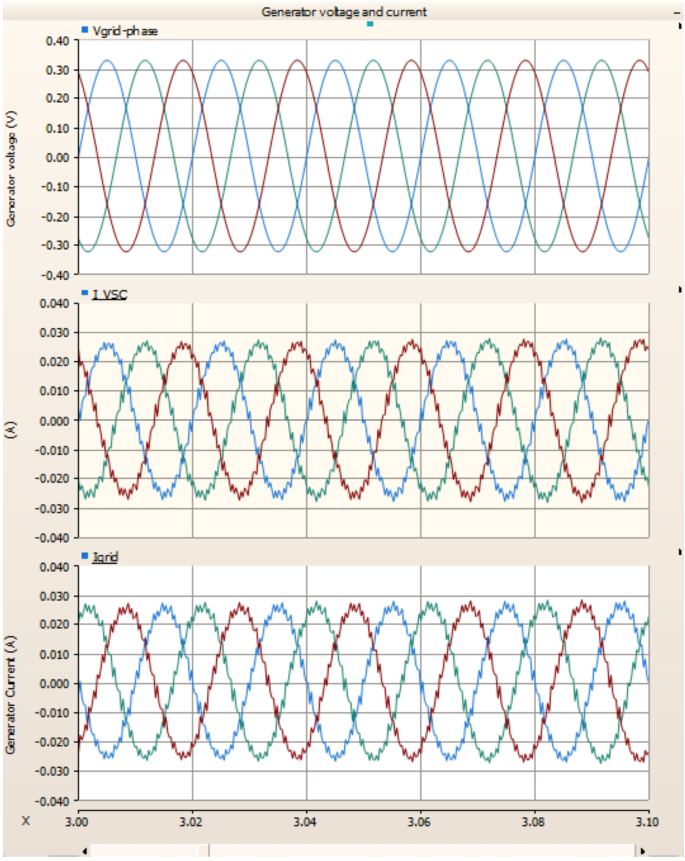


Figure 19

4 Conclusion

The design of the 24 kW grid-connected solar PV system has been validated through analytical calculations, PVSyst simulation, and PSCAD modelling. The difference between the manually calculated energy yield and the PVSyst simulation result is only 8.81%, confirming that the initial sizing assumptions are reasonable and realistic. Furthermore, the PSCAD analysis demonstrates that the selected inverter operates reliably under practical operating conditions without introducing instability into the local distribution grid. The voltage and current waveforms are in phase, confirming proper grid synchronization. While the fundamental component of the current is sinusoidal, the waveform shows the expected high-frequency switching ripple under all tested conditions, including morning ramp-up, evening shutdown, and rapid irradiance fluctuations due to cloud cover. Therefore, the proposed rooftop solar PV system design is verified to be both viable and technically robust for implementation.

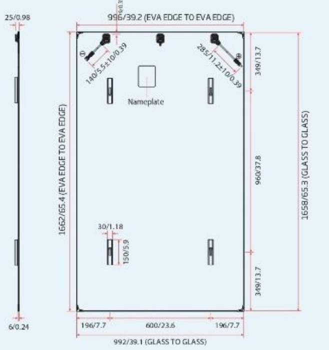
Annex A: Solar Module Datasheet

DUOMAX plus

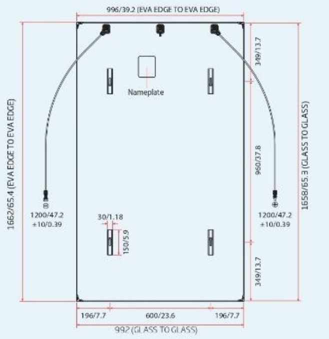
DUAL GLASS 60-CELL MODULE

PRODUCTS	INSTALLATION METHOD	POWER RANGE
TSM-DEG5(II)	Clamp	280-315W
TSM-DEG5.40(II)	Gecko Grip	280-315W
TSM-DEG5.07(II)	Clamp	280-310W
TSM-DEG5.47(II)	Gecko Grip	280-310W

DIMENSIONS OF PV MODULE (mm/inches)

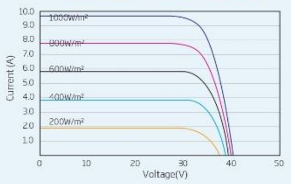


Back View (Portrait)

