



# Analysis of electricity consumption without and with solar system, before and after lockdown in Pune city, India

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## ABSTRACT-

The net energy consumption has decreased across the country and state, however domestic energy consumption has spiked up massively due to the lockdown and heavy use of electrical appliances. There is also a detailed survey of 20 households showing us the ups and downs in energy consumption. The massive impact on energy consumption was due to reduction in commercial and industrial activities. However, domestic energy consumption across Pune as well as our state rose at an alarming rate.

Due to the decrease in energy demand, share of renewables, mainly solar have increased sharply leading people to use and harness solar energy. Domestic energy consumption can decrease by approximate 500 units per house per month.

## INTRODUCTION –

COVID-19, definitely a bigger word than assumed at the first. On March 11, 2020 the WHO declared that COVID-19 was a global pandemic indicating significant global spread of an infectious disease. Apart from infected human leading to dead bodies there have also been multiple things and on-going to think upon, which brings us to our topic of how COVID affect consumption of electricity. The demand of electricity has been reduced significantly due to the recent COVID-19 pandemic. Government around the world was compelled to reduce the business activity in response to minimize threat of corona virus.

Hence, there is a significant increase in residential load demand while there is a substantial decrease in commercial and industrial loads.

COVID-19 pandemic has caused direct or indirect effects on every industry. It has brought the world to a standstill and has impacted our lives deeply. Solar energy sector has been highly affected in these unprecedented times. With the prevailing uncertainties in the industry, the solar energy sector is trying to bounce back in business to achieve the renewable energy target of 100 GW by 2022 set by the Government. Solar rooftop sector has been badly affected because of two reasons: one is its labour cost and other one is its dependence on the country's commercial and industrial sectors.

These things and concern lead us to a deeper level of interrogation on our topic , which we would see as follows-

## METHODOLOGY AND TECHNIQUES USED

- Arithmetic Mean :



### Arithmetic Mean Formula

$$\text{Arithmetic Mean} = \sum \frac{X_i}{n}$$



$$\text{Arithmetic Mean} = \sum \frac{(f_i * X_i)}{f_i}$$



- Standard Deviation :

### Sample Standard Deviation Formula



$$\sigma = \sqrt{\frac{\sum_i^n (X_i - \bar{X})^2}{n - 1}}$$



- Coefficient of Variation :



$$\text{Coefficient of Variation Formula} = \frac{\text{Standard Deviation}}{\text{Mean}}$$



## Electricity consumption Household during the COVID-19 lockdown

### Important details

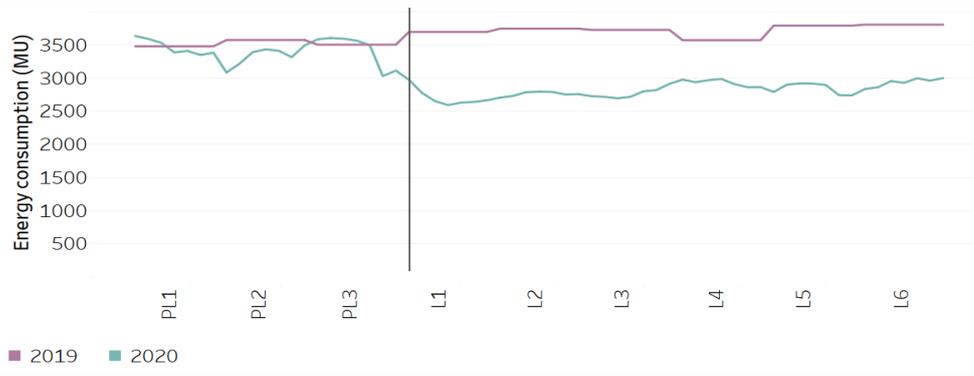
In the lockdown period, the daily average electricity consumption of all sample households was 26% higher than in the pre-lockdown period.

- Households with AC in Pune city and Pune district saw an increase of about 45-60%
- In Pune, the number of households without air conditioning increased by 22%. Pune had a 3-4 degree Celsius cooler maximum temperature than the rest of the state.
- In all districts, average daily outage hours were 10-18% lower during the lockdown period compared to the pre-lockdown period, with the exception of Pune, where they were 8% higher.

