Comparison of DC-DC Boost converter without MPPT, with MPPT Perturb & Observe and with MPPT Incremental & Conductance Algorithm

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Abstract- *In this paper, A Comparison of two MPPT algorithms, perturb & observe algorithm and incremental & conductance algorithm has made. Boost converter with Perturb & Observe and incremental conductance method is able to transfer unusable power into usable power. The performance of Perturb & Observe and incremental & conductance algorithm is verified through simulation study using PSIM.*

I. INTRODUCTION

Maximum power point tracking (MPPT) is used in photovoltaic (PV) systems to maximize the photovoltaic array output power, irrespective of the change in temperature and irradiation conditions. A MPPT system has been developed, consisting of a Boost-type DC to DC converter. The main difference between the method used in the proposed MPPT system and other techniques used in the past is that the PV array output power is used to directly control the DC to DC converter, thus reducing the complexity of the system. The resulting system has high-efficiency, lower-cost and can be easily modified to handle more energy sources.

There are various types of algorithms which are used but two types of MPPT algorithms are widely used to track the maximum power point, first Perturb & Observe algorithm and second Incremental & Conductance.

II. MPPT AND DC-DC BOOST CONVERTER

Basic function of MPPT is to extract maximum output power from solar panel. It functions as heart of PV system to achieve high efficiency. Here we will see how solar PV system is work without MPPT and with MPPT in accordance with the DC-DC boost converter.

(A) DC-DC boost converter without MPPT

Circuit diagram DC-DC Boost converter without MPPT

As shown in Figure DC-DC Boost converter without MPPT for 25 W solar panel has been used in this simulation and all the output result was taken as per standard data of temperature 25℃ and solar radiation of 1000 W/m^2.