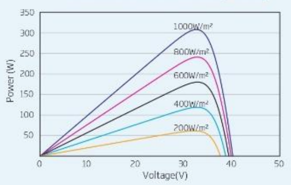


Back View (Landscape)

I-V CURVES OF PV MODULE(305W)



P-V CURVES OF PV MODULE(305W)



ELECTRICAL DATA (STC)

Peak Power Watts-P_{MAX} (Wp)*	280	285	290	295	300	305	310	315
Power Output Tolerance-P_{MAX} (W)	0 ~ +5							
Maximum Power Voltage-V_{MPP} (V)	31.7	31.8	32.2	32.5	32.7	32.9	33.1	33.3
Maximum Power Current-I_{MPP} (A)	8.84	8.96	9.02	9.08	9.18	9.26	9.37	9.46
Open Circuit Voltage-V_{OC} (V)	38.4	38.5	38.7	39.4	39.8	40.0	40.2	40.4
Short Circuit Current-I_{SC} (A)	9.44	9.49	9.59	9.75	9.81	9.84	9.86	9.88
Module Efficiency η_m (%)	17.0	17.3	17.6	17.9	18.2	18.5	18.8	19.2

STC: Irradiance 1000W/m², Cell Temperature 25°C, Air Mass AM1.5.
*Measuring tolerance: ±3%.

ELECTRICAL DATA (NOCT)

Maximum Power-P_{MAX} (Wp)	209	212	216	220	223	227	231	235
Maximum Power Voltage-V_{MPP} (V)	29.4	29.5	29.9	30.1	30.3	30.5	30.7	30.9
Maximum Power Current-I_{MPP} (A)	7.10	7.20	7.25	7.30	7.38	7.44	7.53	7.60
Open Circuit Voltage-V_{OC} (V)	35.7	35.8	36.0	36.6	37.0	37.2	37.4	37.5
Short Circuit Current-I_{SC} (A)	7.62	7.66	7.74	7.87	7.92	7.94	7.96	7.98

NOCT: Irradiance at 800W/m², Ambient Temperature 20°C, Wind Speed 1m/s.

MECHANICAL DATA

Solar Cells	Monocrystalline 156.75 × 156.75 mm (6 inches)
Cell Orientation	60 cells (6 × 10)
Module Dimensions	1658 × 992 × 6 mm (65.3 × 39.1 × 0.236 inches) 1662 × 996 × 6 mm with edge banding (65.4 × 39.2 × 0.236 inches) 1664 × 998 × 7.6 mm with corner protector (65.5 × 39.3 × 0.299 inches)*
Weight	23.5 kg (51.8 lb)
Front Glass	2.5 mm (0.10 inches), High Transmission, AR Coated Heat Strengthened Glass
EVA	White [DEG5(II), PEG5.40(II)]; Transparent [DEG5.07(II), DEG5.47(II)]
Back Glass	2.5 mm (0.10 inches), Heat Strengthened Glass
Frame	Frameless
J-Box	IP 67 or IP 68 rated
Cables	Photovoltaic Technology Cable 4.0 mm² (0.006 inches²) Portrait: 140/285 mm (5.5/11.2 inches) Landscape: 1200/1200 mm (47.2/47.2 inches)
Connector	Trina TS4 (1500V)
Fire Type	Type 13

TEMPERATURE RATINGS

NOCT (Nominal Operating Cell Temperature)	44°C (±2°C)
Temperature Coefficient of P_{MAX}	- 0.39%/°C
Temperature Coefficient of V_{OC}	- 0.29%/°C
Temperature Coefficient of I_{SC}	0.05%/°C

MAXIMUM RATINGS

Operational Temperature	-40~+85°C
Maximum SystemVoltage	1500V DC (IEC) 1000V DC (UL)
Max Series Fuse Rating	15A(Power ≤290W) 20A(Power ≥295W)

(DO NOT connect Fuse in Combiner Box with two or more strings in parallel connection)

WARRANTY

10 year Product Workmanship Warranty

30 year Linear Power Warranty

(Please refer to product warranty for details)

PACKAGING CONFIGURATION

Modules per box: 33 pieces

Modules per 40' container: 858 pieces

MORE OPTIONS

More Options	☐ 2.0mm Glass: 19.7 kg (43.4 lb) [Only for DEG5.40(II)/DEG5.47(II)] ☐ Compact AR Coating ☐ POE (Polyoleÿn Elastomer) Adhesive

*Not applicable to slide-in racking solution

Trinasolar

CAUTION: READ SAFETY AND INSTALLATION INSTRUCTIONS BEFORE USING THE PRODUCT.

