

# Study the Performance of 112.5kW grid connected Solar photovoltaic power plant at Shraddha park, Raisoni Group of Institution

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**Abstract** – Thrust from government policies, regulations, and solar Technology advancements have brought rapid rise in installed capacity of off grid & grid connected solar photovoltaic (SPV) system in India. In this paper, the grid connected solar photovoltaic (SPV) power plant of Raisoni Group of Institution, Hariganga campus, Nagpur, India is presented and its performance is being noted. This power plant has a capacity of 112.5kW and has been in operation since 31<sup>st</sup> March 2016.

**Keywords:** Solar PV modules, 3 phase Inverter, Transformer, 11kv transmission line, HT panels

## I. INTRODUCTION

Raisoni Group of Institution 112.5KW Solar Plant which is mounted on the teris of GHRAET, Hariganga campus, Nagpur. The Plant is Installed on 31 March 2016 upto 80KW then further 32.5KW is successfully added in it on 11 June 2017, so the installed capacity of this plant is 112.5KW. In Hariganga campus there is one more solar plant, which is mounted on G H Raisoni Polytechnic whose installed capacity is 60KW. The combination of this two solar plant makes it as 172.5KW Capacity of solar power. The Generation of this two Solar Plant gives the supply to the total campus as possible. The remaining unused Generation gives back to Substation (Hingna Substation no.1) by 11KV transmission line.

**Location & Area:** 21.1238462° Latitude & 79.0021815° Longitude and the area is 3354 Sq-m

**Land:** G H Raisoni Academy of Engg. & Tech.

**Installed By:** Amplus Solar Power Private Limited, New Delhi

### A. Present PV Scenario in India

In terms of overall installed capacity, India comes fourth after Japan, Germany and U.S (with installed capacity of 110 MW). In the area of photovoltaic India today is the second largest manufacturer in the world of PV panels based on crystalline solar cells. Industrial production in this area has reached a level of 11MW per year which is about 10% of the world's total PV production.

A major drive has also been initiated by the government to export Indian PV products, systems, technologies, and services. Solar Photovoltaic plant and equipment has been exported to countries in the Middle East & Africa.

