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Grid Connected Solar Roof Top System for 3-Phase Domestic Load

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Abstract- The amount of fossil fuel or conventional sources of energy have forced us to think about utilization of solar energy and solar energy is going to be a best suitable option which can play a major role to meet energy demand in India. It emerges as a huge source of renewable energy both nationally and globally. The large magnitude of solar energy available makes it a highly appealing source of electricity. The amount of solar energy is several times larger than the total world energy consumption. In recent years, particularly with the adoption of the National action plan on climate change, the Jawaharlal Nehru National Solar Mission, and solar policies by several states, India has taken several steps towards increasing the share of renewable in its energy requirement by promoting the solar roof-top schemes. In this paper the residential building having load demand of 7 kW and actual installation of 2 kW solar roof-top systems is discussed.

Keywords: Renewable energy, solar rooftop system, Energy demand, solar policies, National solar mission

1. Introduction

India's solar market, especially solar photovoltaic, has seen significant growth after the launch of the Jawaharlal Nehru National Solar Mission in 2010, with an installed capacity of over 3 GW in just four years. The Government of India is determined towards achieving 100 GW of grid interactive solar power capacity by 2020, of which 40 GW would be deployed through decentralized and rooftop-scale solar projects.

Rooftop solar PV would play a prominent role in meeting energy demands across segments. It has already achieved grid parity for commercial and industrial consumers, and fast becoming attractive for residential consumers as well. As a result, multiple state governments have taken necessary steps to kick-start implementation of rooftop solar PV projects.

There are basically two solar PV systems: stand-alone and grid-connected. Stand-alone solar PV systems work with batteries. In this paper, the grid connected actual solar roof top system of one residential building is studied. It feed solar energy directly into the building loads without battery storage. Surplus energy, if any, is exported to the grid and shortfall, if any, is imported from the grid.

Circuit diagram of 2 KW solar roof top System:

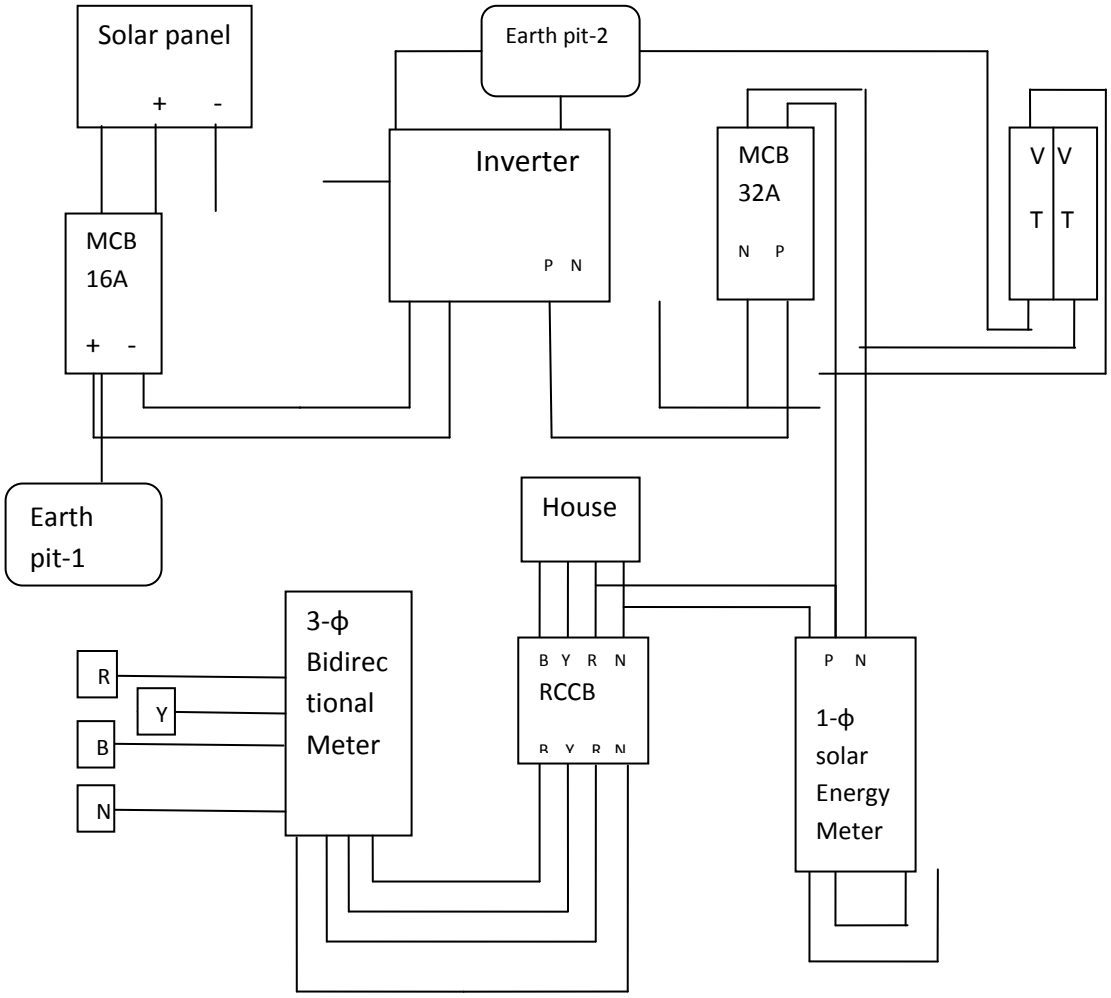

Fig.1 circuit diagram of grid connected solar roof-top system

II. Circuit description

In this paper, grid connected actual model of 2 kW solar roof-top system of one residential building is examined. As shown in fig 1, the load of the house is fed through 3-ϕ supply from the grid. AC 3-ϕ, 4 wire Static watt-hour meter with bidirectional features is connected in the circuit to measure the kwh imported from the grid and kwh exported to the grid. AC 1-ϕ, 2 wire Static watt-hour meter is also connected towards solar side to measure the kwh generated by the solar PV system.