To date, the lockdown has been extended a few times with incremental relief. Because of the decrease in commercial and industrial activity, it had a substantial effect on electricity demand. As compared to the previous week's high, electricity consumption in India fell by 22% in the first week of the lockdown. Daily electricity consumption was 25-30% lower during the initial lockdown phase.

**The residential electricity consumption, on the other hand, is expected to have increased during the lockdown as people spent more time at home.**

### Daily all India electricity consumption



#: PL1 to PL3 are pre-lockdown weeks 1 to 3 and L1 to L6 are lockdown weeks 1 to 6.

Source: **National Load Dispatch Centre**

We analysed the minute-wise load and voltage data of 81 households participating in our eMARC initiative to examine the impact of the lockdown on their electricity consumption and electricity supply.

Our analysis period is from 4th March, 2020 to 5th May, 2020. The distribution of the households considered for the analysis.

Table 1: Distribution of eMARC locations considered for the analysis.

| Location      | No. of households |
|---------------|-------------------|
| Pune city     | 28                |
| Pune district | 17                |

Table 2: Period of Analysis

|                          |         |                                    |
|--------------------------|---------|------------------------------------|
| Pre-lockdown period (PL) | 3 weeks | 4th March, 2020 – 24th March, 2020 |
| Lockdown period (L)      | 6 weeks | 25th March, 2020 – 5th May, 2020   |

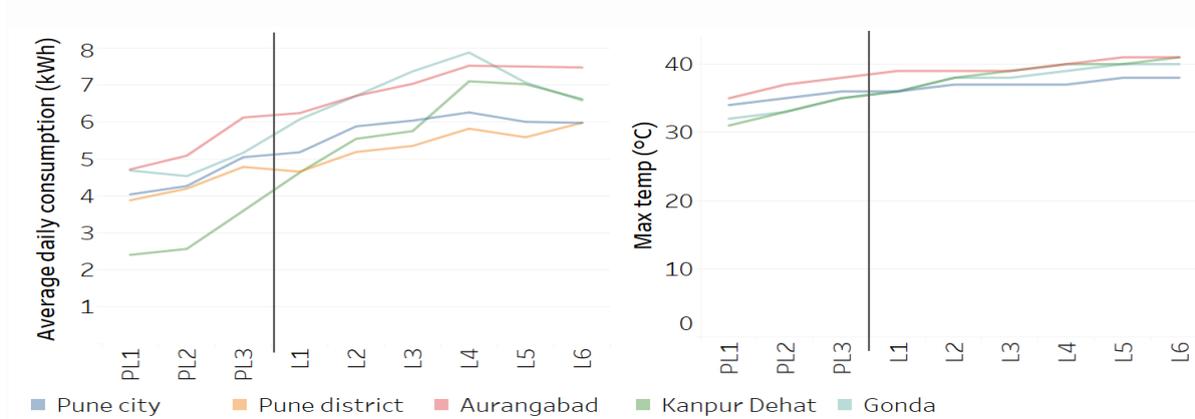
## Average daily electricity consumption increased in EMARC households during the lockdown

All of the sample households' electricity consumption increased (see Figure 2), with the daily average for the sample during the lockdown time being 26% higher than the daily average before the lockdown.. This increase can be attributed to two factors:

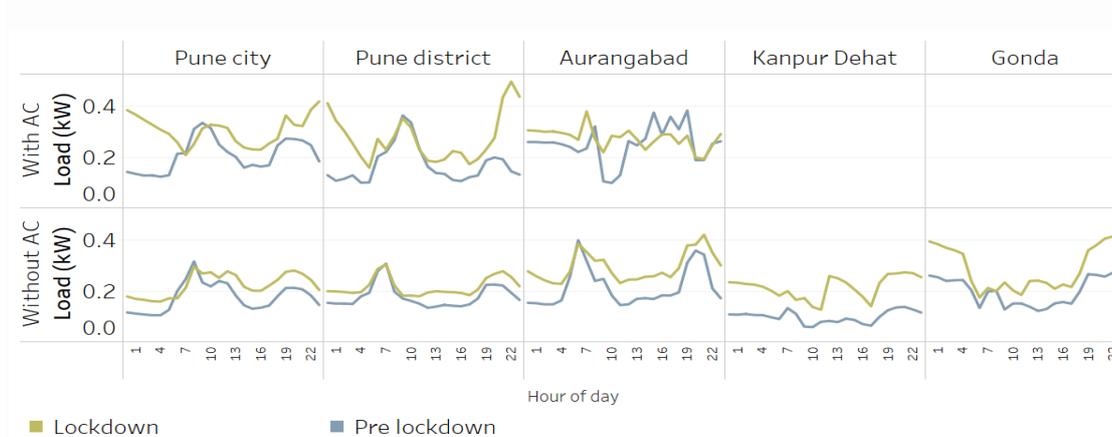
- 1 increase in summer temperatures
- 2 people spending more time at home during lockdown.