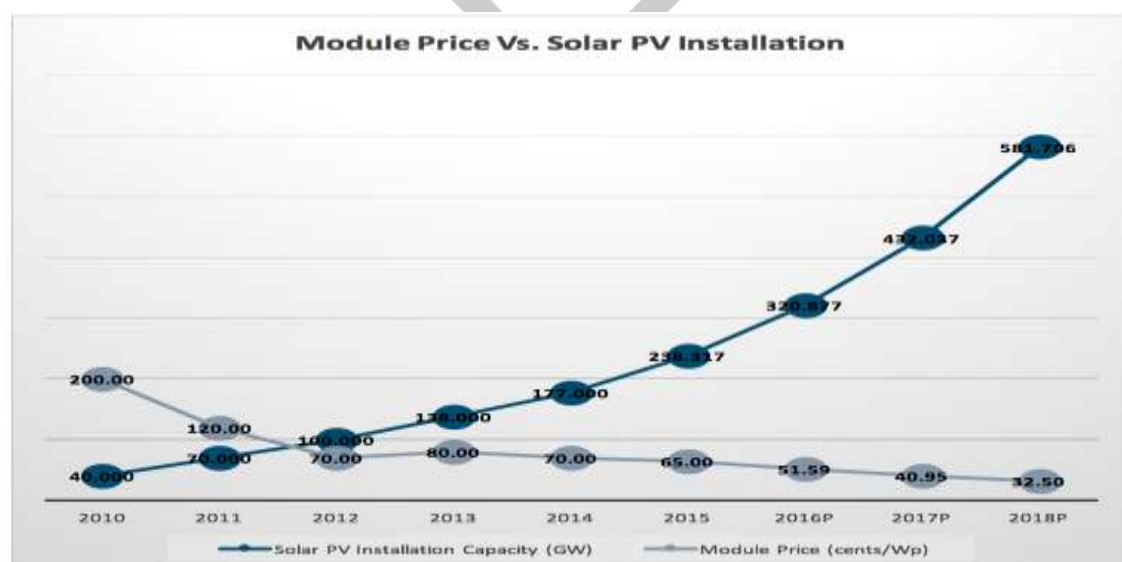


Fig. 1 Model Price vs Solar PV installation

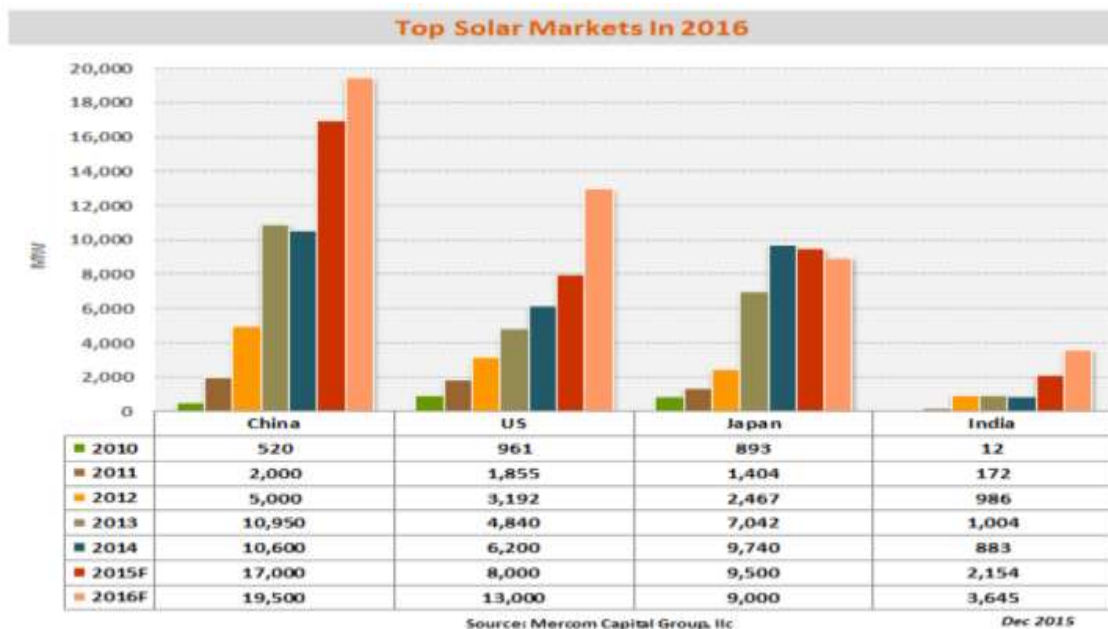


Fig. 2 Top Solar Market in 2017

## II. LITERATURE SURVEY

### [1] High-Performance Constant Power Generation in Grid-Connected PV Systems

In this paper the PV system has been proposed the maximum supply in power due to that there is a fast & smooth transition between maximum power point tracking & constant power generation. The control strategy proposed that the solar irradiance levels, high- performance & stable operation are always achieved.

Conclusion:

1. Maximum power point tracking operation is mandatory for Grid connected PV systems in order to maximum the energy yield.
2. The proposed solution can ensure a stable constant power generation operation.
3. In comparison with traditional methods, the proposed control strategy forces the PV system to operate at the left side of the maximum power point & hence it can achieve a stable operation as well as smooth transitions.

### [2] Reactive Power Capacity Enhancement of a PV-Grid System to Increase PV Penetration Level in Smart Grid Scenario

This paper provides a possible solution of reactive power support to improve the voltage profile. In this paper a novel scheme is proposed that the auxiliary circuit in conjunction with a PV grid system which increases the system reactive power compensation capacity compared to the original capacity of the main PV system.

Conclusion:

1. Distributed power generation is being contemplated for reducing the stress on the power grid.
2. Reactive power compensation without hampering power quality is a challenging task.
3. The demonstrated proposed scheme method of enhancing the reactive power capacity of the inverter based distributed generation system.

