

ANNUAL REPORT (2021)
ON
PERFORMANCE OF 100kWp ROOF TOP SOLAR POWER PLANT AT
MITS GWALIOR

Submitted To



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(the report has been prepared with support from Shree Prafull Dubey the electrical maintains section of MITS workshop)

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MITS Case Study

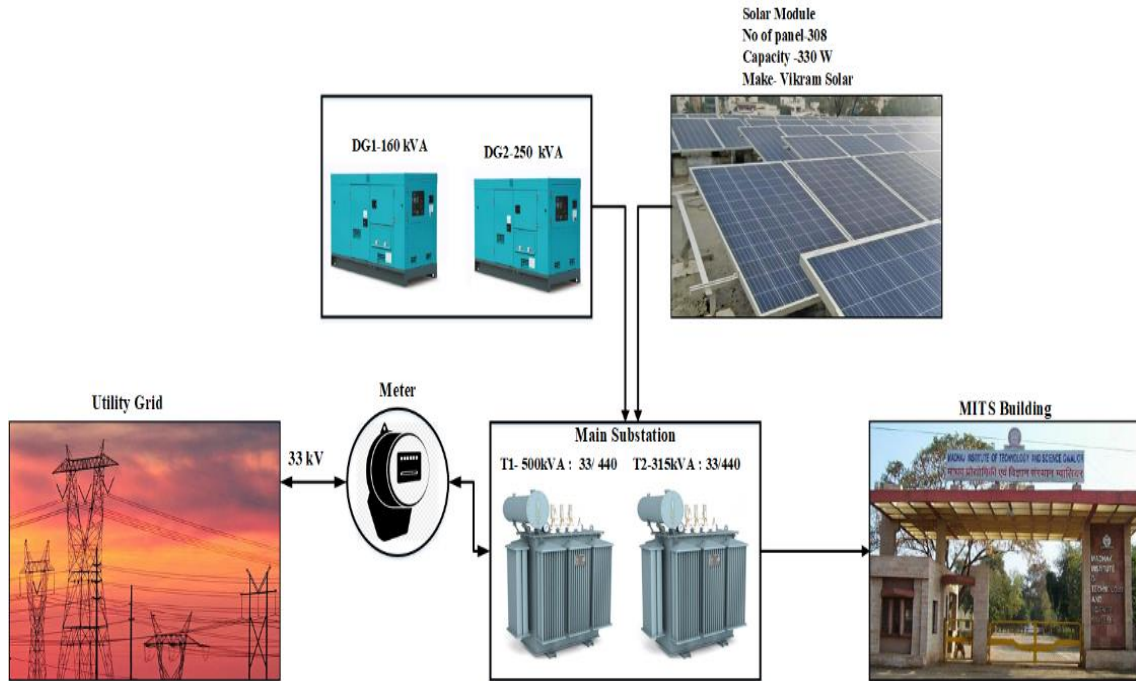


Fig. 1 Schematic diagram of hybrid system

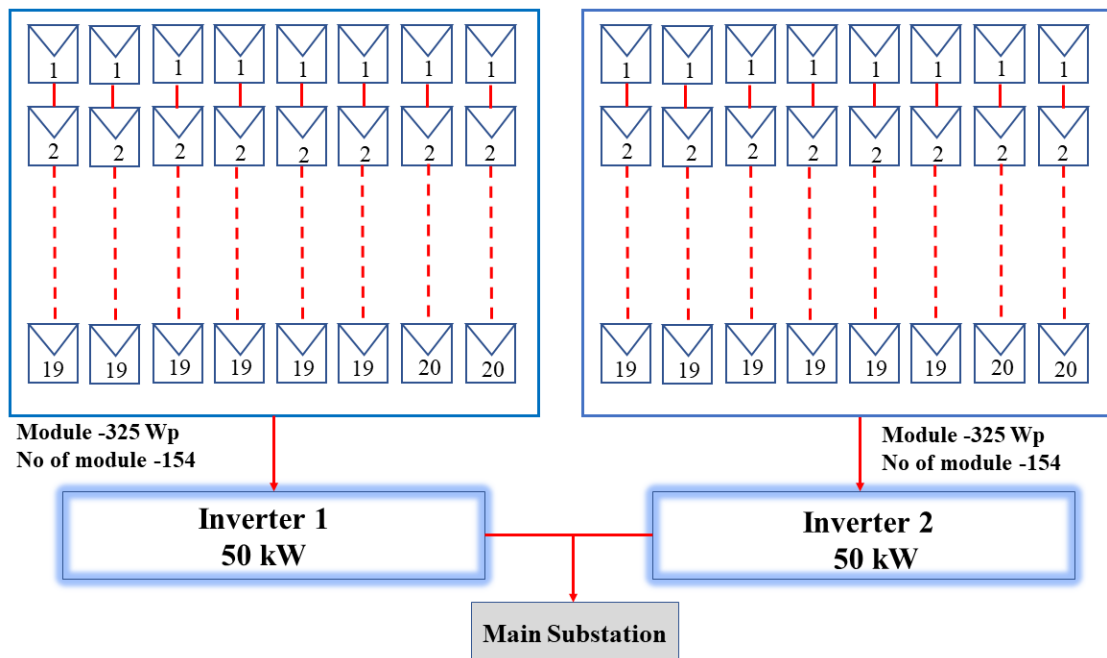


Fig.2 Schematic diagram of 100kWp rooftop solar power plant at MITS, Gwalior