The actual magnitude of the increment varies with region and ownership of air-conditioners (AC). Households with AC in Pune district and Pune city experienced an increase of about 45-60% in their average daily electricity consumption in the lockdown period as compared to the pre-lockdown period.

### Average daily electricity consumption of eMARC households



### Average daily hourly load curves of eMARC households



On average we find that every month of full lockdown reduced demand by 20% on average, or over 1.5% on an annual basis.

Demand reductions have lifted the share of renewables in electricity supply, as their output is largely unaffected by demand.

Homeowners can save approximately 600 units of electricity monthly that can reduce their electricity bills by around ₹5,500 (~\$75.2) with the installation of a 5 kW rooftop solar system in their homes,

Here is the breakdown of numbers for a 5 kW rooftop solar system. Assuming that a 1 kW system would generate 4 units (kWh) per day on an average, a 5 kW system would generate about 20 kWh/day or 600 units per month

If your electricity bills are generally around ₹3,000(\$40.33)/month, your power bills will be zero by installing a 5 kW rooftop solar system. And if your monthly bill is about ₹7,000 (\$94.12)/month, then with the system installed, your bills will be reduced to just ₹4,000 (\$53.78)/month.

Net Metering is vital if you have to sell excess electricity to the grid and get paid for it in return. A net metering connection is not easy to get, and availability.

| Financial Benefits From a 5kW Rooftop Project   |                      | MERCOM<br>INDIA RESEARCH |  |
|---|----------------------|--------------------------|--|
| Scenarios   | Units of Electricity | Cost of Electricity      |  |
|   | (kWh)* /Month        | ₹/Month                  |  |
| <b>Case -1 - Customer Paying ₹1,500/month</b>   |                      |                          |  |
| Monthly Consumption Assumption  | 273                  | 1,500                    |  |
| 5 kW** Rooftop Installation Generation Potential  | 600                  | 3,300                    |  |
| Power Customer Can Sell Through Net metering  | -327                 | -1,800                   |  |
| <b>Case -2 - Customer Paying ₹3,000/month</b>   |                      |                          |  |
| Monthly Consumption Assumption  | 545                  | 3,000                    |  |
| 5 kW Rooftop Installation Generation Potential  | 600                  | 3,300                    |  |
| Total Bill Assuming Net Metering is Available   |                      | -300                     |  |
| <b>Case -3- Customer Paying ₹7,000/month</b>  |                      |                          |  |
| Monthly Consumption Assumption  | 1273                 | 7,000                    |  |
| 5 kW Rooftop Installation Generation Potential  | 600                  | 3,300                    |  |
| Total Bill Assuming Net Metering is Available   | 673                  | 3,700                    |  |
| <i>Note:</i>  |                      |                          |  |
| * The ₹/kwh varies depending on DISCOMs. For this example, we considered an average Rate of ₹5.5/kWh                        |                      |                          |  |
| ** A 5 kW solar system needs approximately 500 sq ft of shade-free roof   |                      |                          |  |
| Power connection to the building meter - 6 KW ( since most of the states allow only 80% of the demand connected to a house) |                      |                          |  |
| Source: Mercom India Research   |                      |                          |  |