Two separate earthing is provided for Solar panels and Inverter. Protective means are also put on solar side and grid side respectively. The ratings and specifications of each measure components are written herewith. As this is a grid connected solar power system, the kwh generated by the solar roof-top is fed into the grid and to the house. The shortfall of power required by the house is supplied by the grid and excess power from the solar system is fed to the grid. The usage of kwh can be known from the reading of 3-ϕ bidirectional meter and 1-ϕ solar energy meter. This solar PV system does not work in the absence of power from the grid.

III. Technical specification of components used in solar PV system:

1. Solar Panel

Pmpp	: 260 Wp
Voltage at Max Power (V_{max})	: 31.0V
Current at Max Power (I_{max})	: 8.40A
By pass Diode Rating	: 15A
System voltage	: 1000 V_{DC}
Application Class	: A

2. Grid-tied Solar Inverter

Make	: Shenzhen INVT Electric
D.C input	
V_{max} Pv	: 450 V
MPPT voltage Range	: 100V-410V
Max.current	:12A
A.C Output	
Max.Continuous Current	: 9A
Continuous Power	: 2KW
Nominal Voltage	: 230V
Frequency	: 50/60 HZ
Power factor Range (Full load)	: >0.99
Temp.	: -25°C to +60°C

3. Valve Trab For Phase

Type	: VAL-MS
Make	: PHOENIX
Type	: 320/40 ST GY
U_c	: 335V AC
U_p	: 1.5 KV
I_n	: 20KA
I_{max}	: 40KA

Valve Trab for Earthing

Type	: F-MS
Make	: PHOENIX
Type	: 320/40 ST GY
U_c	: 335V AC

U_p : 1.5 KV

I_n : 20KA

4. **AC 3-ϕ, 4 wire Static watt-hour Meter (Bidirectional Energy Meter)**
   Type: PPEM 26, CLASS 1, 10-60A
   3x240V, 50Hz, Optical Port
   KWH, KVArh, KVAh
   1600 imp/KVArh
   1600 imp/KWH
5. **AC 1-ϕ, 2 wire Static watt-hour Meter (Solar Energy Meter)**
   Type: SPEM 01, CLASS 1, 5-30A
   240V, 50Hz, Optical Port
   6400 imp/KWH
6. **MCB DC Side**
   16A, Double Pole
7. **MCB AC Side**
   32A, Double Pole
8. **Earth Pit 1 for Inverter**
9. **Earth Pit 2 for Solar panels**

IV.Analysis Part:

The load demand of most of the house is 4-6 KW and the KW of solar roof- top should be 40-50% of total load demand. The calculations of solar roof top can be done as follows.

(A) Calculation of Solar PV modules:

Number of solar panels = 08
Power of each solar panel = 260 W
Total power of Solar PV system = 260 x 8
= 2080 W
≈ 2 Kw

(B) Cost Involved in the project:

Subsidy offered by the Central Government @ 30 % up to 10 Kw
Subsidy offered by the State Government is

(I) 10000/- for 1Kw
(II) 20000/- for 2 Kw and above

Table-1 statement of cost involved in solar roof-top

A	Basic Cost of Solar PV plant	1,38,000/-
B	Subsidy Central Government @30%	41,400/-
C	Subsidy State Government (Lump sum)	20,000/-
D	Solar PV Plant cost D = (A-(B+C))	76,600/-
E	Connectivity charges for 1-ϕ solar Energy meter	1500/-
F	Effective cost of solar roof top Project F=(D+E)	78,100/-

V. Results and Discussion

Table- 2 summary of kwh recorded in bidirectional meter

Sr. No.	Month of Billing	kwh Import	kwh Export	kwh Credited/ Used	Amount To be paid (Rs).
1	February-March	345	628	283 credited	-911/-
2	April-May	1129	516	613 used	4180/-

1. In the month of Feb/March as shown in tablet-2, the kwh consumed by the consumer is directly deducted from the kwh exported. In this case as kwh exported is more than the kwh imported, the consumer need not to pay anything and at the same time the difference of 283 kwh is credited in consumer's account at the rate of Rs.3.22 per kwh, so Rs.911 is credited in consumer's account for next billing cycle.
2. In the month of April/May as shown in tablet-2, the consumption of the consumer is increased, so the kwh exported is less than the kwh imported. here the difference of 613 kwh is charged at the rate of Rs.6.82 per kwh.
3. The major benefit of solar roof top is that the exported kwh is directly deducted from the consumed kwh which may cost at the rate of Rs.6 to 7 per kwh. e.g. if solar roof-top is not installed the electricity charges for the month of April/May would be approximately Rs.7702/- at the rate of Rs.6.82 per kwh.

Conclusion and future scope:

The actual model of 2 kw grid connected solar roof top system of one residential building is examined here and concluded that the 2 kw grid connected solar roof top system for the domestic load can be installed as mentioned and which generate 4-5 kwh per kw per day. The record of generation as well as utilization of electrical energy is observed in different energy meters. The pay-back period of this system is around 3 years. This type of system can be installed in 1-ϕ residential load, domestic load and agriculture load.

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