Pros and Cons of distributed solar power generation and benefit of Battery Storage in respect to the profitability of a DISCOM

Current era of mass scale proliferation of mini and micro solar power generation plants has been taken place already. As a consequence, Electricity business is transforming to a new and uncertain practice from the past. Business owners practicing power distribution are scared most. In this current changing scenario does power distribution companies could make profit? Should distributed generation of mini and micro solar power generation be promoted? Even if mini and micro solar power generation is accepted by the DISCOMS would they allow or promote usage of battery to the mini and micro solar power generation plants. Let us discuss with these topics.

As a first step of this discussion, let us examine the power demand and supply scenario of electricity in an area, let it be a State of India.

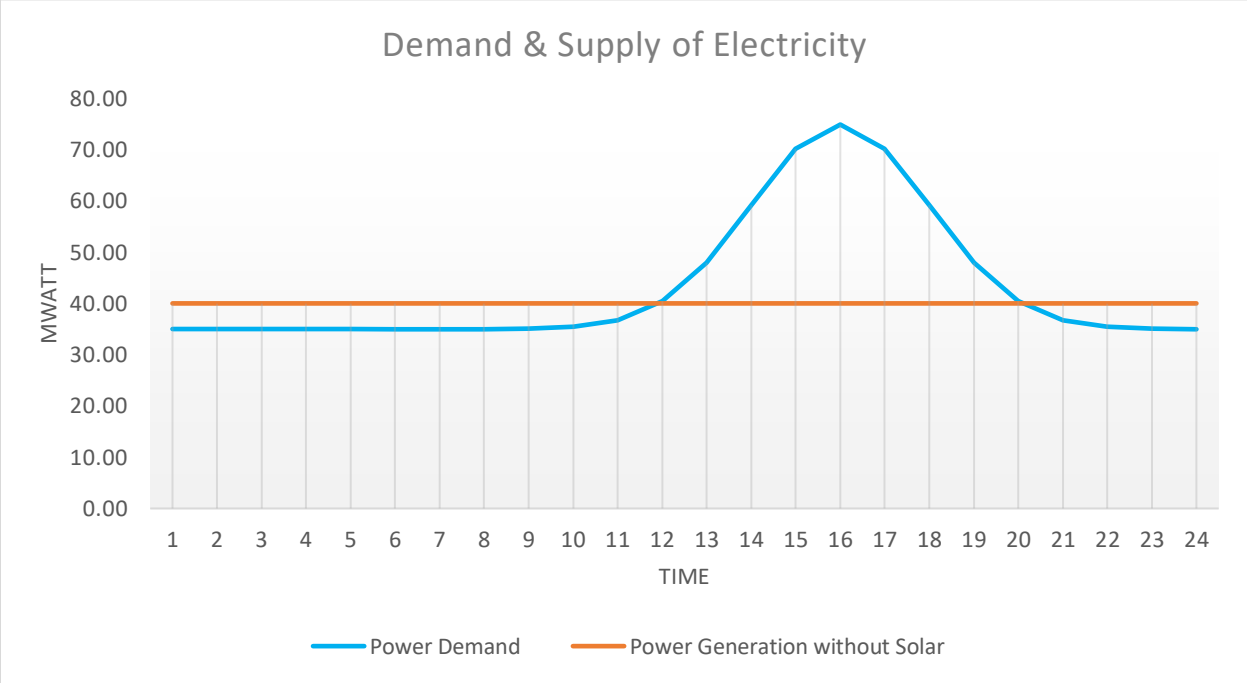

Figure 1: Demand & Supply of Electricity in a State

In the past, number of power plants mainly Thermal and Hydro type generated electric energy almost in Stateline throughout the day. It was almost a flat curve as shown in figure-1. However, electricity demand was not a flat curve in a day. Electricity demand picked up from 10AM and died down at 10PM, approximately. Therefore, in a day, from 10PM to 10AM next day electricity supply was more than the electricity demand. But at the prime time between 10AM to 10PM supply of electricity is much less than electricity demand. To fight with this situation DISCOMS used several mechanisms, such as,

1. Load Shade to some feeder so that supply-demand match.
2. Use different electricity prices based on Normal, Pick and Off-Pick demand of electricity so that consumer purchase more electricity pay more money.
3. Purchase electricity from other State with a higher rate so that Demand-supply gap of electricity could be reduced.
4. Use Pump storage plants, which pumped up water at off-pick demand session and use that water to generated and supply electricity at pick electricity demand session. This storage and supply of electricity has control on how much amount electricity will be produce as well as when it is produced (i.e. Lag).