Version number: TSM_EN_2018_A www.trinasolar.com

Annex B: Inverter Datasheet

SUN2000-12/15/17/20/25KTL-M5

Technical Specification

Technical Specification	SUN2000 -12KTL-M5	SUN2000 -15KTL-M5	SUN2000 -17KTL-M5	SUN2000 -20KTL-M5	SUN2000 -25KTL-M5
Efficiency					
Max. efficiency	98.4%	98.4%	98.4%	98.4%	98.4%
European weighted efficiency	97.9%	98.0%	98.1%	98.1%	98.2%
Input					
Recommended max. PV power [1]	18,000 Wp	22,500 Wp	25,500 Wp	30,000 Wp	37,500 Wp
Max. input voltage [2]	1100 V				
Full-load MPPT voltage range	370V~800V	410V~800V	440V~800V	480V~800V	530~800V
MPPT Operating voltage range [3]	200 V ~ 1000 V				
Start-up voltage	200 V				
Rated input voltage	600 V				
Max. input current per MPPT	30 A (two string) / 20 A (single string)				
Max. short-circuit current	40 A				
Number of MPP trackers	2				
Max. number of inputs	4				
Output					
Grid connection	Three phase				
Rated output power	12,000 W	15,000 W	17,000 W	20,000 W	25,000 W
Max. apparent power	13,200 W	16,500 VA	18,700 VA	22,000 VA	27,500 VA
Rated output voltage	220 Vac / 380 Vac, 230 Vac / 400 Vac, 239.6 Vac / 415Vac, 3W + N + PE				
Rated AC grid frequency	50 Hz / 60 Hz				
Max. output current	18.2A/380Vac 17.3A/400Vac 16.7A/415Vac	25.2A/380Vac 23.9A/400Vac 23.1A/415Vac	28.6A/380Vac 27.1A/400Vac 26.1A/415Vac	33.6A/380Vac 31.9A/400Vac 30.8A/415Vac	42.0A/380Vac 39.9A/400Vac 38.5A/415Vac
Adjustable power factor	0.8 leading ... 0.8 lagging				
Max. total harmonic distortion	≤ 3 %				
Features & Protections					
Overvoltage Category	PV II/AC III				
Input-side disconnection device	Yes				
Anti-islanding protection	Yes				
AC over-current protection	Yes				
DC reverse-polarity protection	Yes				
String fault detection	Yes				
DC surge protection	TYPE II				
AC surge protection	CLASS II				
Residual current monitoring unit	Yes				
Arc fault protection	Yes				
Ripple control ripple control	Yes				
Integrated PID recovery [4]	Yes				
General Data					
Operation temperature range	-25 ~ + 60 °C (-13 °F ~ 140 °F)				
Relative humidity	0 % RH ~ 100% RH				
Max. operating altitude	0 ~ 4,000 m (13,123 ft.) (Derating above 2000 m)				
Cooling	Smart air cooling				
Display	LED Indicators; Integrated WLAN + FusionSolar App				
Communication	RS485; WLAN/Ethernet via Smart Dongle-WLAN-FE (Optional) 4G / 3G / 2G via Smart Dongle-4G (Optional)				
Weight (with mounting plate)	21kg (46.4 lb)				
Dimensions (W x H x D) (incl. mounting plate)	546 x 460 x 228mm (21.5 x 18.1 x 9.0 inch)				
Degree of protection	IP66				
Optimizer Compatibility					
DC MBUS compatible optimizer	SUN2000-450W-P, SUN2000-450W-P2, SUN2000-600W-P, SUN2000-1300W-P, SUN2000-1100W-P				
Standard Compliance (more available upon request)					
Safety	EN/IEC 62109-1, EN/IEC 62109-2				
Grid connection standards	G99, EN 50549, CEI 0-21, CEI 0-16, VDE-AR-N-4105, VDE-AR-N-4110, C10/11, ABNT, VFR 2019, UNE 217001, UNE 217002, RD 244, TOR D4, IEC61727, IEC62116				