### [3] Stability of Photovoltaic and Wind Turbine Grid-Connected Inverters for a Large Set of Grid Impedance Values

This paper proposed the analysis of stability problems of grid connected inverters used in distributed generation. The measurement is vast which is made on a single phase system & on a three phase system used as scale prototype for photovoltaic & wind turbines which validates the analysis.

Conclusion:

1. Wind turbine three phase systems & photovoltaic is a single phase system can be connected at different grid conditions.
2. The conclusion shows that as the grid condition is different then the designing can be compromised.
3. The system can become unstable due to the reduced bandwidth or the change in the resonance frequency.

### [4] System Stability Impact of Large-Scale and Distributed Solar Photovoltaic Generation: The Case of Ontario, Canada

This paper presents a comparative investigation of solar photovoltaic effect on system stability at different penetrating levels. There is a relevant dynamics models. Based on that the impact is examined through Eigen values, voltage stability & transient stability analysis.

Conclusion:

1. In this paper, the impact of solar photovoltaic generator penetration level on the stability on power system was assessed.
2. The dynamic behaviour of the system containing SPVG installations was examined for different penetration levels by means of small signal stability, voltage stability & time domain contingency analysis.

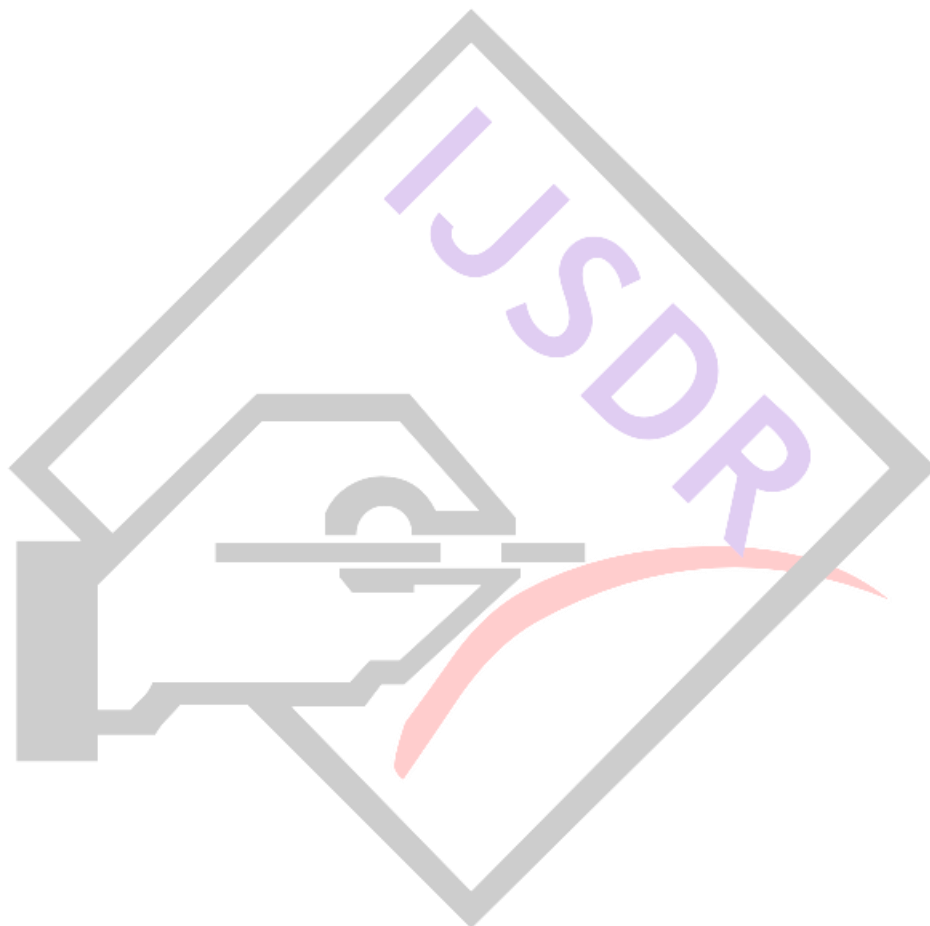
3.Voltage stability & transient stability demonstrated that the dynamic SPVG can considerably improves system stability.