Now, what happen when many solar generations are allowed. The demand and supply curves of our ideal state is given below:

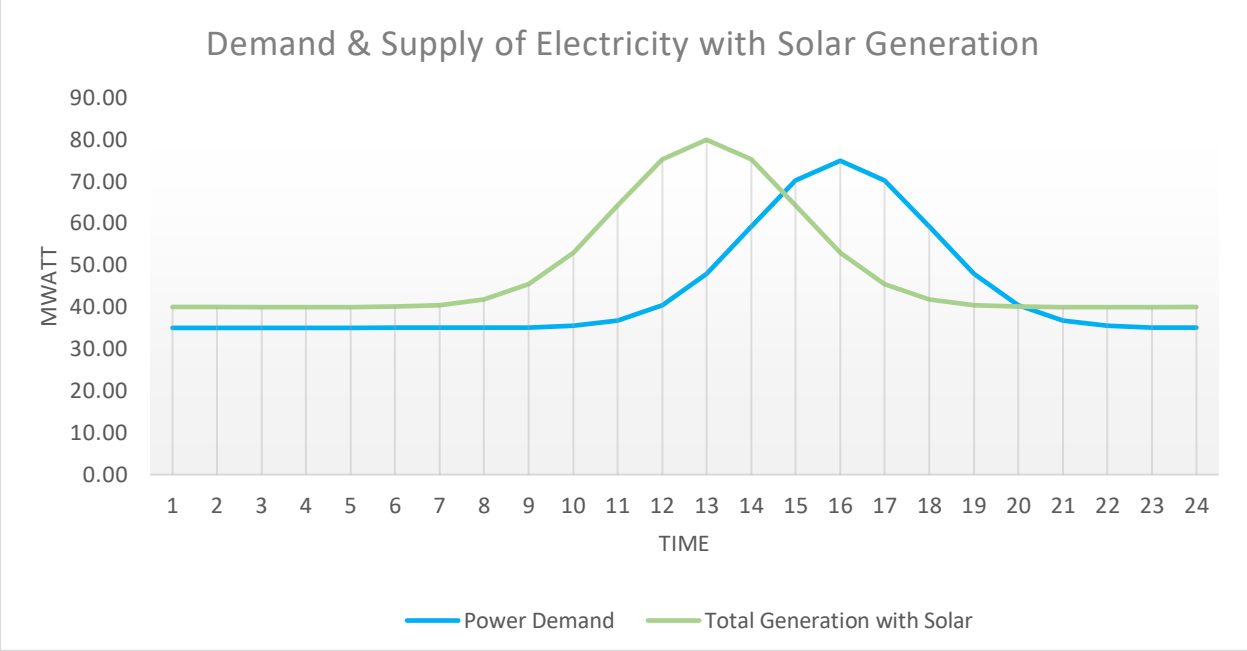

Figure 2: Demand & Supply of Electricity with Solar Generation.

In our ideal state we assume that the state has maximum power demand in a day is 74MW. It has thermal generation capability let 40MW. Hence it allowed a solar generation as 40MWp. (Assumed that as usual, STC condition of solar panel rating is not achieved, hence maximum solar generation will be around 35MW in a day.)

Question comes how to manage these two different picks at different time? One answer is to allow and promote usage of battery along with the solar generation plant. A battery has an ability to store energy and supply it at a time lag. If the DISCOM of our ideal state could leverage this Time-Lag supply characteristic of Battery, then our power demand and supply could be given below in the figure 3. Assuming that a loss of electricity is taken place in the Battery conversion process.

