

**ANNUAL REPORT (2022)**  
**ON**  
**PERFORMANCE OF 100kW<sub>p</sub> ROOF TOP SOLAR POWER PLANT AT**  
**MITS GWALIOR**

Submitted To



**Dr. R.K. Pandit**

Director

Madhav Institute of Technology and Science, Gwalior (M.P.)

By

**POONAM SINGH**

**Research Assistant**

(Enrolment No. 0901EE18PD14)

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

*Under the Supervision of*

**Dr. Manjaree Pandit**

**(Supervisor)**

Professor

Electrical Engineering Department

MITS, Gwalior (M.P.)

## MITS Case Study

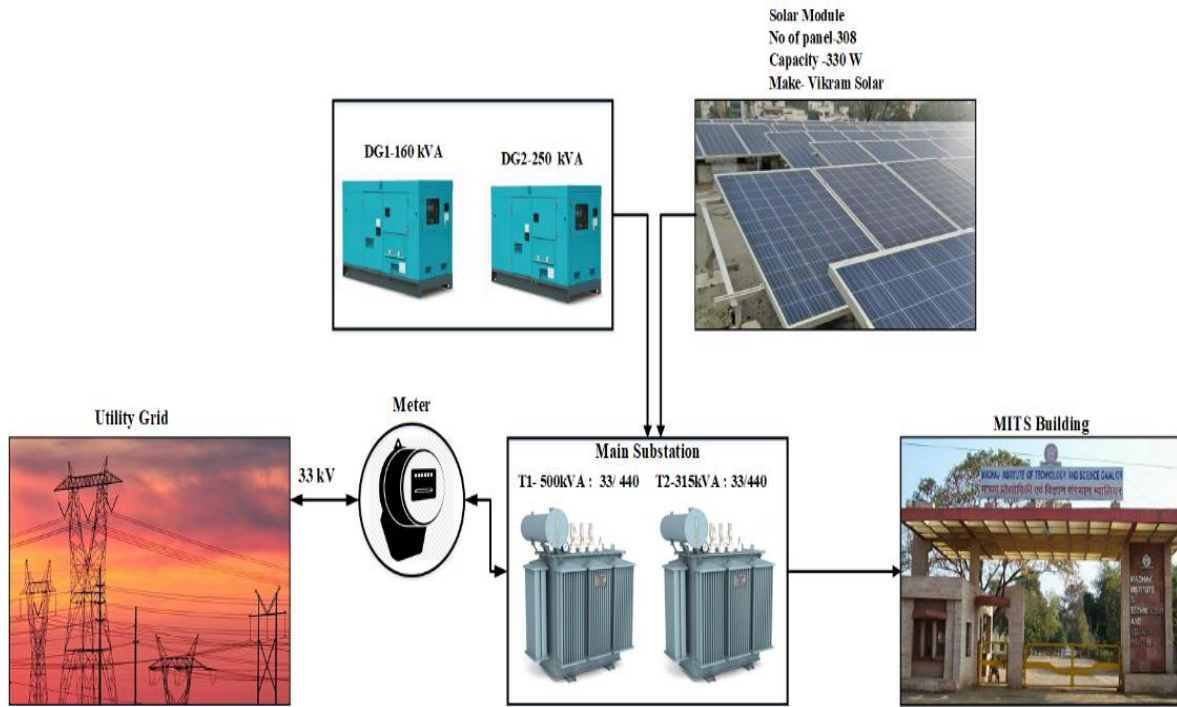


Fig. 1 Schematic diagram of hybrid system