**[5]New Control of PV Solar Farm as STATCOM (PV-STATCOM) for Increasing Grid Power Transmission Limits During Night and Day**

In this paper a novel concept of utilizing a photovoltaic solar farm inverter as STATCOM which is calling as PV-STATCOM for improving stable power transfer limits of the interconnected transmission system. The total inverter rating of PV solar farm which remains in sleep during night time, and it is utilised with voltage & damping control to enhance stable power transmission.

**Conclusion:**

1. Solar farms are idle during nights.
- 2.The PV solar system is a new control as a STATCOM calling as PV-STATCOM.
- 3.The power transfer can be increased more than day time even when the solar distributed generator is generating a high amount of real power.



### III. LANT LAYOUT

#### PLANT LAYOUT

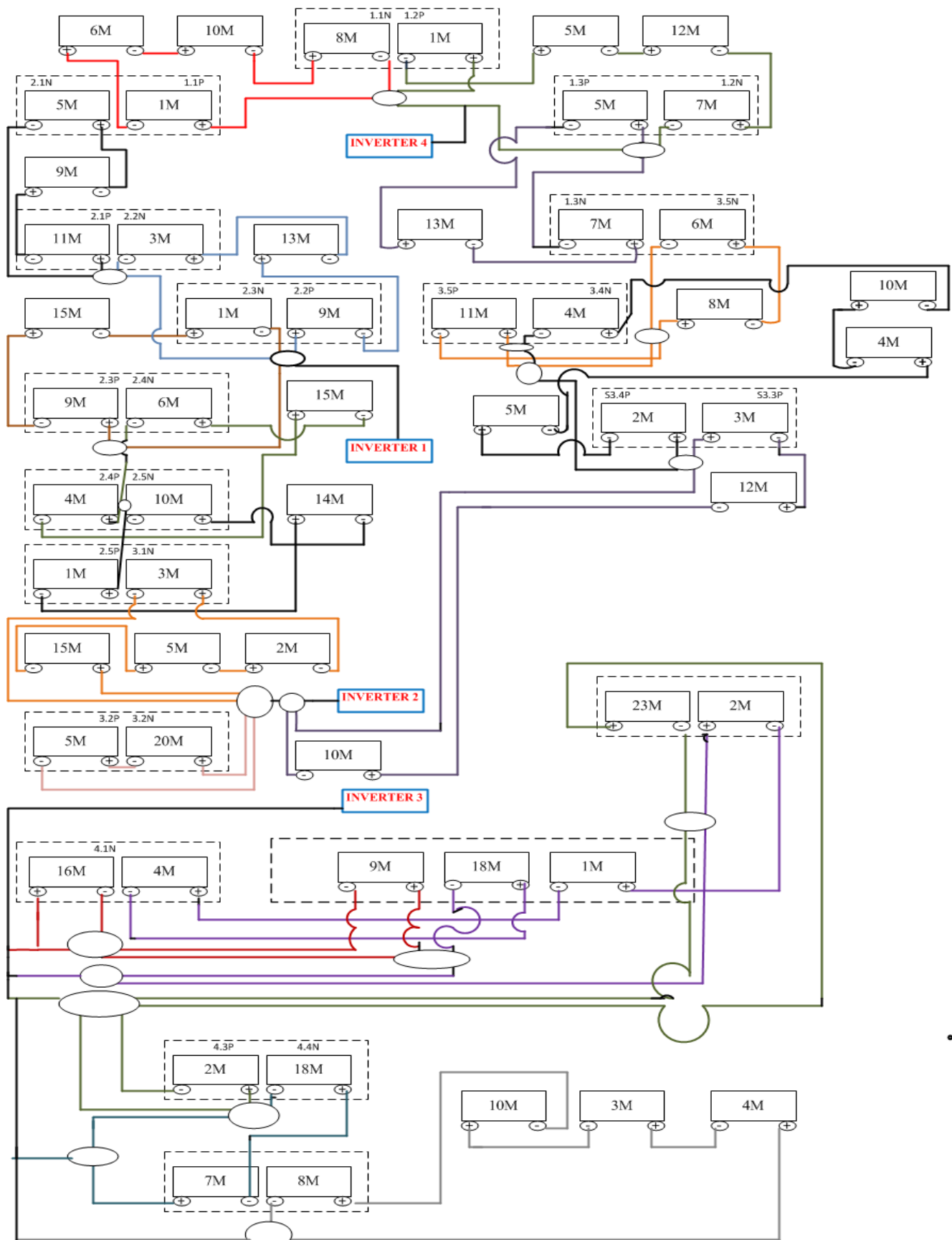


Fig. 3 Plant Layout