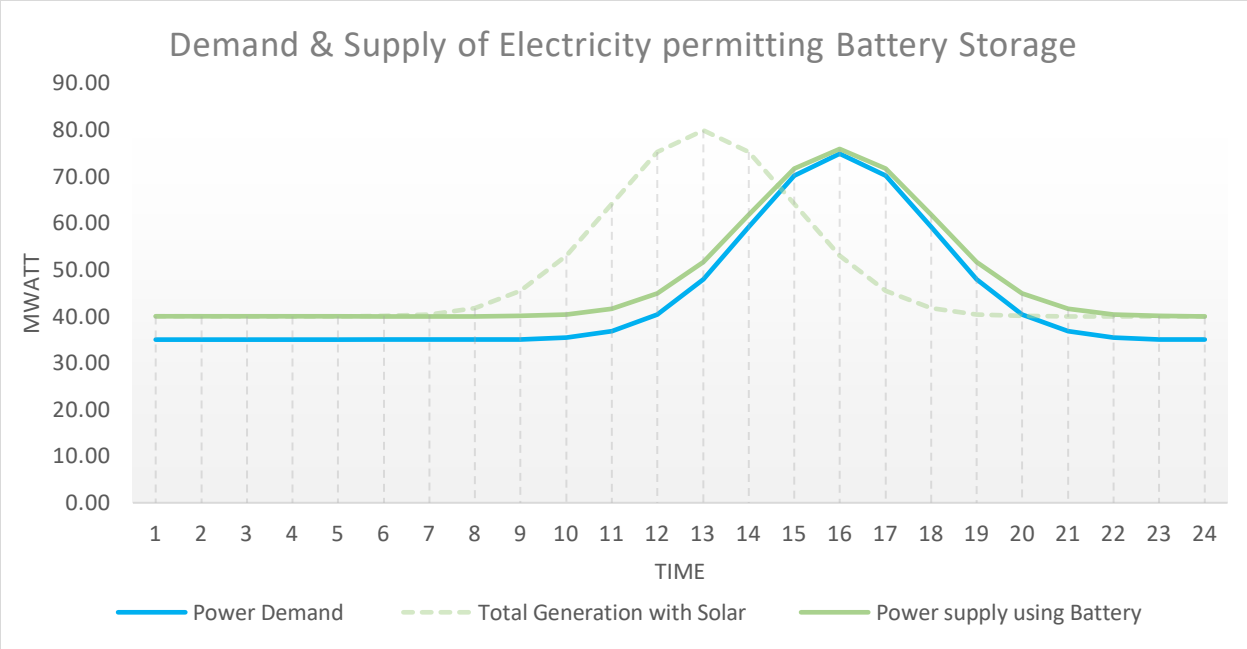

Figure 3: Demand & Supply of Electricity with Battery

Usage of Battery storage system with solar power plant could introduce a time lag of supply of Solar energy. And it has the ability to provide an exactly match with the power demand in our ideal State. This we could see at Figure-3, from the dotted green curve to firm green curve. To accomplish this what is the benefits of DISCOM?

- DISCOM do not need a heavy capital investment for the assets like Pump Storage plant. It only allowed and promote the Solar generator to use Battery storage system. The risk associated with the capital investment will be transferred to the solar generator.
- DISCOM has to offer a higher rate of solar energy price for sailing it to grid at the pick demand period of electricity in a day.
- DISCOM should usage smart meters and associate software to control its demand supply gap as well as its pricing strategy efficiently.
- It is also to mention that 4hrs supply-lagging is needed, since distance between the two picked is 4 hours.
- The battery size is 40MVAmpHr.

Appendix-1: Simulation Data Sheet

Time Stamp	Power Demand MW	Power Generation without Solar MW	Energy Gap MW	Solar Generation MW	Total Generation with Solar MW
1	35.00	40	5.00	0.00	40.00
2	35.00	40	5.00	0.00	40.00
3	35.00	40	5.00	0.00	40.00
4	35.00	40	5.00	0.00	40.00
5	35.00	40	5.00	0.01	40.01
6	35.00	40	5.00	0.09	40.09
7	35.00	40	5.00	0.44	40.44
8	35.01	40	4.99	1.75	41.75
9	35.09	40	4.91	5.40	45.40
10	35.44	40	4.56	12.95	52.95
11	36.75	40	3.25	24.19	64.19
12	40.40	40	-0.40	35.20	75.20
13	47.95	40	-7.95	39.89	79.89
14	59.19	40	-19.19	35.20	75.20
15	70.20	40	-30.20	24.19	64.19
16	74.89	40	-34.89	12.95	52.95
17	70.20	40	-30.20	5.40	45.40
18	59.19	40	-19.19	1.75	41.75
19	47.95	40	-7.95	0.44	40.44
20	40.40	40	-0.40	0.09	40.09
21	36.75	40	3.25	0.01	40.01
22	35.44	40	4.56	0.00	40.00
23	35.09	40	4.91	0.00	40.00
24	35.01	40	4.99	0.00	40.00

Time Stamp	Power Demand MW	Power Generation without Solar MW	Solar Generation MW	Total Generation with Solar MW	Lag schedule produces by battery	Power supply using Battery MW	Battery Energy storage cycle
1	35.00	40	0.00	40.00	0.00	40.00	0.00
2	35.00	40	0.00	40.00	0.00	40.00	0.00
3	35.00	40	0.00	40.00	0.00	40.00	0.00
4	35.00	40	0.00	40.00	0.00	40.00	0.00
5	35.00	40	0.01	40.01	0.00	40.00	0.01
6	35.00	40	0.09	40.09	0.00	40.00	0.09
7	35.00	40	0.44	40.44	0.00	40.00	0.44
8	35.01	40	1.75	41.75	0.01	40.01	1.74

9	35.09	40	5.40	45.40	0.09	40.08	5.32
10	35.44	40	12.95	52.95	0.44	40.40	12.55
11	36.75	40	24.19	64.19	1.75	41.58	22.61
12	40.40	40	35.20	75.20	5.40	44.86	30.34
13	47.95	40	39.89	79.89	12.95	51.65	28.23
14	59.19	40	35.20	75.20	24.19	61.77	13.43
15	70.20	40	24.19	64.19	35.20	71.68	-7.49
16	74.89	40	12.95	52.95	39.89	75.90	-22.95
17	70.20	40	5.40	45.40	35.20	71.68	-26.28
18	59.19	40	1.75	41.75	24.19	61.77	-20.02
19	47.95	40	0.44	40.44	12.95	51.65	-11.21
20	40.40	40	0.09	40.09	5.40	44.86	-4.77
21	36.75	40	0.01	40.01	1.75	41.58	-1.56
22	35.44	40	0.00	40.00	0.44	40.40	-0.40
23	35.09	40	0.00	40.00	0.09	40.08	-0.08
24	35.01	40	0.00	40.00	0.01	40.01	-0.01