*1 Inverter max input PV power is 40,000 Wp when long strings are designed and fully connected with SUN2000-450W-P power optimizers.
*2 The maximum input voltage is the upper limit of the DC voltage. Any higher input DC voltage would probably damage inverter.
*3 Any DC input voltage beyond the operating voltage range may result in inverter improper operating.
*4 SUN2000-12~20KTL-M2 raises potential between PV- and ground to above zero through integrated PID recovery function to recover module degradation from PID. Supported module types include: P-type (mono, poly)

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Annex C: PVSyst Report

PVsyst V8.0.18

PVsyst - Simulation report

Grid-Connected System

Project: My project

Variant: New simulation variant

No 3D scene defined, no shadings

System power: 24.00 kWp

Gurugodella - Sri Lanka

Author

PVsyst V8.0.18
VC0, Simulation date:
24/11/25 23:22
with V8.0.18

Project summary

Geographical Site	Situation		Project settings	
Gurugodella	Latitude	7.42 °(N)	Albedo	0.20
Sri Lanka	Longitude	79.90 °(E)		
	Altitude	15 m		
	Time zone	UTC+5.5		

Weather data
Gurugodella
Meteonorm 8.2, Sat=22% - Synthetic

System summary

Grid-Connected System — **No 3D scene defined, no shadings**

Orientation #1		Near Shadings	User's needs
Fixed plane		no Shadings	Unlimited load (grid)
Tilt/Azimuth	12 / 0 °		

System information

PV Array		Inverters	
Nb. of modules	80 units	Nb. of units	1 unit
Pnom total	24.00 kWp	Total power	20 kWac
		Pnom ratio	1.20

Results summary

Produced Energy	38257 kWh/year	Specific production	1594 kWh/kWp/year	Perf. Ratio PR	82.61 %

Table of contents

General parameters

Grid-Connected System

No 3D scene defined, no shadings

Orientation #1
Fixed plane
Tilt/Azimuth 12 / 0 °

Models used
Transposition Perez
Diffuse Perez, Meteonorm
Circumsolar separate

Horizon
Free Horizon

Near Shadings
no Shadings

User's needs
Unlimited load (grid)

PV Array Characteristics

PV module

Manufacturer	Generic
Model	TSM-DEG5-(II)-300
(Original PVsyst database)	
Unit Nom. Power	300 Wp
Number of PV modules	80 units
Nominal (STC)	24.00 kWp
Modules	4 string x 20 In series
At operating cond. (50°C)	
Pmpp	21.67 kWp
U mpp	584 V
I mpp	37 A

Inverter

Manufacturer	Generic
Model	SUN2000-20KTL-M5-400V
(Original PVsyst database)	
Unit Nom. Power	20.0 kWac
Number of inverters	2 * MPPT 50% 1 unit
Total power	20.0 kWac
Operating voltage	200-1000 V
Max. power (=>48°C)	22.0 kWac
Pnom ratio (DC:AC)	1.20
No power sharing between MPPTs	

Total PV power

Nominal (STC)	24 kWp
Total	80 modules
Module area	132 m²
Cell area	118 m²

Total inverter power

Total power	20 kWac
Number of inverters	1 unit
Pnom ratio	1.20

Array losses

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

DC wiring losses
Global array res. 264 mΩ
Loss Fraction 1.50 % at STC

Module Quality Loss
Loss Fraction -0.75 %

Module mismatch losses
Loss Fraction 2.00 % at MPP

Strings Mismatch loss
Loss Fraction 0.05 %

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	0.963	0.892	0.814	0.679	0.438	0.000

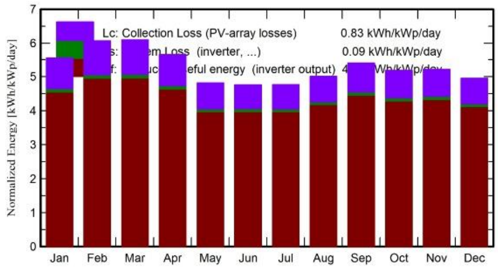
PVsyst V8.0.18
VC0, Simulation date:
24/11/25 23:22
with V8.0.18