#### IV. SYSTEM DIAGRAM

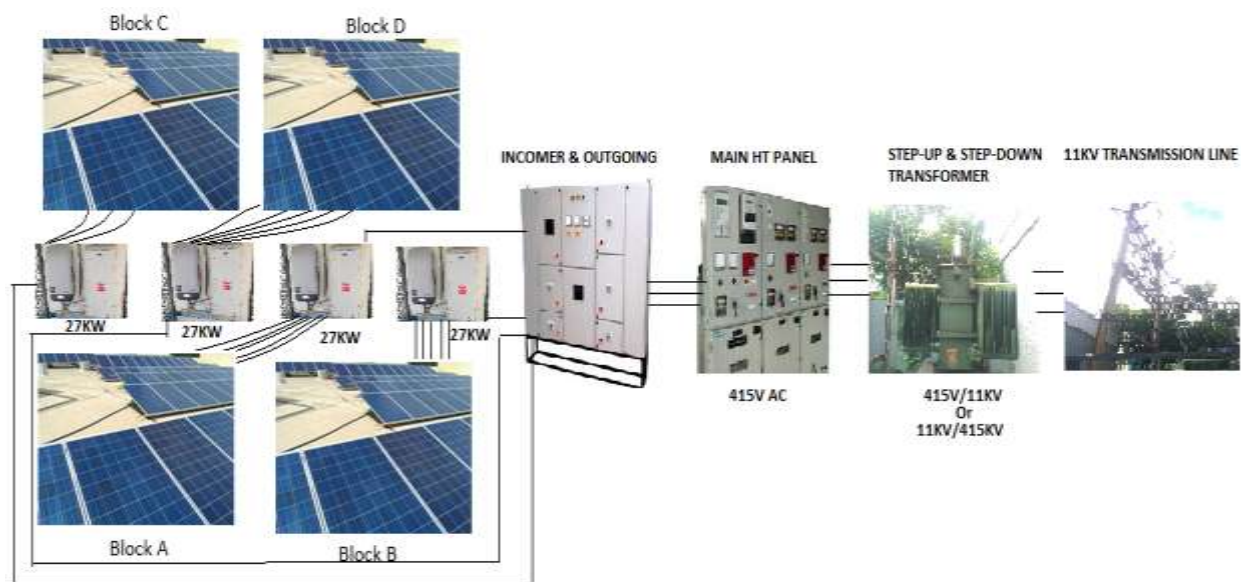


Fig. 4 System Block Diagram

##### A. Details Specification With Ratings

###### [a] Solar Photovoltaic Module:

Company: Vikramsolar

Rated Peak Power (0~+4.99wp)(Pmpp): 250W

Open Circuit Voltage (Voc): 37.45V

Short Circuit Current (Isc): 8.70A

Rated Voltage (Vmpp): 30.58V

Rated Current (Impp): 8.18A

Fill Factor (FF): 76.77%

Efficiency (%): 15.53%

Fire Ratings (Type): Class C

Noct: 45 Degree Celcius

Maximum System Operating Voltage: 1000V (IEC)

Dimension: 1639x982x36mm

Power Specification Is Measured At Standard Test Condition. Insolation: 1000W/M2

AM : 1.5

Cell Temperature: 25 Degree Celcius

Field Wiring: Use Only UI Recognized Matching Connector With 12 Awg Min. Copper Wire. Installation Rated For 90 Degree Celcius Min. Insulation Manual For Bypass Diode Replacement. Use 15a Maximum Series Fuse.