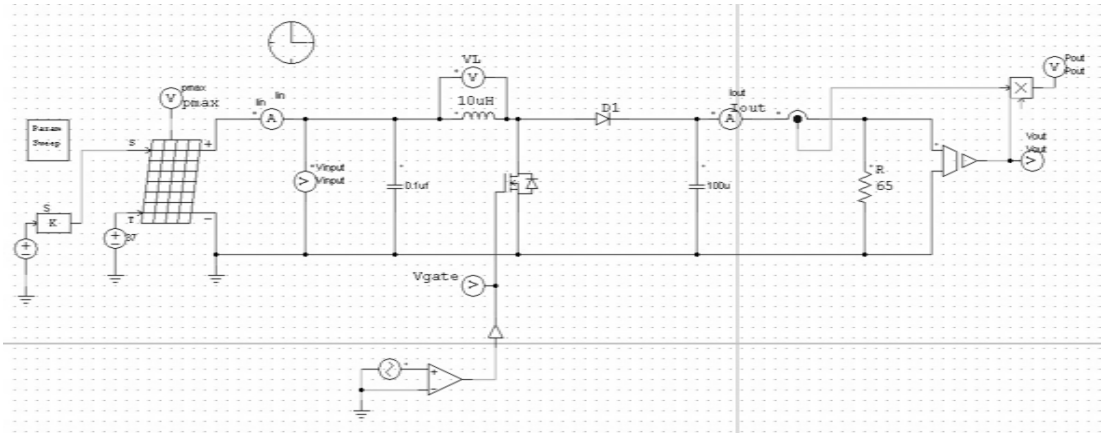

Fig. 1 : Circuit diagram of Boost converter without MPPT system

Output Results of DC-DC Boost Converter without MPPT

- **Initial Solar Panel Maximum Power(25W)**

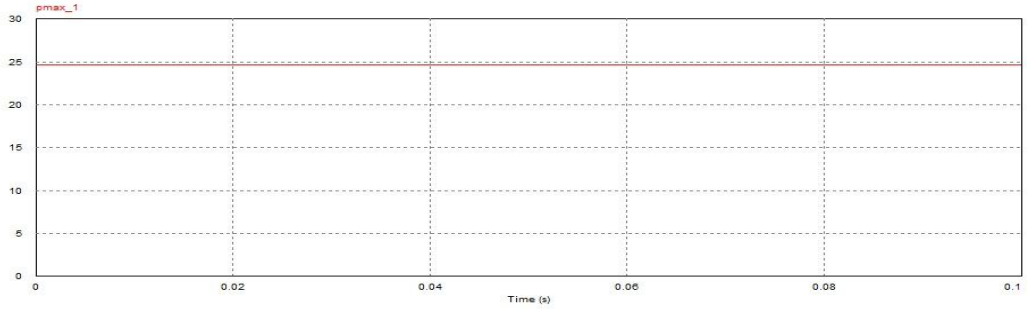

Fig. 2 : Output Power of Initial Solar Panel for without MPPT system

- **Output Voltage (Vout) (20V)**

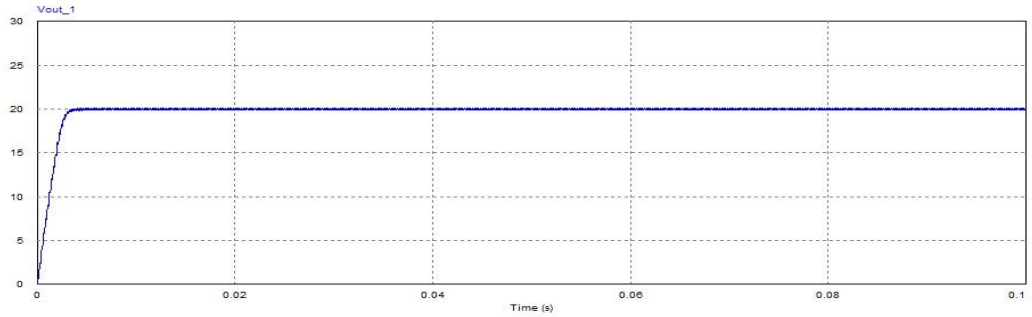

Fig. 3 : Output Voltage of DC-DC Boost Converter without MPPT system

- **Output Current (Io) (0.31A)**

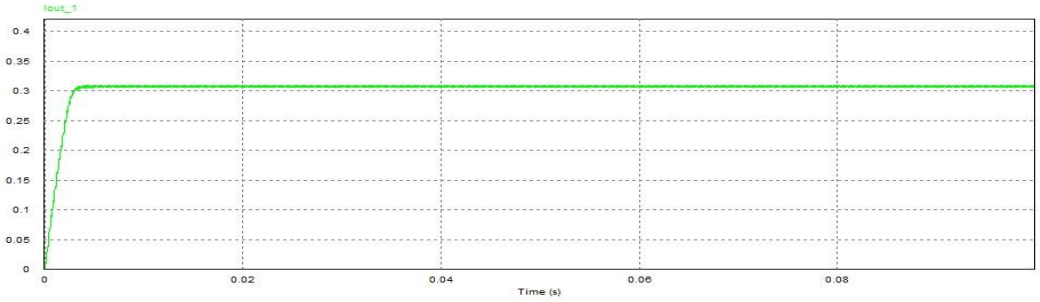

Fig. 4 : Output Current of DC-DC Boost Converter without MPPT system

- **Output Power (Po) (6.3W)**

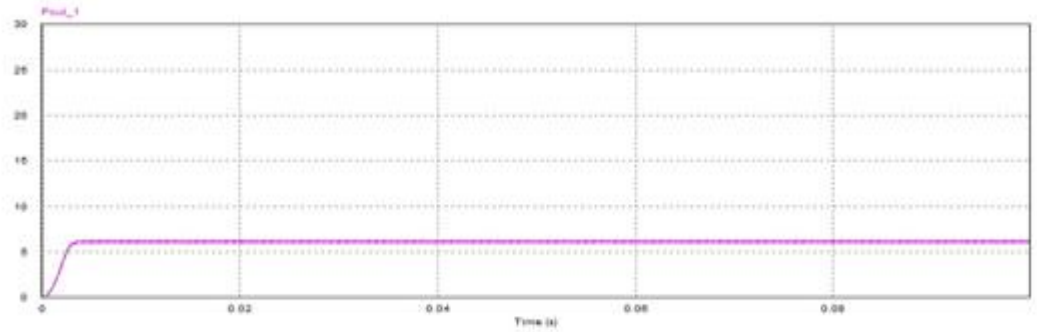

Fig. 5 : Output Power of DC-DC Boost Converter without MPPT system

- **Gate Pulse**

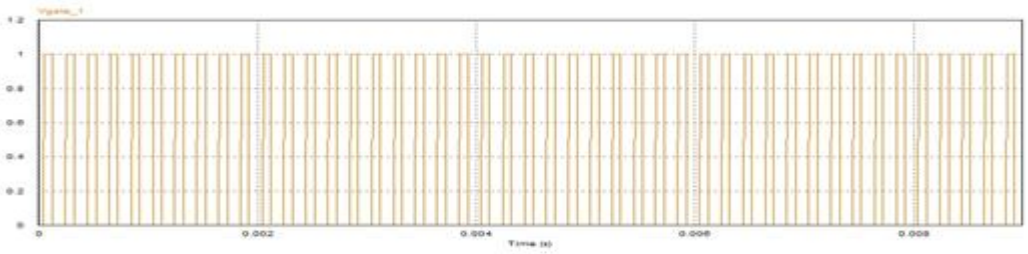

Fig. 6 : Gate Pulse of DC-DC Boost Converter without MPPT system.

- Parametric values for simulation of DC-DC boost converter without MPPT algorithm is as shown in Table

Table 1: Parameter Tabulation without MPPT

Time	Solar Radiation [W/m^2]	Temp. [℃]	Solar Panel Output Power	Solar Panel Output Current	Solar Panel Output Voltage	Output Current	Output Voltage	Output Power	Efficiency
7:30 A.M	240	31.5	5.6998	0.3693	15.0196	0.2180	14.1746	3.0910	54.22%
8:00 A.M	380	32.5	9.0916	0.4511	17.9140	0.2648	17.2143	4.5587	50.14%
8:30 A.M	460	33.5	11.0049	0.4659	18.4610	0.2733	17.7626	4.8540	44.10%
9:00 A.M	560	34.5	13.3749	0.4774	18.8822	0.2798	18.1854	5.0878	38.03%
9:30 A.M	600	35.5	14.2827	0.4797	18.9638	0.2810	18.2676	5.1339	35.94%
10:00 A.M	700	35.5	16.6593	0.4882	19.2719	0.2858	18.5770	5.3093	31.86%
10:30 A.M	760	36.5	18.0079	0.4906	19.3543	0.2871	18.6601	5.3569	29.74%
11:00 A.M	780	36.5	18.4759	0.4919	19.4009	0.2878	18.7069	5.3838	29.13%
11:30 A.M	840	37	19.8381	0.4946	19.4954	0.2892	18.8021	5.4387	27.41%
12:00 Noon	840	37	19.8381	0.4946	19.4954	0.2892	18.8021	5.4387	27.41%
12:30 P.M	840	37.5	19.7980	0.4937	19.4605	0.2887	18.767	5.4184	27.36%
1:00 P.M	840	39.5	19.6373	0.4900	19.3199	0.2865	18.6265	5.3376	27.18%
1:30 P.M	800	38.5	18.7931	0.4895	19.3055	0.2863	18.6117	5.3291	28.35%
2:00 P.M	860	39.5	20.0961	0.4911	19.3599	0.2872	18.6667	5.3607	26.67%
2:30 P.M	620	39.5	14.5421	0.4744	18.7589	0.2778	18.0600	5.0179	34.50%

3:00 P.M	500	39.5	11.7336	0.4614	18.2805	0.2705	17.5829	4.7562	40.53%
3:30 P.M	500	39.5	11.7336	0.4614	18.2805	0.2705	17.5829	4.7562	40.53%
4:00 P.M	360	39.5	8.4449	0.4353	17.3131	0.2556	16.6132	4.2461	50.28%
4:30 P.M	260	39	6.1065	0.3905	15.6345	0.2297	14.9330	3.4307	56.18%
5:00 P.M	160	38.5	3.7785	0.2654	12.2005	0.1574	10.2330	1.6109	42.63%
5:30 P.M	100	38.5	2.4035	0.1745	8.3828	0.1032	6.7118	0.6930	28.83%
6:00 P.M	40	37.5	1.0554	0.0807	4.2466	0.0477	3.1016	0.148	14.02%