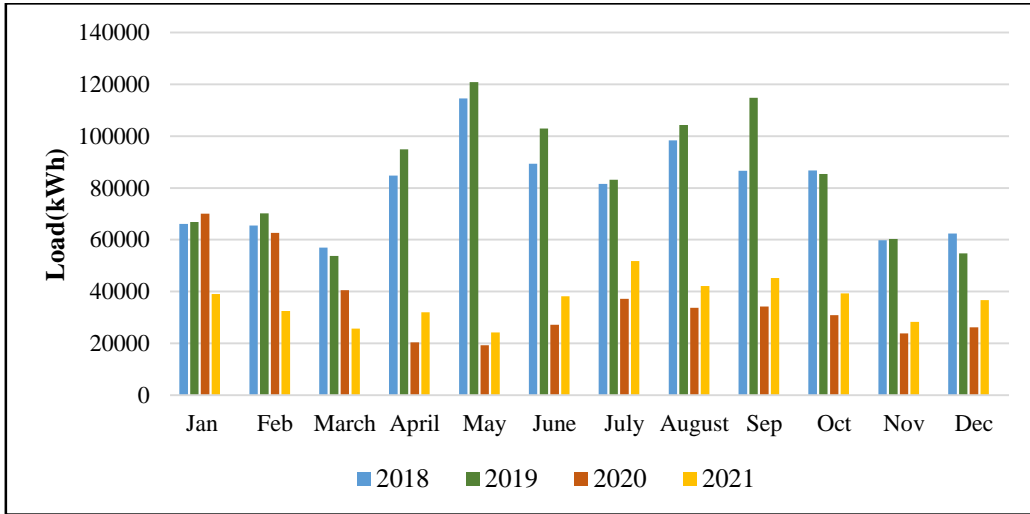


Fig.3 Comparison of monthly load demand from 2018-2021#

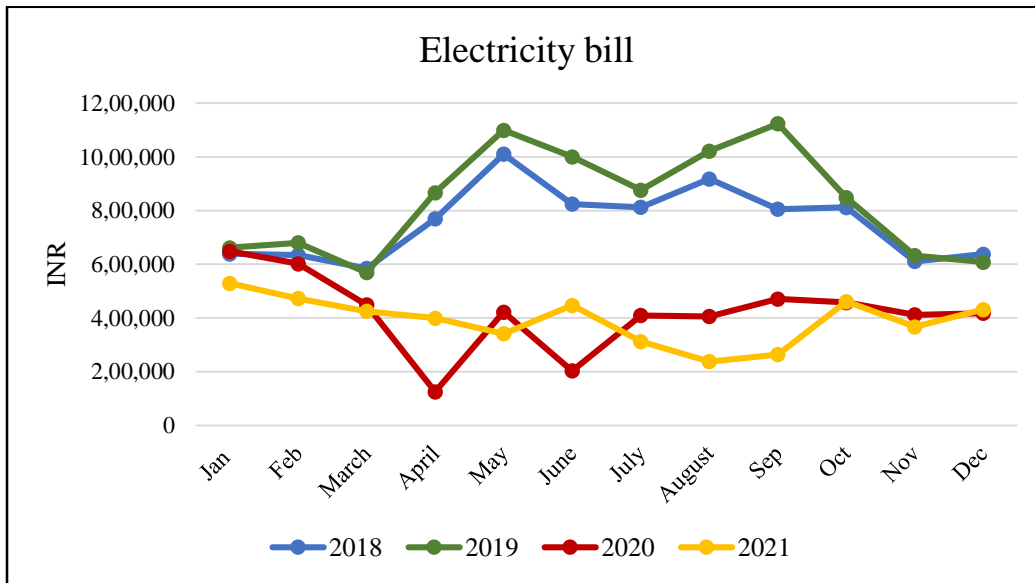


Fig.4 Comparison of electricity bill from 2018-2021#

Note:

From April 2020 to December 2021 the load and electricity bill is lesser due to the COVID effect. Offline classes resumed since March 2020.

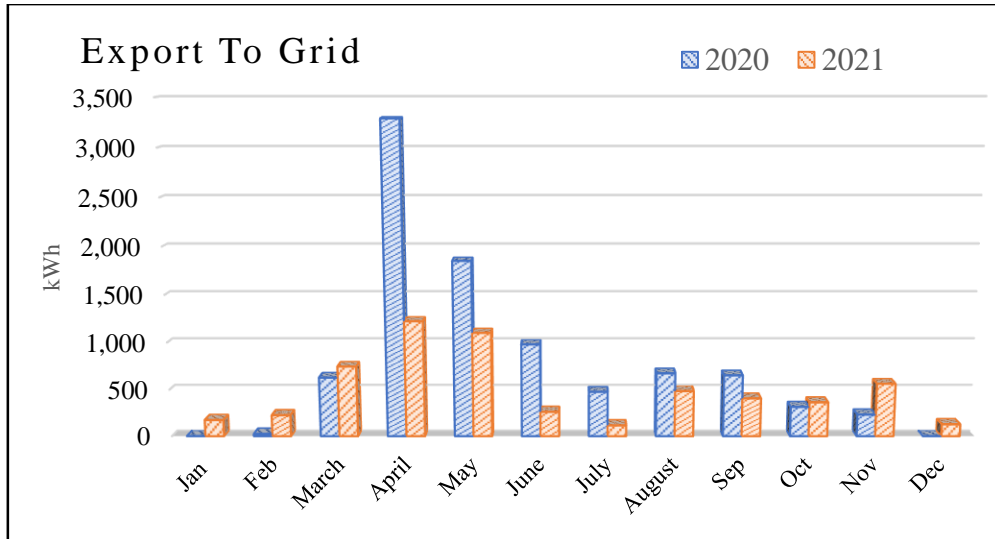


Fig.5 Comparison of monthly data export of solar units to the grid[@]

Note[@]: In April and May 2020 and 2022 the export to grid was highest due to campus being almost closed due to the first and second waves of COVID respectively.

Table 1 Solar energy generation in 2021^{\$}

Months	Solar units' generation(kWh)	Average daily units(kWh)
JAN-2021	8947.5	288.629
FEB-2021	11,552.7	412.596
MARCH-2021	12,946.8	417.639
APRIL-2021	13,890.6	463.02
MAY-2021	13,174.8	424.994
JUNE-2021	12,939	431.3
JULY-2021	10,844	349.806
AUG-2021	11005.2	355.006
SEPT-2021	9519.00	317.3
OCT-2021	14931.00	481.645
NOV-2021	7680.60	256.02
DEC-2021	6925.80	223.413

Note^{\$}: Highest number of units were generated in the month of October, followed by April and May.