###### [b] Pyranometer:

Company: Kipp & Zomen

Classification Iso 9060 Second Class Pyranometer Cmp 3

Serial No. 175082

Sensitivity: 14.29 Micro V/W/M2

Calibration Date: 13 March 2017

Made At Delftech Park 36, 2628xh Delft, NL

### [c] Three Phase Inverter:

Company: Fronius Eco

The Three-Phase Fronius Eco In Power Categories 25.0 And 27.0 Kw Perfectly Meets All The Requirements Of Large-Scale Installations. Thanks To Its Light Weight And Snapinverter Mounting System, This Transformerless Device Can Be Installed Quickly And Easily Either Indoors Or Outdoors. This Inverter Series Sets New Standards With Its Ip 66 Protection Class. In Addition, Its Integrated All-Pole String Fuse Holders And Optional Dc Fuse Mean That String Collection Boxes Are No Longer Required.

Technical Data:

Input Data:

Number Of MPP Trackers: 1

Max. Input Current : 47.7 A

Max. Short Circuit Current, Module Array: 71.6 A

Dc Input Voltage Range : 580 - 1000 V

Feed-In Start Voltage : 650 V

Nominal Input Voltage: 580 V

MPP Voltage Range: 580 - 850 V

Usable MPP Voltage Range: 580 - 850 V

Number Of DC Connections: 6

Max. PV Generator Output: 37.8 KW peak

Output Data:

AC Nominal Output: 27.0 KW

Max. Output Power : 27.0 KVA

AC Output Current: 40.9 / 39.1 A

Grid Connection: 3~ NPE 400/230, 3~ NPE 380/220 V

Ac Voltage Range: 150 - 275 V

Frequency: 50 / 60 Hz

Frequency Range: 45 - 65 Hz

Total Harmonic Distortion: < 2 %

Power Factor: 0 - 1 Ind./Cap.

General Data:

Height: 725 mm

Width: 510 mm

Depth: 225 mm

Weight: 35.7 Kg

Degree Of Protection: IP 66

Protection Class: 1

Overvoltage Category (Dc / Ac): 2 / 3

Night-Time Consumption: < 1 W

Inverter Design: Transformerless

Cooling: Regulated Air Cooling

Installation: Indoors And Outdoors

Ambient Temperature Range: -25°C - +60°C

Permitted Humidity: 0 - 100 %

Max. Altitude: 2 m

DC Connection Technology: 6x DC+ And 6x DC- Screw Terminals 2.5 - 16 mm<sup>2</sup>

AC Connection Technology: 5-Pin AC Screw Terminals 2.5 - 16 mm<sup>2</sup>

Certificates And Compliance With Standards: Öve / Önorm E 8001-4-712, Din V Vde 0126-1-1/A1, Vde Ar N 4105, Iec 62109-1/-2, Iec 62116, Iec 61727, As 3100, As 4777-2, As 4777-3, Cer 06-190, G59/3, Une 206007-1, Si 4777, Cei 0-16, Cei 0-21.

Efficiency:

Max. Efficiency (Pv - Grid): 98.3 %

European Efficiency (Heu): 98.0 %

MPP Adaptation Efficiency: > 99.9 %

Protection Devices:

DC Insulation Measurement: Yes

Overload Behavior: Operating Point Shift, Power Limitation

DC Disconnect: Yes

Integrated String Fuse Holder: Yes

Reverse Polarity Protection: Yes

Interfaces:

Wlan / Ethernet Lan: Fronius Solar.Web, Modbus TCP Sunspec, Fronius Solar Api (Json)

6 Inputs And 4 Digital Inputs/Outputs: Interface to Ripple Control Receiver

USB (Type A Socket): Data Logging, Inverter Update Via USB Flash Drive

2x Rs422 (Rj45 Socket): Fronius Solar Net

Signalling Output: Energy Management (Floating Relay Output)

Datalogger And Web Server: Integrated

External Input: S0 Meter Connection / Evaluation of Overvoltage Protection

Rs485: Modbus Rtu Sunspec or Meter Connection

## V. TECHNOLOGY

**Snapinverter Technology:** The Snapinverter Generation of inverters features a simple, standardised mounting system, making installation and maintenance easier than ever. a special feature in the design of the device is that the connection area is separate from the power stage set compartment, with both being installed separately. the remarkably light connection area and all its cabling is fitted to the wall first, followed by the power stage set. the innovative hinged system makes installation and servicing extremely user-friendly. the inverter is simply placed in the wall bracket and then secured. this means that it is not necessary to remove the entire inverter for servicing, just the power stage set. all the cabling remains in place.