➢ **Solar panel output power and output power without MPPT V/S voltage**

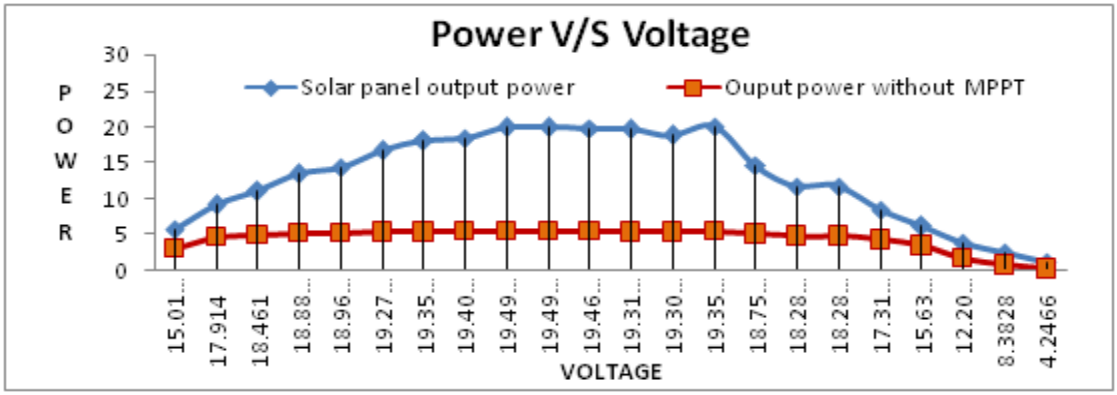

Fig. 7 : Solar panel output power and output power without MPPT V/S voltage

➢ **Efficiency V/S Time**

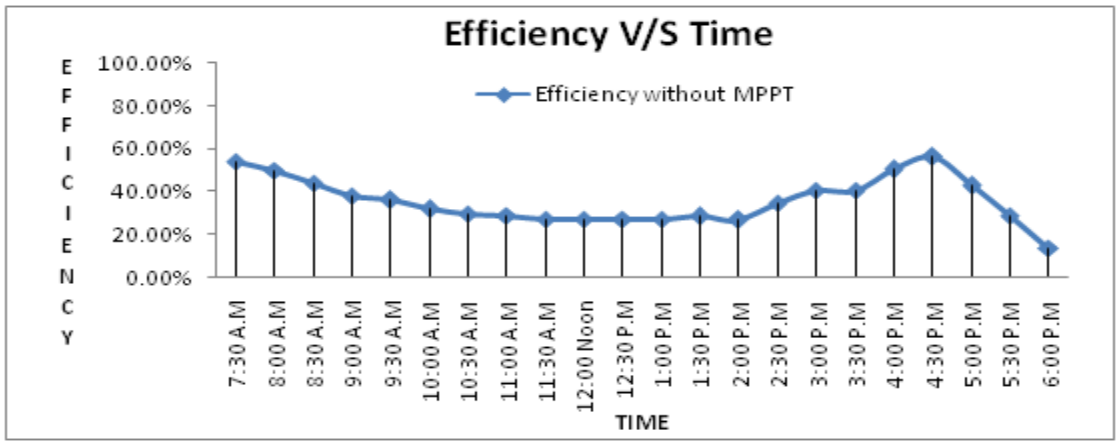

Fig. 8 : Efficiency V/S Time

(B) DC-DC boost converter with MPPT-P&O algorithm

As Up till now we have seen the simulation work of DC-DC boost converter without MPPT. It is clear that the efficiency of the PV system without MPPT is very low, But if we use the MPPT algorithm with PV system along with boost converter then efficiency may increase to large extant.

Mainly most common algorithm used, which are also shown in this work are P&O and IncCond. If we control gate signal of boost converter with control of MPPT controller using this algorithm gives higher efficiency then the system without MPPT

Circuit Diagram of DC-DC Boost Converter with Perturb & Observe Algorithm

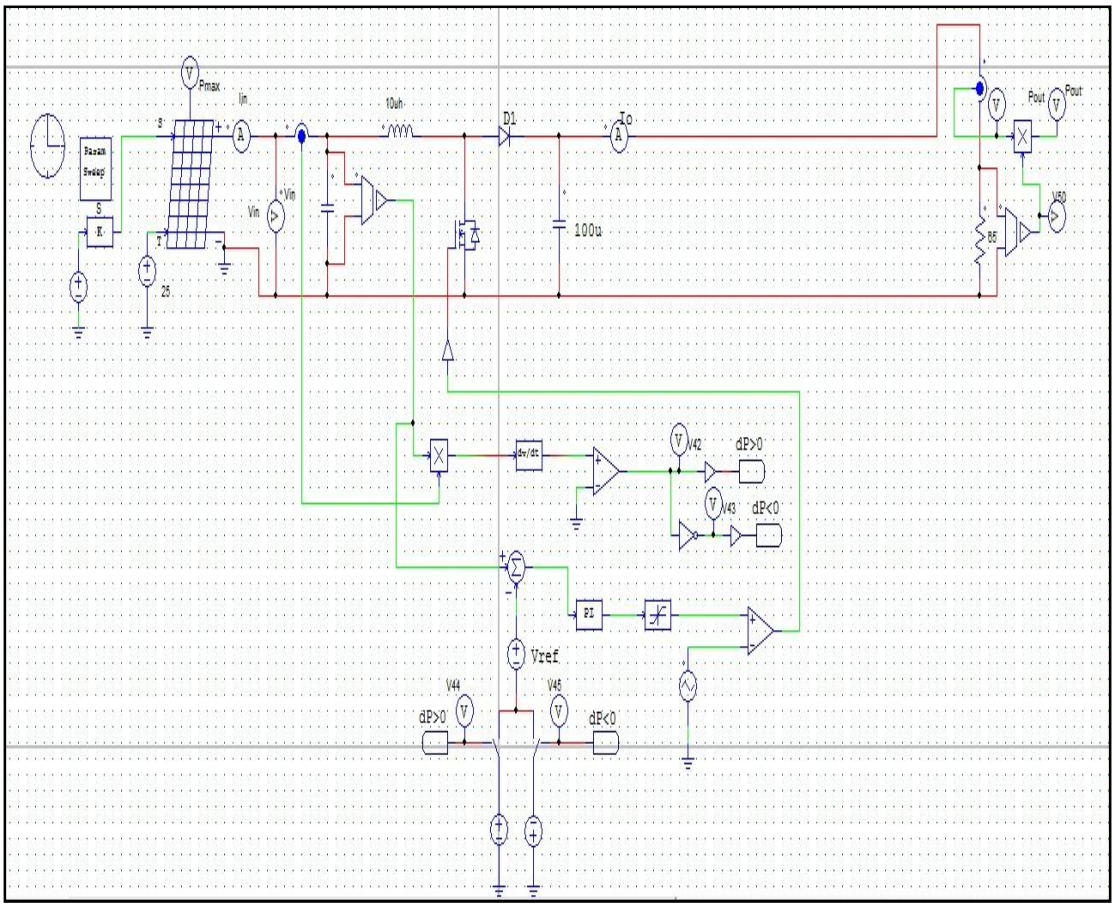

Fig. 9 : Circuit Diagram of DC DC Boost Converter with Perturb & Observe Algorithm

As shown in Figure DC-DC Boost converter with perturb & observe algorithm for 25 W solar panel has been used in this simulation and all the Output result was taken as per 25 ℃ temperature and solar radiation of 1000 W/m^2. Output results for this configuration are shown as under.