Table 2 Solar power consumed / exported to grid

Year	Total generation (kWh)	Consumed(kWh)	Exported to grid (kWh)
2020	131601	122063	9538
2021	134357	128563	5794

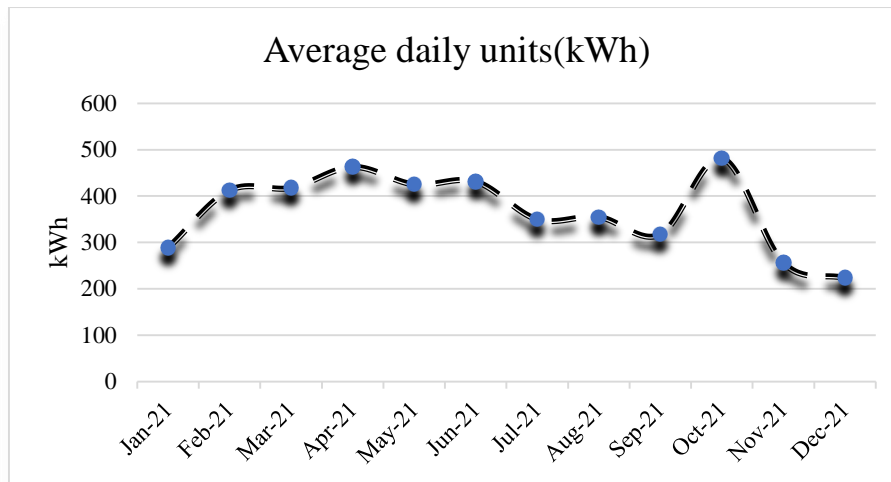


Fig.6 Average daily generation by solar plant

Table 3 Cost saving due to solar plant (January-December 2020)

Month	Units consumed(kWh)	Solar units generated (kWh)	Grid (kWh)	Bill Paid for Solar Power (Rs.)	Bill Paid to MPSEB(Rs.)	Total Expenditure (Rs.)	Amount saved (Rs.)
Jan-20	70,094	6,182.95	63,911	14,529.93	6,05,707.15	6,48,792.00	43,084.85
Feb-20	62,688	11,263.84	51,424	26,470.02	5,20,141.96	6,02,308.00	82,166.04
March-20	40,548	12,470.68	28,077	29,306.10	3,40,122.03	4,49,015.00	1,08,892.97
Apr-20	20,380	12,068.40	8,312	28,360.74	79,477.08	1,25,354.00	45,876.92
May-20	19,278	12,470.68	6,807	29,306.10	1,78,386.41	4,22,236.00	2,43,849.59
June-20	27,236	12,068.40	15,168	28,360.74	1,41,662.71	2,03,469.00	61,806.29
July-20	37,130	12,470.68	24,659	29,306.10	3,01,051.80	4,09,272.00	1,08,220.20
Aug-20	33,742	12,470.68	21,271	29,306.10	2,85,200.08	4,06,085.00	1,20,884.92
Sept-20	34,218	12,313.50	21,905	28,936.73	3,30,342.64	4,71,006.00	1,40,663.36
Oct-20	30,832	9,380.40	21,452	22,043.94	3,36,095.36	4,51,496.00	1,15,400.64
Nov-20	24,046	6,768.60	17,277	15,906.21	3,11,522.52	4,06,961.00	95,438.48
Dec-20	21,889	8,507.64	13,381	19,992.95	1,23,375.25	2,48,948.02	1,25,572.76

Table 4 Cost saving due to solar plant (January-December 2021)