Main results

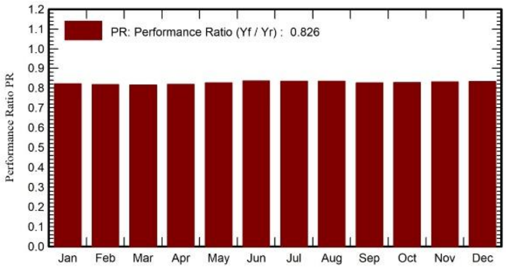
System Production

Produced Energy	38257 kWh/year	Specific production	1594 kWh/kWp/year
		Perf. Ratio PR	82.61 %

Normalized productions (per installed kWp)



Performance Ratio PR



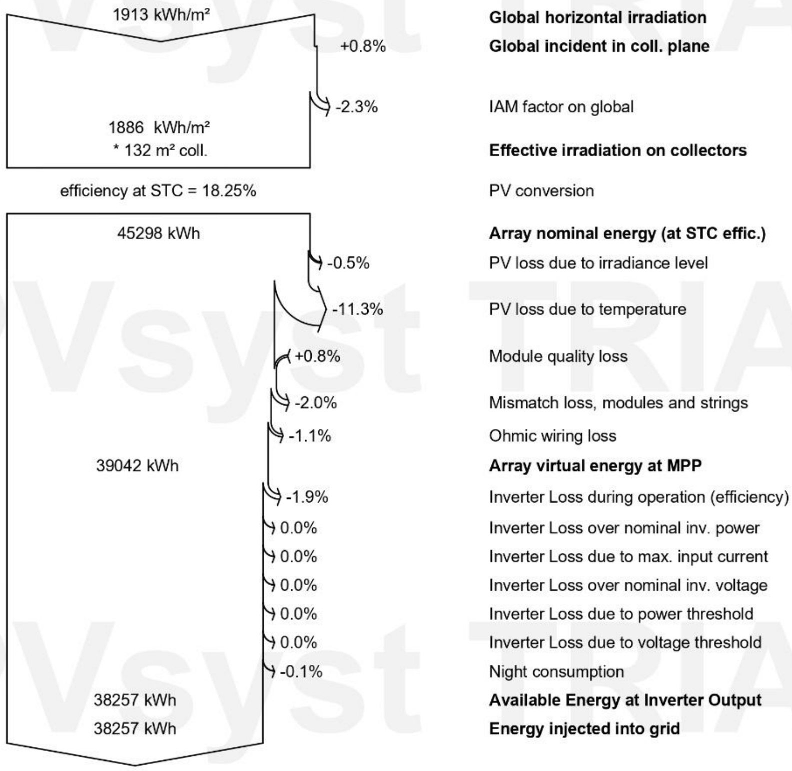
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	157.2	62.27	26.46	172.1	168.4	3461	3391	0.821
February	160.0	66.89	27.22	170.0	166.6	3401	3333	0.817
March	186.1	81.43	28.12	189.2	185.3	3776	3698	0.815
April	174.1	77.02	27.75	170.0	166.4	3411	3341	0.819
May	158.4	83.05	28.73	149.3	145.1	3020	2960	0.826
June	153.6	84.59	27.88	142.9	138.8	2923	2866	0.836
July	157.7	86.50	28.20	147.8	143.7	3020	2961	0.835
August	161.3	91.33	27.90	155.4	151.5	3172	3110	0.834
September	162.1	76.06	27.27	162.2	158.6	3281	3214	0.826
October	156.0	80.77	27.24	160.8	157.7	3260	3194	0.827
November	146.0	70.04	26.21	156.5	153.5	3187	3123	0.831
December	140.9	71.04	26.37	153.5	150.4	3129	3066	0.832
Year	1913.4	931.00	27.45	1929.6	1885.9	39042	38257	0.826