**Integrated Data Communication:** We are the first inverter manufacturer to offer a data communication package with fully integrated datalogging, wlan, ethernet, energy management, web server and a range of interfaces. the inverter is connected to the internet by network cable or wlan - without additional cabling - and grants you the perfect overview of how the pv system is operating. connection to third-party components is provided by means of interfaces such as modbus tcp sunspec, modbus rtu sunspec or fronius solar api (json). the open interfaces can also be operated in parallel to the fronius solar.web

**Smart Grid Ready:** Fronius inverters are ready for the smart grid of tomorrow. the inverters are optimally equipped to meet the technical requirements of grids in the future. a series of smart functions, known as advanced grid features, are built into the devices. they include a number of control functions for optimum feed-in of reactive power and effective power. these functions

are designed to enable stable grid operation even when the pv system density is very high and to prevent unwanted interruptions to feed-in and associated yield losses if grid parameters exceed the thresholds. Fronius inverters therefore help to guarantee the yield of a pv system. Furthermore, where feed-in limits are imposed, Fronius inverters can provide dynamic feed-in control with self-consumption taken into account. Just connect the meter and set the feed-in limit.

**Dynamic Peak Manager:** The dynamic peak manager is a new mpp tracking algorithm that dynamically adapts its behaviour when searching for the optimal operating point. Its special feature is that the dynamic peak manager automatically checks the entire characteristic curve on a regular basis and finds the global maximum power point (gmpp), even in partial shade.

**Zero Feed-In:** Today, an increasing number of grid operators in various countries are stipulating a pv power feed-in limit as a precondition before a system is connected to the grid. With dynamic power reduction, Fronius is offering a solution for optimum feed-in management. The inverter supplies the household consumers with energy first and then reduces the system output to the maximum energy feed-in permitted by the grid operator. With Fronius inverters, zero feed-in is also a possibility thanks to this function, meaning that no pv power is fed into the grid. The relevant requirements of the grid operator can be fulfilled by simply enabling a setting on the inverter's web interface.

## VI. DESIGNING

3-ph Inverter: 4 nos

Modules: 450 nos

Strings: 18 nos

25 Module: 1 String

3-ph Inverter 1no. or 2no. or 3no.: 5 Strings

3-ph Inverter 4nos.: 3 Strings

Installed capacity:  $450 \times 250W = 112.5KW$

## VII. OPERATION & WORKING

In Raison Group of Institution (RGI) at Hariganga campus, Nagpur there are the installation of two solar plants [1] GHRAET whose installed capacity is 112.5KW & [2] GHRPN whose installed capacity is 60KW and they provide the supply to RGI at Hariganga campus and try to fulfill the requirement of supply but unfortunately solar plant haven't capable to supply the required amount of power. So in addition MSCB fulfill their required need of power through 11KV transmission line from Hingna substation no.1. The rate of amount of solar power used by RGI at Hariganga campus whose charges is paid to Amplus solar company, Delhi.