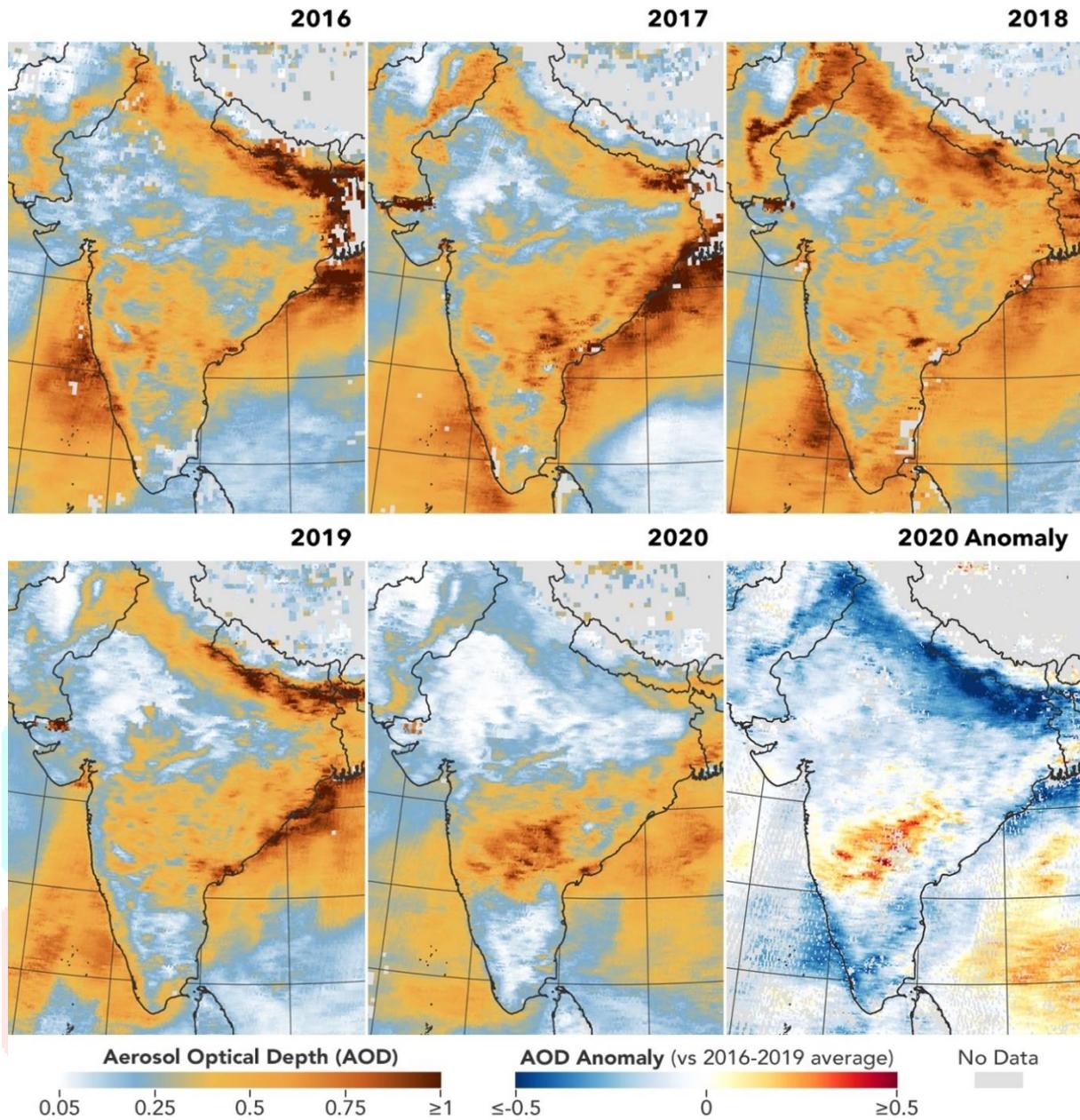
## India's power consumption falls by 19 percent during COVID-19 lockdown

On April 21, the National Aeronautics and Space Administration (NASA) also released an [image](#), according to which its satellite sensors observed aerosol levels at a 20-year low for this time of year in northern India after just a week of reduced human activities.

According to a [data tracker](#) developed by the [Energy Policy Institute at the University of Chicago](#), India's electricity consumption has fallen by 18.72 percent (till April 3, 2020) due to the lockdown. Similarly, as per the [data](#) compiled by the Centre for Research on Energy and Clean Air (CREA), an independent research organisation working on clean air and clean energy, there has been a clear reduction of consumption of petroleum products and coal by industries in regions within and around cities.