Legends

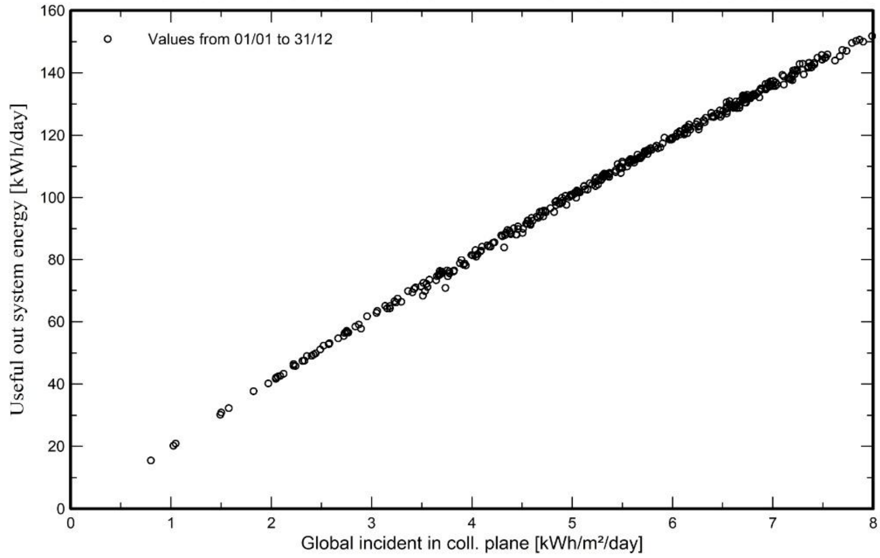
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_Grid	Energy injected into grid
T_Amb	Ambient Temperature	PR	Performance Ratio
GlobInc	Global incident in coll. plane		
GlobEff	Effective Global, corr. for IAM and shadings		

Loss diagram

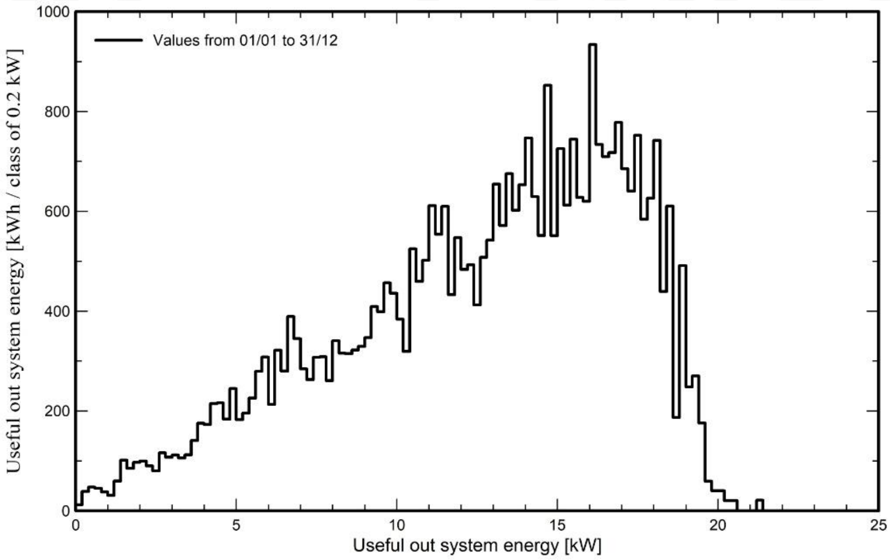


Predef. graphs

Daily Input/Output diagram



System Output Power Distribution



Single-line diagram

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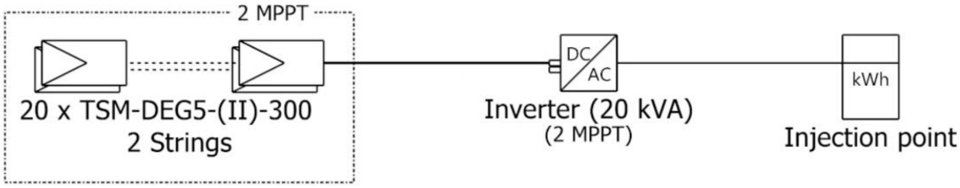

PV module	TSM-DEG5-(II)-300
Inverter	SUN2000-20KTL-M5-400V
String	20 x TSM-DEG5-(II)-300

My project	
VC0 : New simulation variant	24/11/25