Output Results of DC DC Boost Converter with Perturb & Observe Algorithm

- **Initial Solar Panel Maximum Power**

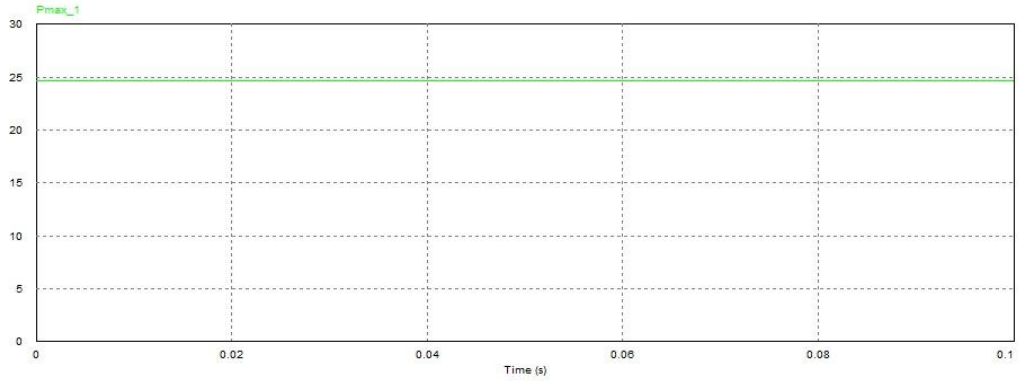

Fig. 10: Output Power of Initial Solar Panel for Perturb & Observe Algorithm

- **Output Voltage (Vout)**

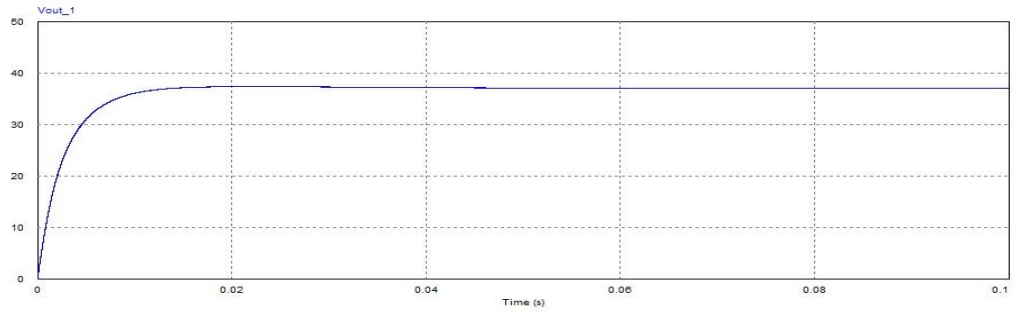

Fig. 11 : Output Voltage of Perturb & Observe Algorithm

- **Output Current (Iout)**

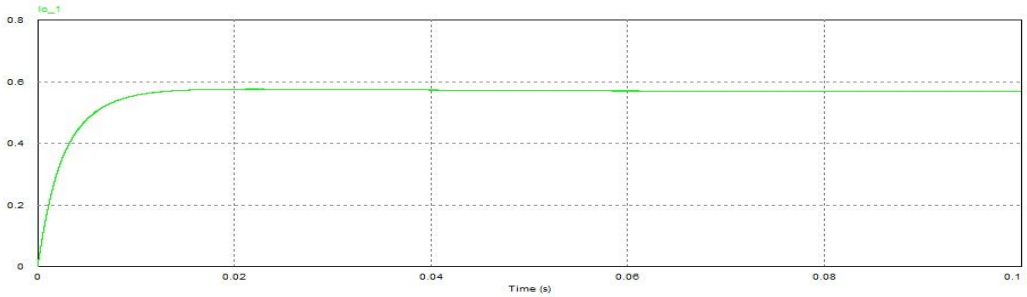

Fig. 12: Output Current of Perturb & Observe Algorithm

- **Output Power (Pout)**

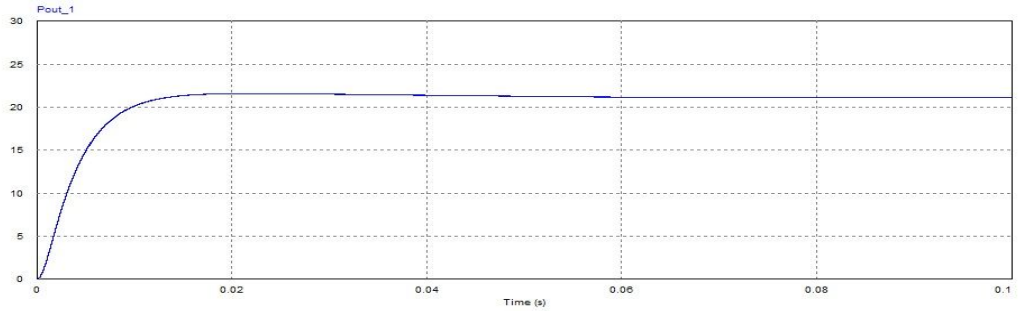

Fig. 13 : Output Power of Perturb & Observe Algorithm

- **Gate Pulse**

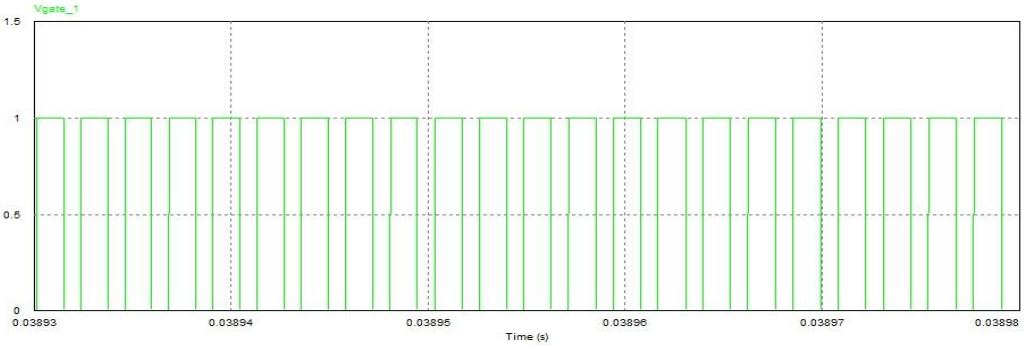

Fig. 14 : Gate Pulse of Perturb& Observe Algorithm

Parametric values for simulation of DC DC boost converter with Perturb& Observe algorithm is as shown in Table.

Table 2 : Parameter Tabulation with MPPT – Perturb & Observe

Time	Solar Radiation [W/m^2]	Temp. [°C]	Solar Panel Output Power	Solar Panel Output Current	Solar Panel Output Voltage	Output Current	Output Voltage	Output Power	Efficiency
7:30 A.M	240	31.5	5.6998	0.3785	12.1056	0.2719	17.6774	4.8075	84.34%
8:00 A.M	380	32.5	9.0916	0.5900	14.2025	0.3474	22.5819	7.8452	86.29%
8:30 A.M	460	33.5	11.0043	0.7163	13.6698	0.3834	24.9240	9.5570	86.84%
9:00 A.M	560	34.5	13.3749	0.8734	12.9497	0.4239	27.5540	11.6804	87.33%
9:30 A.M	600	35.5	14.2827	0.9383	11.6258	0.4390	28.5375	12.5290	87.72%
10:00 A.M	700	35.5	16.6593	1.0265	16.2193	0.4760	30.9461	14.7332	88.43%
10:30 A.M	760	36.5	18.0070	1.1087	16.2388	0.4973	32.3260	16.0765	89.29%
11:00 A.M	780	36.5	18.4759	1.1648	15.7386	0.5041	32.7696	16.5208	89.14%
11:30 A.M	840	37	19.8381	1.248	15.8117	0.5240	34.0637	17.8513	89.98%
12:00 Noon	840	37	19.8381	1.248	15.8117	0.5240	34.0637	17.8513	89.99%
12:30 P.M	840	37.5	19.7980	1.2723	15.2092	0.5240	34.0641	17.8518	90.16%
1:00 P.M	840	39.5	19.6373	1.1915	16.4275	0.5238	34.0468	17.8336	90.81%
1:30 P.M	800	38.5	18.7931	1.2480	12.5593	0.5108	33.2044	16.9620	90.25%
2:00 P.M	860	39.5	20.0961	1.3442	11.558	0.5302	34.4654	18.2748	90.93%
2:30 P.M	620	39.5	14.5421	0.8801	16.4396	0.4468	29.0448	12.9785	89.24%
3:00 P.M	500	39.5	11.7336	0.7905	11.6506	0.4005	26.0332	10.4266	88.86%
3:30 P.M	500	39.5	11.7336	0.7905	11.6506	0.4005	26.0332	10.4266	88.86%
4:00 P.M	360	39.5	8.4449	0.5746	12.0427	0.3397	22.0850	7.5038	87.85%
4:30 P.M	260	39	6.1065	0.4200	12.1374	0.2873	16.6760	5.3660	87.87%
5:00 P.M	160	38.5	3.7785	0.2660	11.5138	0.2206	14.3408	3.164	83.73%
5:30	100	38.5	2.4035	0.1737	11.4920	0.1660	10.792	1.7918	74.54%