## VIII. COSTING

1 Watt = 53 Rs.

1 Module =  $250W = 250 \times 53 = 13,250/-$

450 Module =  $450 \times 13,250 = 59,62,500/-$

1 Three phase Inverter = 3,81,650/-

4 Three phase inverter = 15,26,600/-

Total = 74,89,100/-

## IX. SOLAR DAILY GENERATION READING

| Instt Name | SHRADHA PARK |      | Solar New |      |
|------------|--------------|------|-----------|------|
| Date       | Reading      | Unit | Reading   | Unit |
| 11-Apr-16  | 90372        | 391  | 458       | 379  |
| 12-Apr-16  | 90763        | 381  | 837       | 394  |
| 13-Apr-16  | 91144        | 0    | 1231      | 0    |
| 14-Apr-16  | 91144        | 0    | 1231      | 0    |
| 15-Apr-16  | 91144        | 1242 | 1231      | 1203 |
| 16-Apr-16  | 92386        | 0    | 2434      | 0    |
| 17-Apr-16  | 92386        | 790  | 2434      | 766  |
| 18-Apr-16  | 93176        | 0    | 3200      | 0    |
| 19-Apr-16  | 93176        | 663  | 3200      | 649  |
| 20-Apr-16  | 93839        | 316  | 3849      | 403  |
| 21-Apr-16  | 94155        | 384  | 4252      | 399  |
| 22-Apr-16  | 94539        | 411  | 4651      | 388  |
| 23-Apr-16  | 94950        | 0    | 5039      | 0    |
| 24-Apr-16  | 94950        | 863  | 5039      | 773  |
| 25-Apr-16  | 95813        | 423  | 5812      | 472  |
| 26-Apr-16  | 96236        | 372  | 6284      | 402  |
| 27-Apr-16  | 96608        | 351  | 6686      | 360  |
| 28-Apr-16  | 96959        | 318  | 7046      | 299  |
| 29-Apr-16  | 97277        | 341  | 7345      | 356  |
| 30-Apr-16  | 97618        | 0    | 7701      | 0    |
| 01-May-16  | 97618        | 399  | 7701      | 502  |
| 02-May-16  | 98017        | 284  | 8203      | 288  |
| 03-May-16  | 98301        | 386  | 8491      | 374  |
| 04-May-16  | 98687        | 330  | 8865      | 316  |
| 05-May-16  | 99017        | 424  | 9181      | 345  |
| 06-May-16  | 99441        | 405  | 9526      | 364  |
| 07-May-16  | 99846        | 0    | 9890      | 0    |
| 08-May-16  | 99846        | 0    | 9890      | 0    |
| 09-May-16  | 99846        | 1075 | 9890      | 623  |
| 10-May-16  | 100921       | 373  | 10513     | 330  |
| 11-May-16  | 101294       | 317  | 10843     | 254  |
| 12-May-16  | 101611       | 354  | 11097     | 347  |
| 13-May-16  | 101965       | 349  | 11444     | 398  |
| 14-May-16  | 102314       | 0    | 11842     | 0    |
| 15-May-16  | 102314       | 728  | 11842     | 686  |
| 16-May-16  | 103042       | 418  | 12528     | 286  |
| 17-May-16  | 103460       | 380  | 12814     | 311  |
| 18-May-16  | 103840       | 368  | 13125     | 291  |
| 19-May-16  | 104208       | 288  | 13416     | 224  |
| 20-May-16  | 104496       | 0    | 13640     | 0    |
| 21-May-16  | 104496       | 0    | 13640     | 0    |
| 22-May-16  | 104496       | 1151 | 13640     | 292  |
| 23-May-16  | 105647       | 397  | 13932     | 328  |
| 24-May-16  | 106044       | 467  | 14260     | 289  |
| 25-May-16  | 106511       | 302  | 14549     | 398  |

## X. CONCLUSION

Thus it is conclude that the performance of Solar photovoltaic power plant is good & the Efficiency is also maintaining good because of daily washing of solar modules and futher due to weekly maintenance of solar module and by checking the inverter performance its power factor is also better nearly 0.97PF.

## XI. FUTURE SCOPE

- [1] The Efficiency of Solar PV cell is low in order to increase the efficiency certain techniques may be employed like MPPT. In future lots of works will be done on efficiency of Solar PV cell.
- [2] Change the Solar panel with new technology Solar panel for increasing the Solar module efficiency.
- [2] To increase the plant efficiency, Micro-Inverter technology will be adopted for preventing plant breakdown, Overload also to preventing the damage of Solar Module.
- [3] Dual axis technique will be adopt for getting maximum time irradiation from sun.
- [4] For voltage stability we will also use such devices like STATCOM, which is very much effective and compensate the voltage.

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