Month	Units consumed (kWh)	Solar units generated (kWh)	Grid import (kWh)	Bill Paid to Solar (Rs.)	Bill Paid to MPSEB(Rs.)	Total Expenditure (Rs.)	Amount saved (Rs.)
Jan-2021	39,024	8,947.50	30,077	21,026.62	5,08,153.38	5,29,180	1,00,304.80
Feb-2021	32,484	11,552.70	20,931	27,148.85	4,45,632.16	4,72,781	1,40,992.30
March-2021	25,688	12,946.80	12,741	30,425.00	3,94,813.00	4,25,238	1,83,895.80
April-2021	31,944	13,890.60	18,053	32,643.00	3,66,652.00	3,99,295	1,40,987.30
May-2021	24,174	13,174.80	10,999	30,961.00	3,10,673.00	3,41,634	1,55,229.10
June-2021	38,158	12,939.00	25,219	30,407.00	4,16,687.00	4,47,094	1,21,198.20
July-2021	51,760	10,844.00	40,916	25,484.00	2,86,657.00	3,12,141	39,911.23
Aug-2021	42,102	11,005.20	31,097	25,862.00	2,12,098.00	2,37,960	36,339.26
Sept-2021	45,258	9,519.00	35,739	22,370.00	2,41,671.00	2,64,041	33,165.07
Oct-2021	39,244	14,931.00	24,313	35,087.85	4,26,107.15	4,61,195	140,381.10
Nov-2021	28,328	7,680.60	20,647	18,049.41	3,48,920.59	3,66,970	81,447.55
Dec-2021	36,710	6,925.80	29,784	16,275.63	4,15,399.37	4,31,675	65,165.25

Table 5. Cost saving due to solar rooftop plant (Year 2020 & 2021)

Year	Total units consumed (kWh)	Solar units generated (kWh)	Total bill Paid to Solar (Rs.)	Total Expenditure (Rs.)	Saving in Electricity bill (Rs)	% Saving
2020	4,22,081	1,31,601	3,01,825.66	48,44,942.02	12,91,857.01	26.66%
2021	4,34,874	1,34,357	3,15,740.36	46,89,204.00	12,39,016.96	26.42%

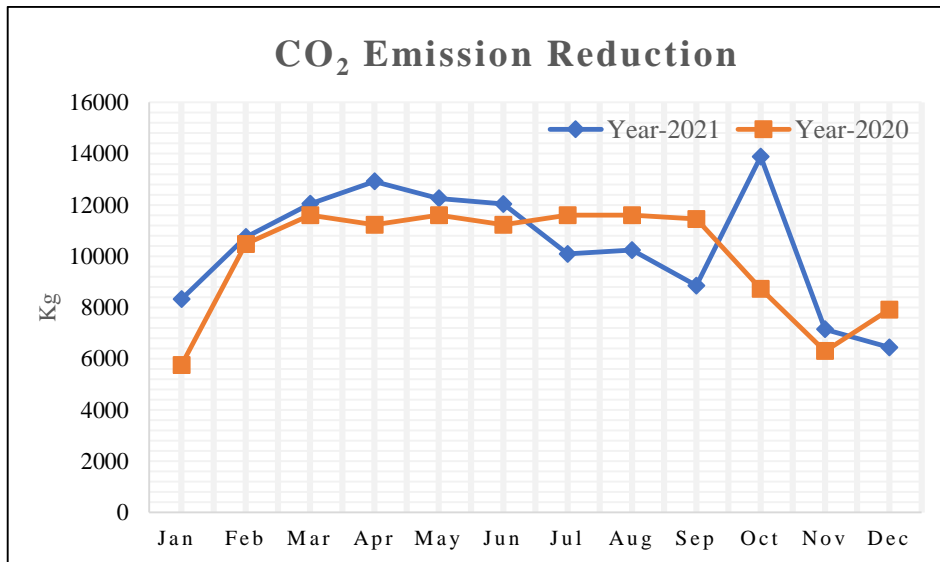


Fig.7 Monthly CO₂ emission reduction comparison in 2020 and 2021

Table 6 CO₂ emission reduction comparison in 2020 and 2021

Years	CO ₂ emission reduction
2020	1,19,445.90 kg
2021	1,24,952.01 kg

Table 7. Power factor management in 2018

Month/Year	POWER FACTOR	INCENTIVE (Rs.)	PENALTY (Rs.)
Jan-2018	0.9602	9110.00	00
Feb-2018	0.9635	9017.00	00
MARCH-2018	0.9592	3923.19	00
APRIL-2018	0.9705	17544.25	00
MAY-2018	0.9682	15761.40	00
JUNE-2018	0.9607	12271.40	00
JULY-2018	0.9581	5459.16	00
AUG-2018	0.9590	6751.18	00
SEPT-2018	0.9586	5988.02	00
OCT-2018	0.9628	12294.34	00
NOV-2018	0.9400	00.00	00
DEC-2018	0.9515	4418.00	00