P.M							0		
6:00 P.M	40	37.5	1.0554	0.0806	5.6977	0.0769	5.0029	0.3850	36.47%

- **Solar panel output power and output power with MPPT-P&O algorithm V/S voltage**

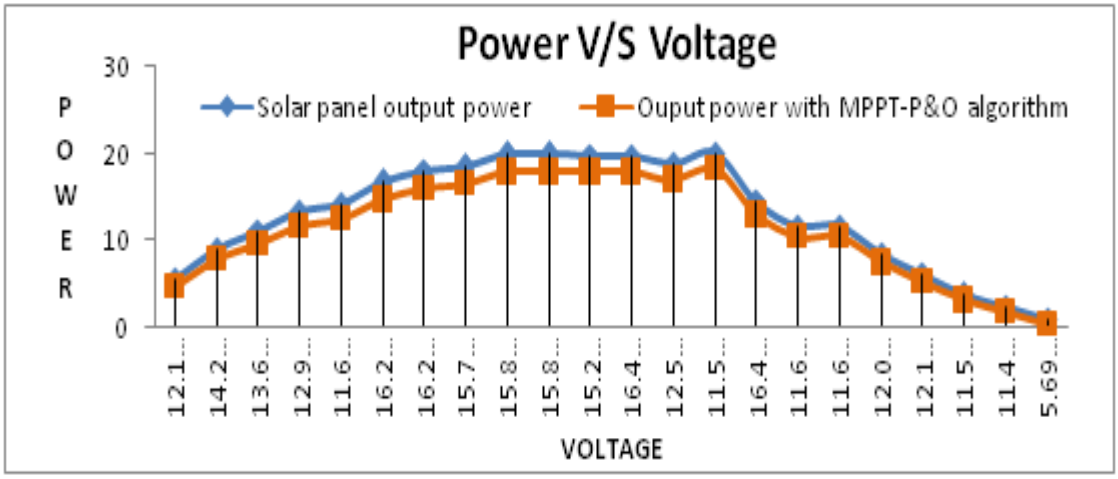

Fig. 15: Solar panel output power and output power with MPPT-P&O algorithm V/S voltage

- **Efficiency V/S Time**

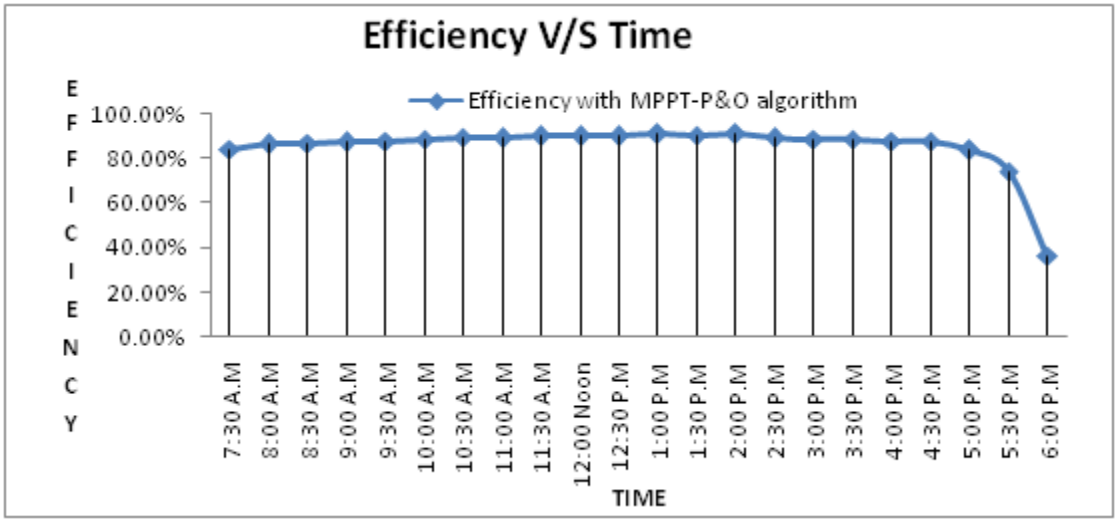

Fig. 16: Efficiency V/S Time

(C) DC-DC Boost Converter with MPPT Incremental & Conductance Algorithm

Circuit Diagram of DC DC Boost Converter with MPPT Incremental & Conductance Algorithm

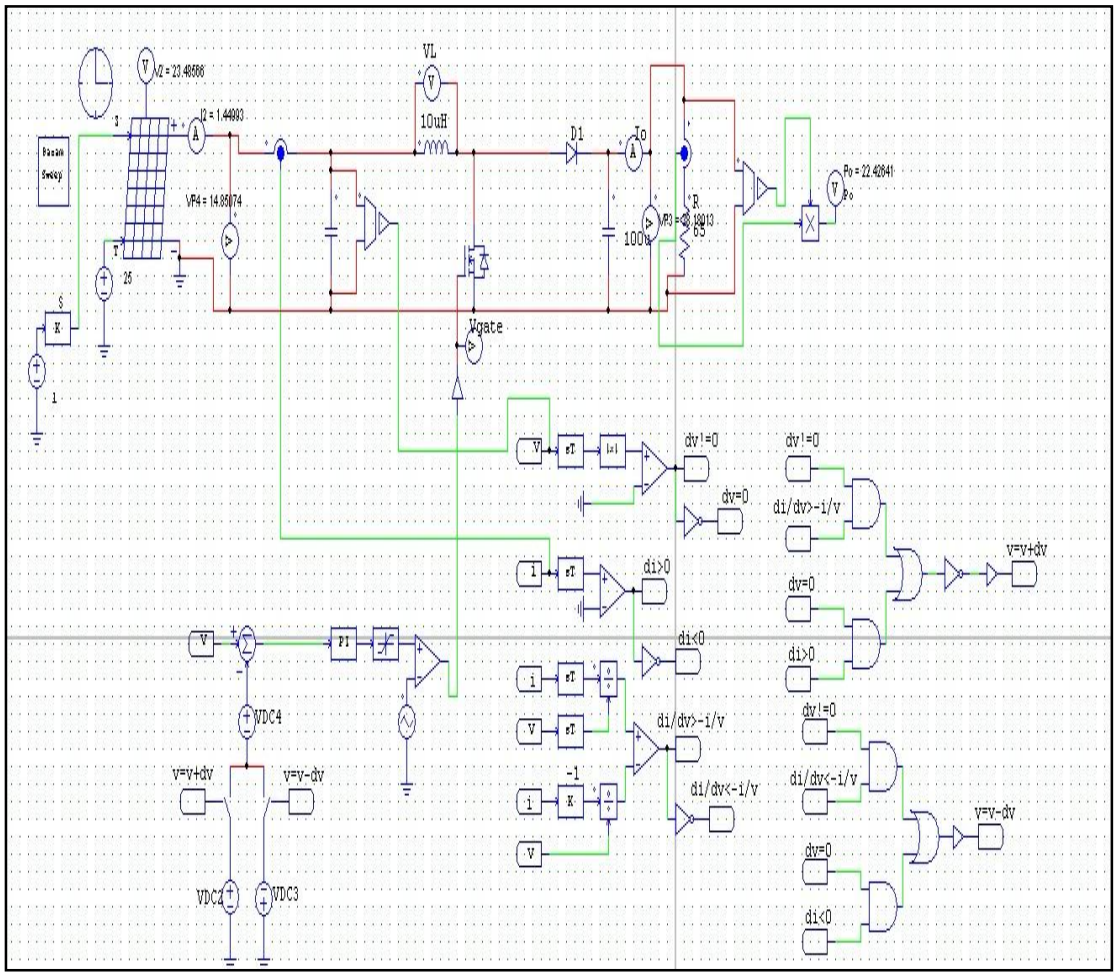

Fig. 17: Circuit Diagram of DC DC Boost Converter with MPPT Incremental & Conductance Algorithm

As shown in Figure DC DC Boost converter with Incremental & Conductance algorithm for 25 W solar panel has been used in this simulation and all the Output result was taken as per 25℃ temperature and solar radiation of 1000 W/m^2. Output results for this configuration has shown as under.