The report compared power generation in India during the two weeks before March 24 (the day the lockdown was announced) and two weeks after and found a 19 percent overall reduction in power generation in India. Coal-based power generation in particular reduced by 26 percent during the same

period, said the CREA



report.

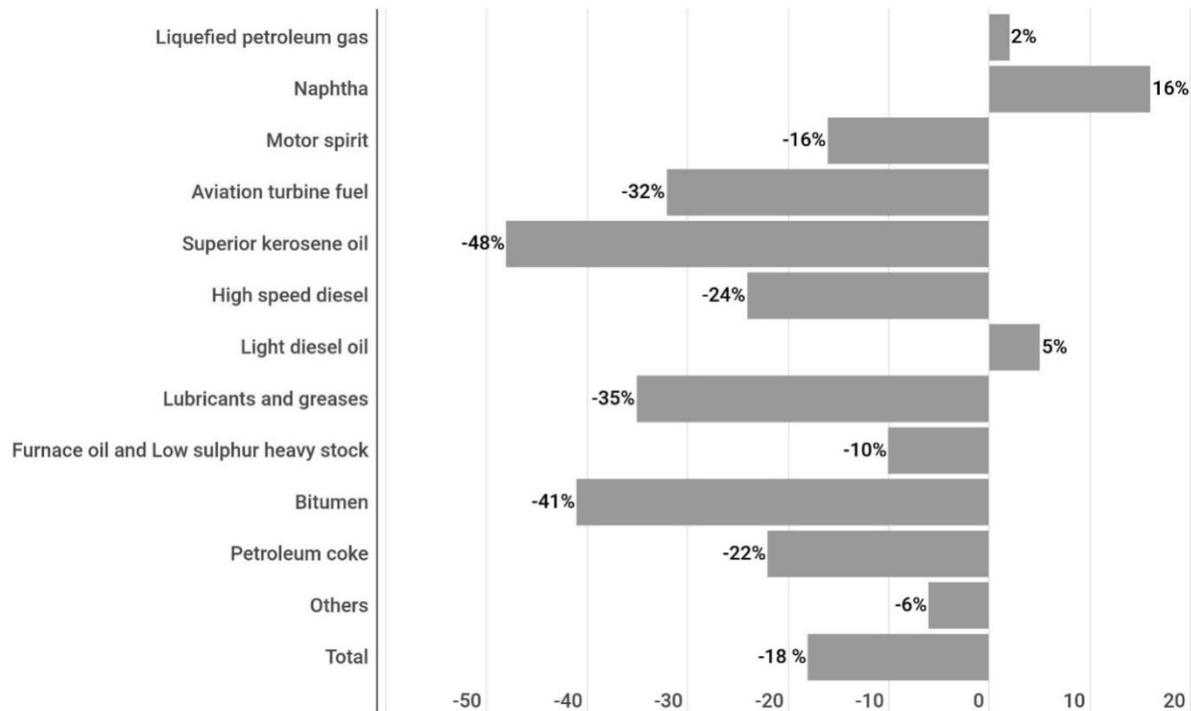
During the lockdown, northern India has recorded aerosol levels at a 20-year low. Photo by NASA Earth Observatory.

On March 24, Prime Minister Narendra Modi had announced a three-week nationwide lockdown starting from March 25 which, on April 14, was extended till May 3.

According to the CREA report, there has been a reduction in the consumption of diesel/petrol and other petroleum products in the transportation sector within cities. Consumption of diesel decreased by 24 percent in March 2020 compared to March 2019, with most of the fall post the lockdown. "Overall consumption of petroleum products in India decreased by 18 percent during the same period."

During the lockdown period, no city entered the very poor category. Among the cities in poor category during the lockdown period, instances of Singrauli and Brajrajnagar are found frequently. It is worth noting that Singrauli is home to several power plants, which are operational during the lockdown period and

Brajrajnagar has in its vicinity numerous open-cast and underground coal mines,” explained the CPCB



Petroleum Products

Change in consumption in March 2020 vs March 2019

report.

**Coronavirus: India's March electricity usage falls 9.2% amid lockdown**

**Coronavirus: That was India's fastest pace of decline in consumption since October, when power use fell at its steepest in over 12 years due to a broad economic slowdown**

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