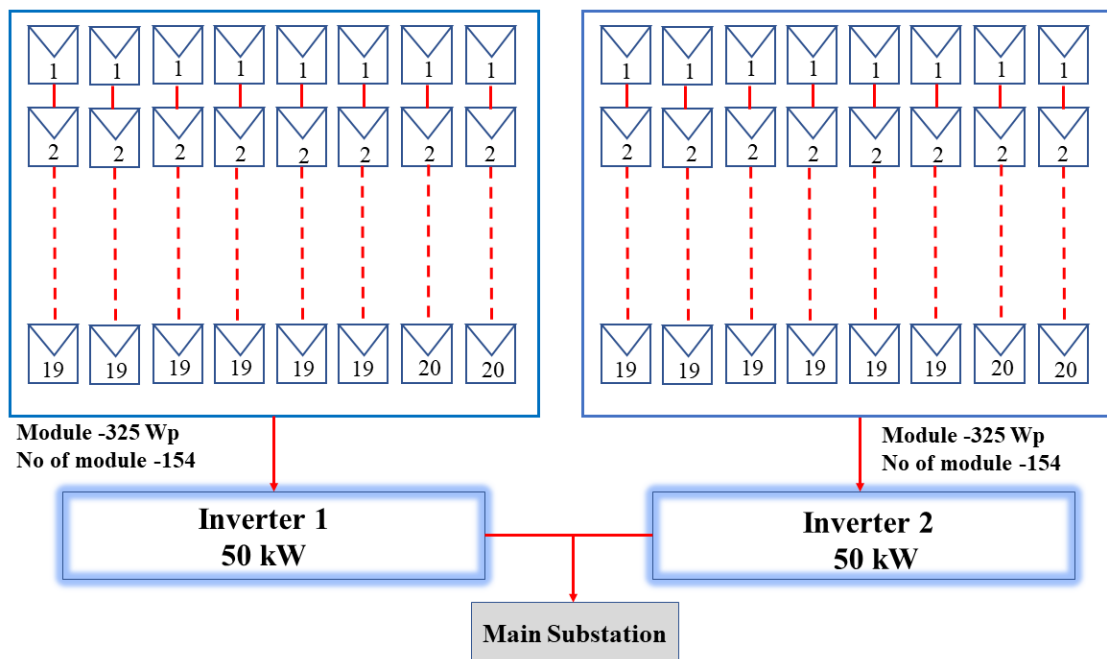


Fig.2 Schematic diagram of 100kWp rooftop solar power plant at MITS, Gwalior

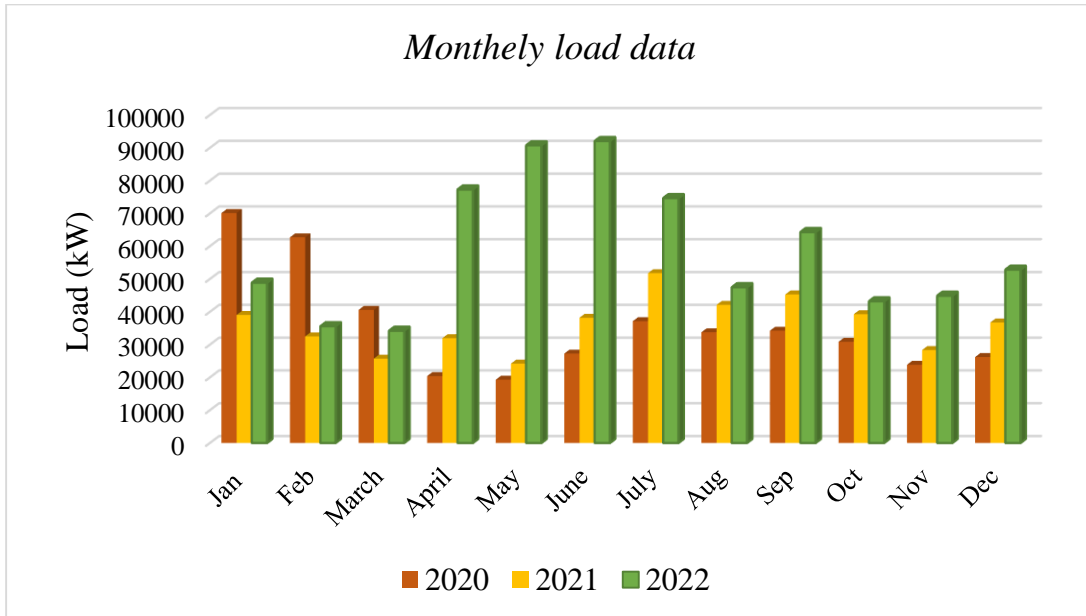


Fig.3 Comparison of monthly load demand from 2020-2022#

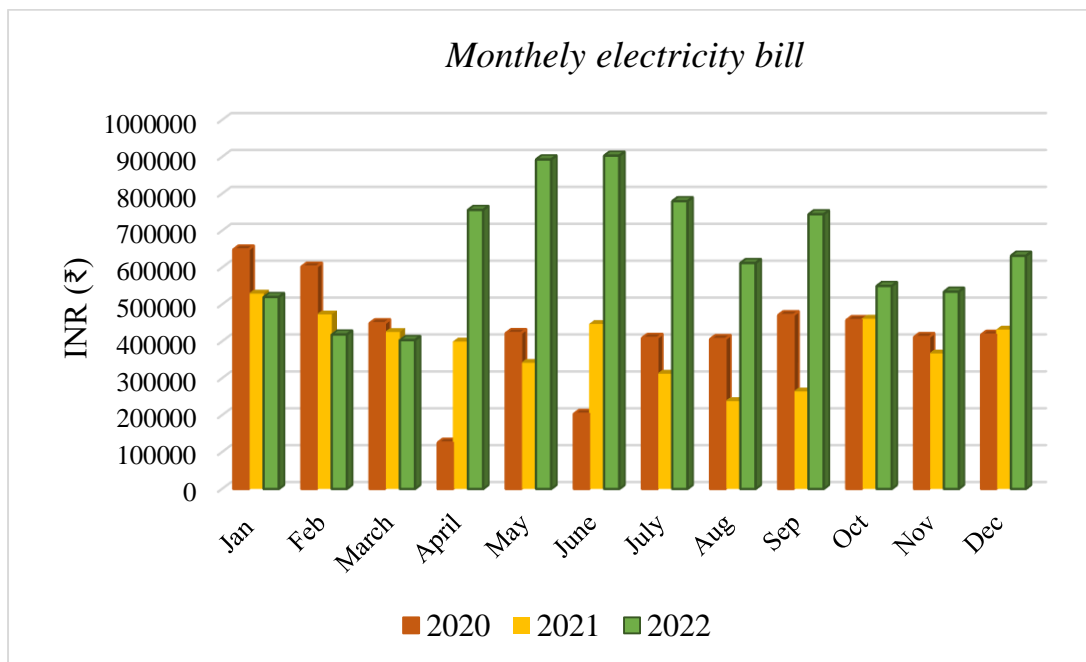


Fig.4 Comparison of electricity bill from 2020-2022#

Note:

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

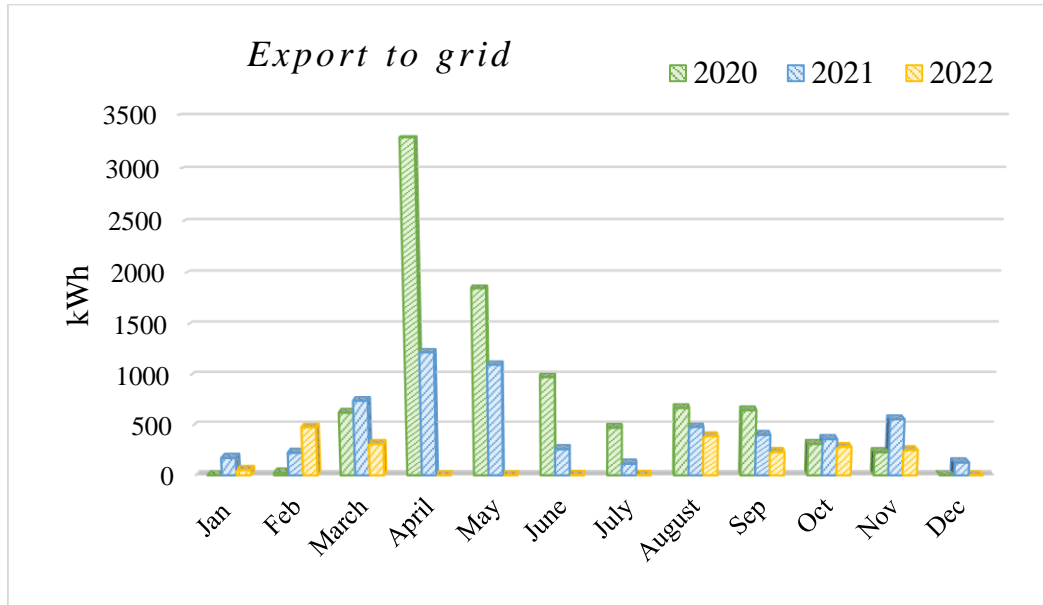


Fig.5 Comparison of monthly data export of solar units to the grid<sup>@</sup>

**Note<sup>@</sup>:** In April and May 2020 and 2021 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 2022<sup>s</sup>

Months	Solar units' generation(kWh)	Average daily units(kWh)
Jan	6,963.90	224.64194
Feb	11,448.00	408.85714
March	10,205.70	329.21613
April	11,180.40	372.68
May	12,224.40	394.33548
June	12,671.40	422.38
July	11827.50	381.53226
August	12151.20	391.97419
Sep	9766.50	325.55
Oct	9,699.90	312.9
Nov	9,544.50	318.15
Dec	6,826.80	220.21935

**Note<sup>s</sup>:** Highest number of units were generated in the month of June, followed by May and August.

Table 2 Solar power consumed / exported to grid

Year	Total generation (kWh)	Consumed(kWh)	Exported to grid (kWh)
2020	131601.00	122063.00	9538
2021	134357.00	128563.00	5794
2022	124510.20	122496.20	2014

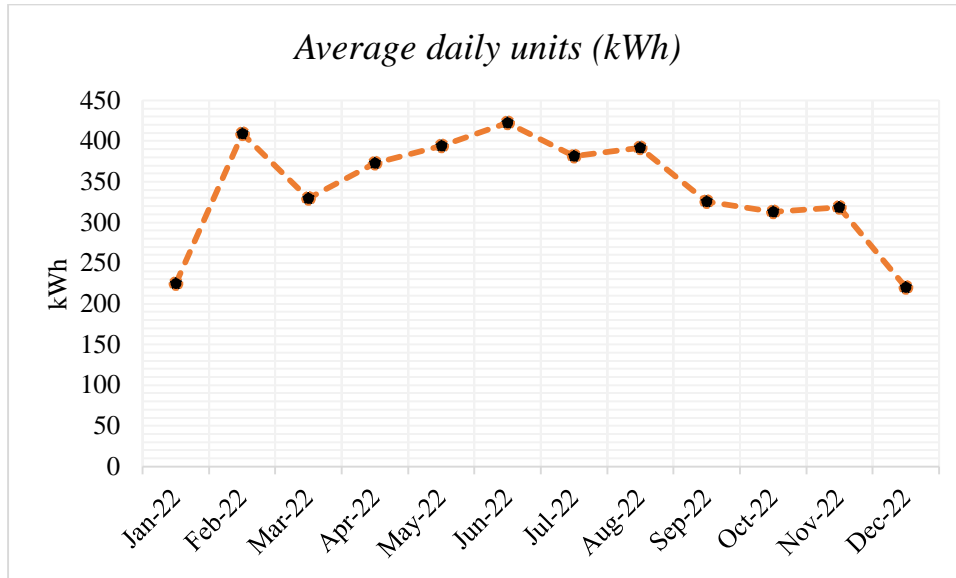


Fig.6 Average daily generation by solar plant

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 4 Cost saving due to solar plant (January-December 2022)