Output Results of DC-DC Boost Converter with Incremental & Conductance Algorithm

- **Initial Solar Panel Maximum Power**

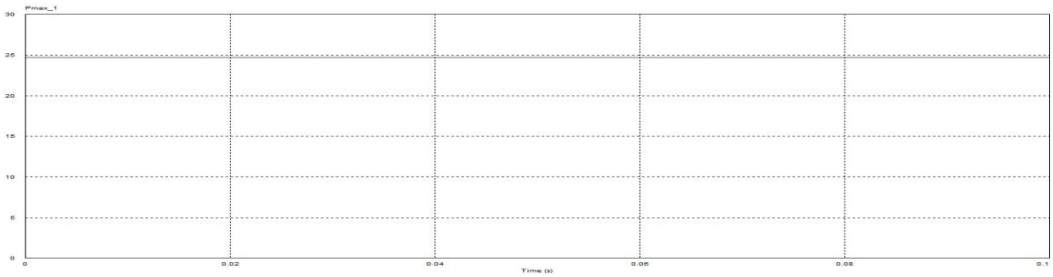

Fig. 18 : Output Power of Initial Solar Panel for Incremental Conductance algorithm

- **Output Current (Iout)**

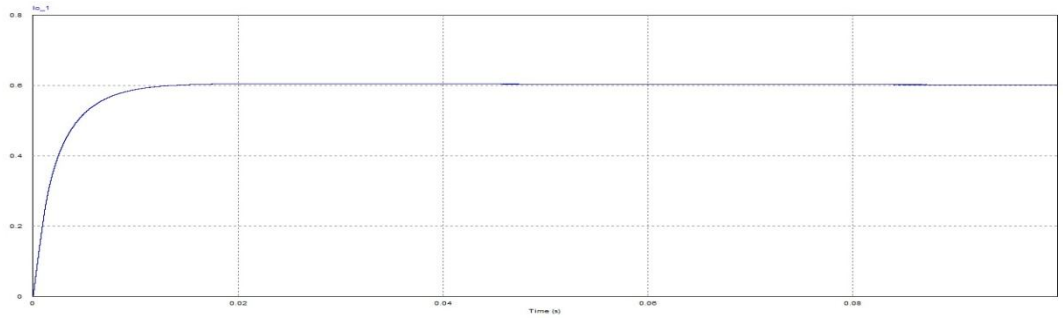

Fig. 19 : Output Current of Incremental Conductance Algorithm

- **Output Voltage (Vout)**

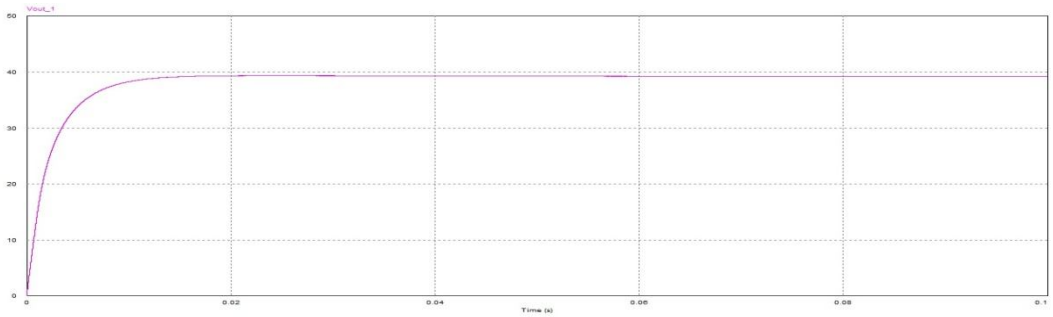

Fig. 20: Output Voltage of Incremental & Conductance Algorithm

- **Output Power (Pout)**

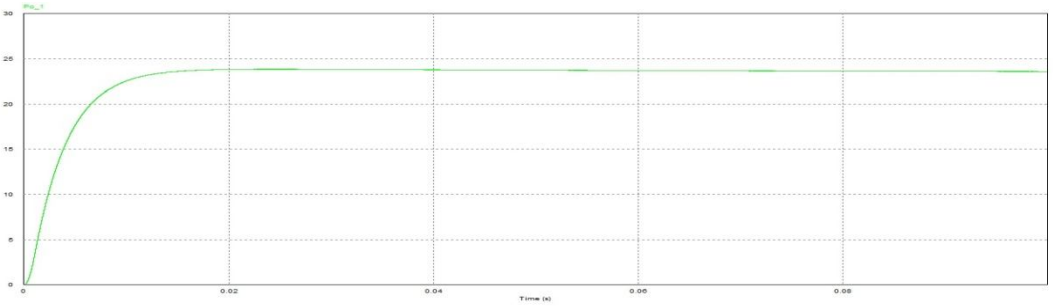

Fig. 21 : Output Power of Incremental & Conductance Algorithm

- **Gate Pulse**

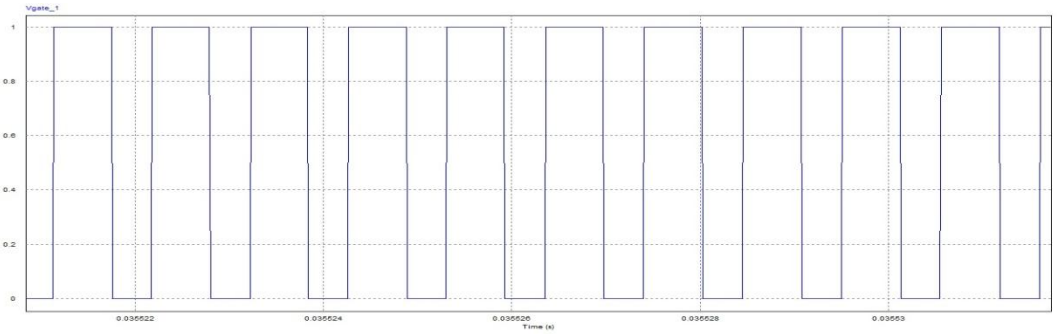

Fig. 22: Gate Pulse of Incremental & Conductance Algorithm

Table 3: Parameter Tabulation with MPPT – Incremental Conductance

Time	Solar Radiation [W/m^2]	Temp. [℃]	Solar Panel Output Power	Solar Panel Output Current	Solar Panel Output Voltage	Output Current	Output Voltage	Output Power	Efficiency
7:30 A.M	240	31.5	5.6998	0.36764	15.20326	0.28992	18.84506	5.46363	95.86%
8:00 A.M	380	32.5	9.0916	0.57857	15.3963	0.36728	23.87342	8.76828	96.44%
8:30 A.M	460	33.5	11.0043	0.66707	16.48982	0.40465	26.30256	10.64349	96.72%
9:00 A.M	560	34.5	13.37497	0.85144	15.34834	0.44679	29.04131	12.97529	97.01%
9:30 A.M	600	35.5	14.28271	0.88387	16.1451	0.46213	30.03831	13.88159	97.19%
10:00 A.M	700	35.5	16.65934	1.03951	15.95943	0.49952	32.46854	16.2186	97.35%
10:30 A.M	760	36.5	18.00705	1.10341	16.31937	0.51982	33.78805	17.56363	97.53%
11:00 A.M	780	36.5	18.47597	1.1484	16.06277	0.52664	34.23141	18.02758	97.57%
11:30 A.M	840	37	19.8381	1.26651	15.39639	0.54605	35.49352	19.38132	97.69%