Table 8. Power factor management in 2019

Month/Year	POWER FACTOR	INCENTIVE	PENALTY
Jan-2019	0.9578	4721.00	00
Feb-2019	0.9630	9919.76	00
MARCH-2019	0.9563	3798.08	00
APRIL-2019	0.9668	13430.00	00
MAY-2019	0.9635	16687.23	00
JUNE-2019	0.9552	6661.23	00
JULY-2019	0.9538	5405.07	00
AUG-2019	0.9630	10861.56	00
SEPT-2019	0.9704	24790.21	00
OCT-2019	0.9727	19502.42	00
NOV-2019	0.9743	13623.36	00
DEC-2019	0.9648	8329.81	00

Table 9. Power factor management in 2020*

Month/Year	POWER FACTOR	INCENTIVE	PENALTY
Jan-2020	0.9774	15140.30	00
Feb-2020	0.9667	9023.62	00
MARCH-2020	0.9251	00	00
APRIL-2020	0.8730	00	3686.31
MAY-2020	0.8545	00	6264.65
JUNE-2020	0.8900	00	1887.81
JULY-2020	0.9275	00	00
AUG-2020	0.9207	00	00
SEPT-2020	0.9386	00	00
OCT-2020	0.8874	00	2200.35
NOV-2020	0.8567	00	6867.96
DEC-2020	0.9158	00	00

Table 7. Power factor management in 2021*

Month/Year	POWER FACTOR	INCENTIVE	PENALTY
Jan-2021	0.9500	00	00
Feb-2021	0.9100	00	00
MARCH-2021	0.8600	00	7572.82
APRIL-2021	0.8700	00	6957.40
MAY-2021	0.8400	00	12285.23
JUNE-2021	0.8900	00	2770.27
JULY-2021	0.9200	00	00
AUG-2021	0.9200	00	00
SEPT-2021	0.9275	00	00
OCT-2021	0.9116	00	00
NOV-2021	0.8844	00	4067.90
DEC-2021	0.9416	00	00

Note*: If the power factor becomes less than 0.9 penalty is imposed, when greater than 0.95, incentive is given by the utility. During COVID periods, the load was very less as compared to the total transformer capacity, hence the power factor has been low, leading to penalty.

Conclusions

The institute has a 100kWp rooftop solar power plant, with net metering, functional since November 2019.

- ✓ This plant generates about 1.35 Lac units per year
- ✓ Export to the grid is about 6000-7000 units per year
- ✓ The present total annual demand is about 4.35 Lac units, however pre-Covid load was about 10.5 Lac units.
- ✓ Thus, about 30 % of the demand in MITS is met by the solar plant, presently and if pre-Covid scenario is assumed then about 12.5% demand will be met by the solar plant
- ✓ There is a saving of about 12-12.5 Lac rupees annually, i.e. about 26%, under pre-Covid scenario the saving will be about 10.5%.
- ✓ Generation of about 1.20 Lac kilograms of CO₂ emission is prevented by this green initiative.
- ✓ A fully grown tree can roughly absorb around 20 kilograms of carbon dioxide (CO₂) per year, which is equivalent to having 6000 fully grown trees.
- ✓ The addition of 300kWp plant will be a big step in environmental preservation.
- ✓ It is expected that the enhanced solar capacity will result in reducing about 4.8 Lac kilograms of CO₂ from the global atmosphere.

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Appendix

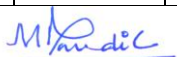
Table A1: Data used for preparing this report

Solar price per unit	Average price per unit (Grid) [#]	CO ₂ emission rate	
2.35 Rs.		0.93 kg/kWh	

Actual unit rate taken from the electricity bill

Table A2: Data of MITS energy system

Contract Demand	Rating of Transformer-I	Rating of Transformer-II	Rating of DG-I	Rating of DG-II	Rating of Inverter-I	Rating of Inverter-II	Solar Panels
350kVA	500kVA, 33kV/440V	315kVA, 33/440	160kVA	250kVA	50kW	50kW	325Wp


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