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-22	55,783.90	6,963.90	48,872.00	16,365.00	5,20,150.00	57,752.54	55,783.90
Feb-22	46,558.00	11,448.00	35,592.00	26,903.00	4,18,603.00	1,07,738.69	46,558.00
Mar-22	44,109.70	10,205.70	34,218.00	23,983.00	4,03,471.00	96,354.37	44,109.70
Apr-22	88,462.40	11,180.40	77,282.00	26,274.00	7,56,126.00	83,114.88	88,462.40
May-22	1,02,962.40	12,224.40	90,738.00	28,727.00	8,93,004.00	91,580.24	1,02,962.40
Jun-22	1,04,727.40	12,671.40	92,058.00	29,778.00	9,03,178.00	94,540.69	1,04,727.40
Jul-22	86,481.50	11,827.50	74,656.00	27,795.00	7,79,758.00	95,739.45	86,481.50
Aug-22	59,234.20	12,151.20	47,475.00	28,555.00	6,12,301.00	1,28,163.10	59,234.20
Sep-22	73,832.50	9,766.50	64,300.00	22,951.00	7,44,326.00	90,104.36	73,832.50
Oct-22	52,605.90	9,699.90	43,190.00	22,795.00	5,50,035.00	1,00,735.55	52,605.90
Nov-22	54,180.50	9,544.50	44,888.00	22,430.00	5,34,517.00	91,223.93	54,180.50
Dec-22	59,666.80	6,826.80	52,840.00	16,043.00	6,31,956.00	65,604.18	59,666.80

Table 5. Cost saving due to solar rooftop plant (Year 2020-2022)

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	4,22,081.00	1,31,601.00	3,01,825.66	48,44,942.02	12,91,857.01	26.66%
2021	4,34,874.00	1,34,357.00	3,15,740.36	46,89,204.00	12,39,016.96	26.42%
2022	8,28,605.20	1,24,510.20	2,92,599.00	77,47,425.00	11,02,651.98	14.23%

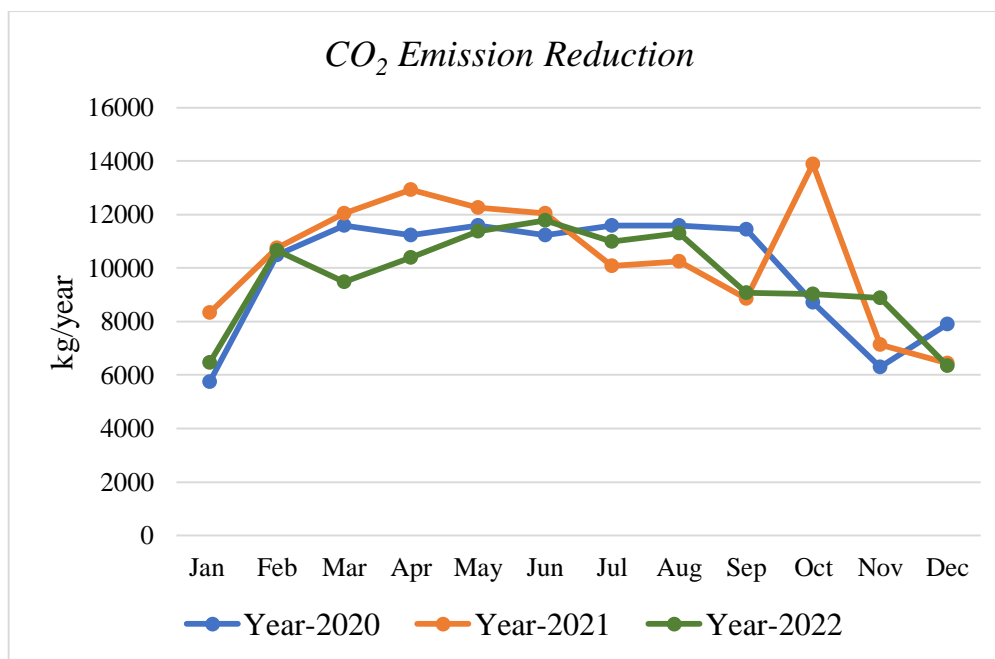


Fig.7 Monthly CO<sub>2</sub> emission reduction comparison in 2020 to 2022

Table 6 CO<sub>2</sub> emission reduction comparison in 2020 and 2021

Years	CO <sub>2</sub> emission reduction (kg/year)
2020	1,19,445.90
2021	1,24,952.01
2022	1,15,794.49