12:00 Noon	840	37	19.8381	1.21653	16.30697	0.54605	35.49298	19.38086	97.69%
12:30 P.M	840	37.5	19.79805	1.21773	16.25817	0.54559	35.46339	19.34855	97.72%
1:00 P.M	840	39.5	19.63733	1.22684	16.0029	0.54361	35.33449	19.20815	97.81%
1:30 P.M	800	38.5	18.79315	1.19122	15.69676	0.53155	34.5505	18.36507	97.72%
2:00 P.M	860	39.5	20.09611	1.28895	15.43483	0.54999	35.74919	19.66153	97.83%
2:30 P.M	620	39.5	14.54213	0.9024	16.11235	0.46689	30.34778	14.16909	97.43%
3:00 P.M	500	39.5	11.7336	0.75496	15.44115	0.4187	27.21564	11.3952	97.11%
3:30 P.M	500	39.5	11.7336	0.71839	16.27867	0.41869	27.21456	11.39437	97.10%
4:00 P.M	360	39.5	8.44499	0.51444	16.27571	0.35387	23.00167	8.13967	96.38%
4:30 P.M	260	39	6.10652	0.39513	15.44438	0.29934	19.45689	5.82416	95.38%
5:00 P.M	160	38.5	3.77853	0.23387	15.90125	0.23387	15.20125	3.55504	94.08%
5:30 P.M	100	38.5	2.4035	0.17329	11.97043	0.17339	11.27043	1.95419	81.31%
6:00 P.M	40	37.5	1.0554	0.0806	5.94402	0.08067	5.24402	0.42307	40.09%

➢ **Solar panel output power and output power with MPPT-INC algorithm V/S voltage**

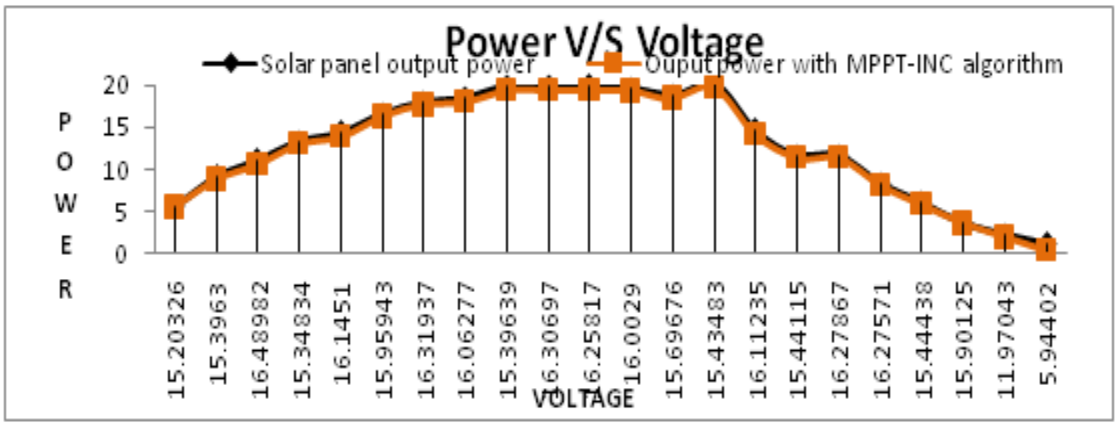

Fig. 23: Solar panel output power and output power with MPPT-INC algorithm V/S voltage

➢ **Efficiency V/S Time**

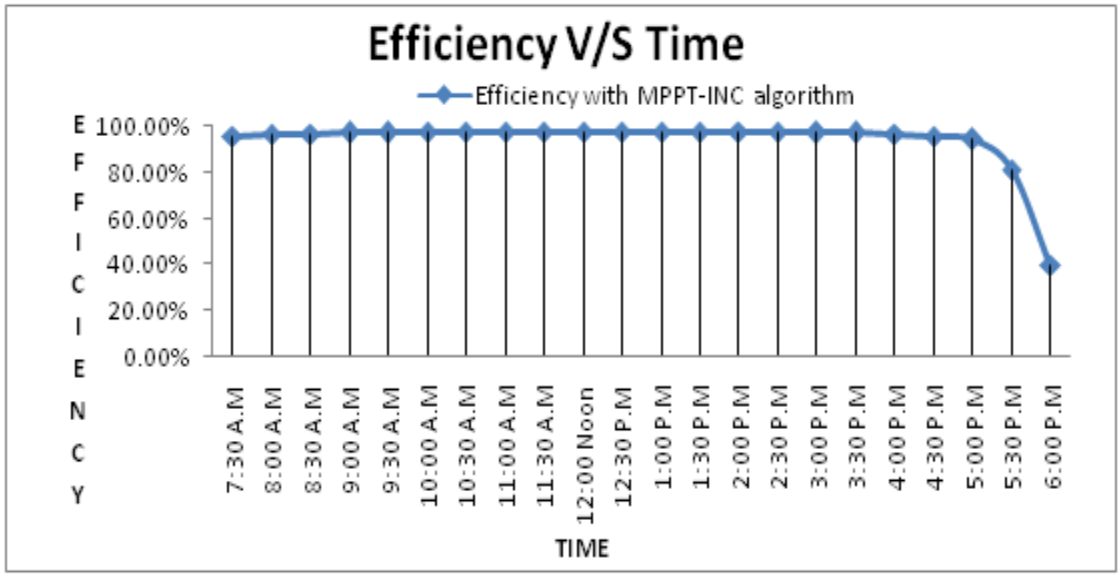

Fig. 24: Efficiency V/S Time

(D) Comparison of Boost Converter without MPPT, Perturb & Observe Algorithm and Incremental & Conductance Algorithm

Table 4: Comparision of without MPPT, With MPPT-P&O and MPPT-Inc

Time	Solar Radiation [W/m^2]	Temp. [°C]	Efficiency		
			Without MPPT	With MPPT-P&O Algorithm	With MPPT-Incremental Conductance Algorithm
7:30 A.M	240	31.5	54.22%	84.34%	95.86%
8:00 A.M	380	32.5	50.14%	86.29%	96.44%
8:30 A.M	460	33.5	44.10%	86.84%	96.72%