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	<b>0.8730</b>	00	3686.31
MAY-2020	<b>0.8545</b>	00	6264.65
JUNE-2020	<b>0.8900</b>	00	1887.81
JULY-2020	0.9275	00	00
AUG-2020	0.9207	00	00
SEPT-2020	0.9386	00	00
OCT-2020	<b>0.8874</b>	00	2200.35
NOV-2020	<b>0.8567</b>	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	<b>0.8600</b>	00	7572.82
APRIL-2021	<b>0.8700</b>	00	6957.40
MAY-2021	<b>0.8400</b>	00	12285.23
JUNE-2021	<b>0.8900</b>	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.

Table 8. Power factor management in 2022

Month/Year	POWER FACTOR	INCENTIVE	PENALTY
Jan-2022	0.9717	10,732.29	----
Feb-2022	0.9788	7,816.00	----
MARCH-2022	0.9866	12,523.79	-----
APRIL-2022	0.9912	39,908.18	-----
MAY-2022	0.9957	47,256.35	-----
JUNE-2022	0.9896	33,604.62	-----
JULY-2022	0.9924	39,089.88	-----
AUG-2022	0.9845	17,755.65	-----
SEPT-2022	0.9885	24,048.20	-----
OCT-2022	0.9766	9,821.41	-----
NOV-2022	0.9881	16,917.04	-----
DEC-2022	0.99	20,026.36	-----

## Conclusions

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

- ✓ This plant generates average about 1.30 Lac units per year
- ✓ Present status export to grid is around 2014 units per year but during COVID was exported to grid around 6000-7000 units per year
- ✓ Current total annual demand is around 8.28 lakh units but during COVID was around 4.35 lakh units as students are not in campus
- ✓ Thus, 15% of the demand in MITS is currently met by the solar plant. But during COVID scenario around 30% demand was met by solar plant
- ✓ The current annual savings is around Rs 11.02 Lakhs, i.e. around 14.23% but the savings under COVID situation was around 26%.
- ✓ Generation of about 1.15 Lac kilograms of CO<sub>2</sub> emission is prevented by this green initiative.
- ✓ A fully grown tree can roughly absorb around 20 kilograms of carbon dioxide (CO<sub>2</sub>) per year, which is equivalent to having 5,790 fully grown trees.
- ✓ In the current situation the power factor incentive received due to higher power factor is around 2.8 lakhs. Last year, due to less load, a power factor penalty of about 34 thousand was imposed.
- ✓ 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 CO<sub>2</sub> from the global atmosphere.

## REFERENCES

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- [2] Ma, C.M., Ge, Q.S.: 'Method for Calculating CO<sub>2</sub> Emissions from the Power Sector at the Provincial Level in China', Advances in Climate Change Research.,2014, 5(2), pp. 92-99
- [3] Honghai, Y., Zhi, W., Li, C., Jianan, W.: 'CO<sub>2</sub> Emission Calculation and Emission Characteristics Analysis of Typical 600MW Coal-fired Thermal Power Unit', E3S Web of Conferences, 2020, 165, 01029
- [4] Mittal, M.L., Sharma, C., Singh, R.: Estimates of Emissions from Coal Fired Thermal Power Plants in India. In 2012 International Emission Inventory Conference. (2012).



## Appendix

**Table A1: Data used for preparing this report**

Solar price per unit	Average price per unit (Grid) <sup>#</sup>	CO <sub>2</sub> 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

*M. Pandit*  
(Dr. Manjaree Pandit)  
Dean Academics.