9:00 A.M	560	34.5	38.03%	87.33%	97.01%
9:30 A.M	600	35.5	35.94%	87.72%	97.19%
10:00 A.M	700	35.5	31.86%	88.43%	97.35%
10:30 A.M	760	36.5	29.74%	89.29%	97.53%
11:00 A.M	780	36.5	29.13%	89.14%	97.57%
11:30 A.M	840	37	27.41%	89.98%	97.69%
12:00 Noon	840	37	27.41%	89.99%	97.69%
12:30 P.M	840	37.5	27.36%	90.16%	97.72%
1:00 P.M	840	39.5	27.18%	90.81%	97.81%
1:30 P.M	800	38.5	28.35%	90.25%	97.72%
2:00 P.M	860	39.5	26.67%	90.93%	97.83%
2:30 P.M	620	39.5	34.50%	89.24%	97.43%
3:00 P.M	500	39.5	40.53%	88.86%	97.11%
3:30 P.M	500	39.5	40.53%	88.86%	97.10%
4:00 P.M	360	39.5	50.28%	87.85%	96.38%
4:30 P.M	260	39	56.18%	87.87%	95.38%
5:00 P.M	160	38.5	42.63%	83.73%	94.08%
5:30 P.M	100	38.5	28.83%	74.54%	81.31%
6:00 P.M	40	37.5	14.02%	36.47%	40.09%

- **Comparison of Solar panel output power, Without MPPT, With MPPT-P&O, and With MPPT-INC output power**

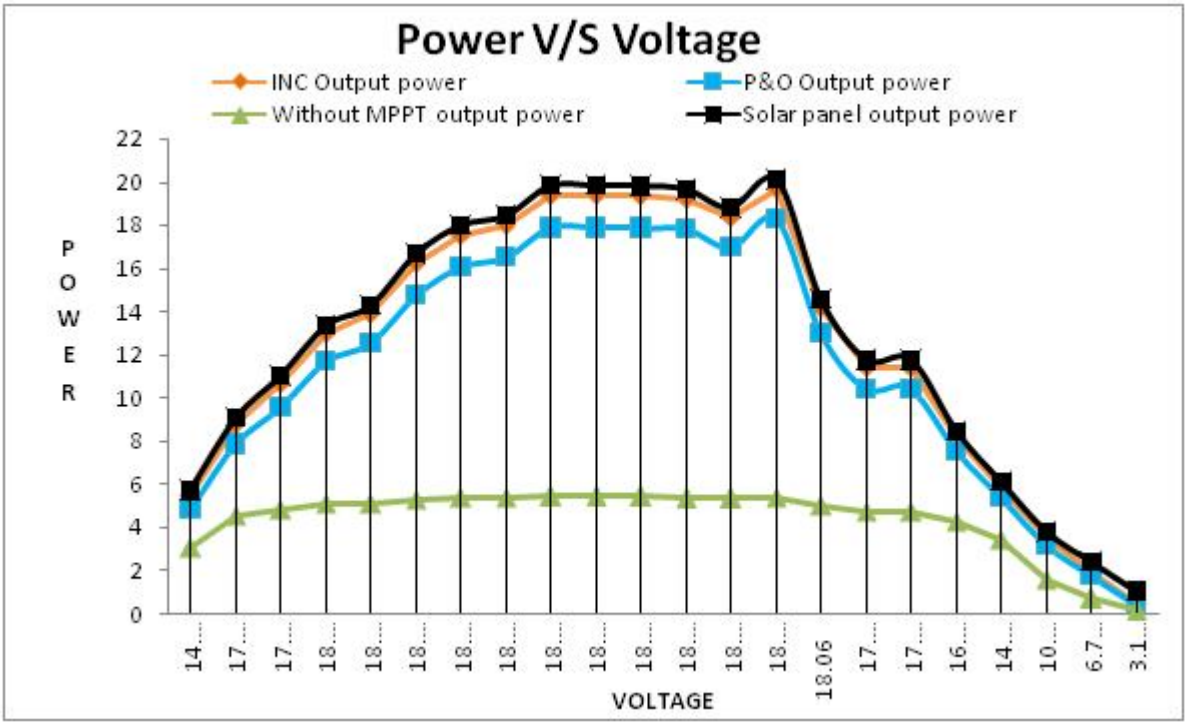

Fig. 25 : Comparison of Solar panel output power, Without MPPT, With MPPT-P&O, and With MPPT-INC output power

➢ **Efficiency comparison of Without MPPT, With MPPT-P&O, and With MPPT-INC**

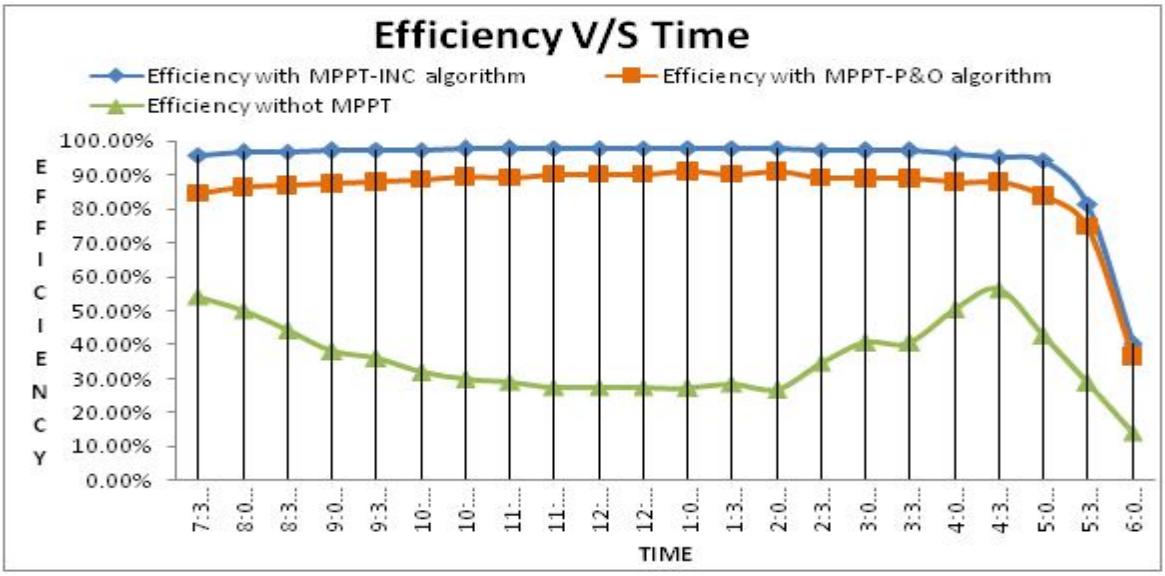

Fig. 26 : Efficiency comparison of Without MPPT, With MPPT-P&O, and With MPPT-INC

III. CONCLUSION

This paper has presented a comparison of DC-DC Boost Converter without MPPT, with MPPT P&O and with MPPT INC. Here this paper deals to say that DC-DC Boost Converter with MPPT P&O and with MPPT INC give good result compare to the DC-DC Boost Converter without MPPT. And in this paper it is obseved that DC-DC Boost Converter with MPPT INC give good solar power output and efficiency with compared to DC-DC Boost Converter without MPPT and DC-DC Boost Converter with MPPT P&O in changing atmospheric condition.

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