Does Covid-19 Impact Photovoltaics?

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***Abstract*— To stop COVID-19 from spreading, on March 19th 2020 a curfew was announced in India, followed by a lockdown on March 24th. The sudden halt of business- and public life in Delhi has resulted in a notable reduction in air pollution levels and have caused clearer skies. Images released end of March in newspapers and on the internet show just how big the difference is: blue skies are visible where there is typically thick grey smog. The change in visibility also affects the amount of sunlight reaching the ground. Using methods developed in house, we explore how much insolation has changed as a consequence. In late March 2020, we found that more than 8% more sunlight reached the ground in Delhi than in previous years. In terms of PV energy yield this change is comparable to moving a PV installation from Toronto to Houston.**

Keywords—COVID-19, Solar Resource, air pollution

I. Introduction

By the end of March 2020, images appeared in newspapers and on the internet that showed unusual motives: blue skies were visible in Delhi, where there is usually a thick, grey smog. The changes were caused by a curfew and a lockdown that in quick succession were enacted on March 22nd and March 24th by prime minister Modi. In previous studies, we had discussed the impact of haze [1, 2] and air pollution [3] on energy yield and performance of PV systems. We were also able to formulate quantitative relations between small particle matter (PM2.5) concentrations and insolation in Delhi and Singapore. Based on these studies, we expected that clearer skies in Delhi would coincide with higher levels of ground insolation and PV performance. In this contribution, we present and discuss our preliminary findings.

II. Air Pollution in Delhi

For this study, we used air pollution data measured at the US embassy once every hour [13]. To explore whether levels in 2020 were unusual, we calculated the PM2.5 particle concentrations anomaly by:

$$\Delta PM2.5(t) = \frac{PM2.5_{2020}(t)}{\sum_n \frac{PM2.5_y(t)}{N}}$$

i.e. we divided each value for 2020 by the average of previous years (2017 to 2019). The result of this procedure is shown in figure 1, additionally smoothed by a moving average over one week.

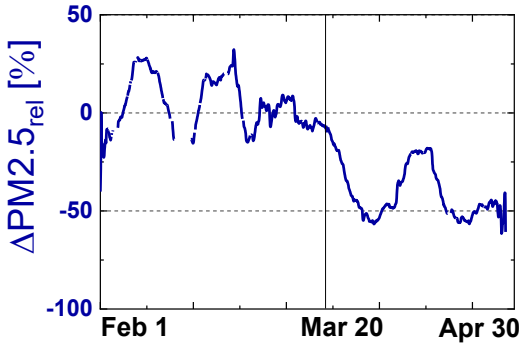

Fig. 1. *PM2.5 concentration anomaly in Delhi between Feb. 1st and April 30th.*

III. Clear Sky Insolation Before and After Lockdown

Similar as shown in [6], we reconstructed clear sky irradiance in early March, before and in late March, after the lockdown was initiated. The results of this calculation is shown in figure 2. We have summarized 2020 clear sky insolation in red, and the average of the years 2017 to 2019 in blue. In late March, we observe insolation levels that are notably higher than in previous years, yet we see no such difference in early March.

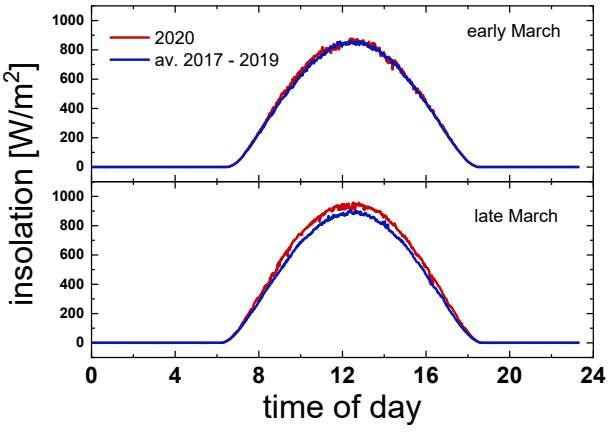

Fig. 2. *Reconstrudtced clear sky insolation in early March (above) and late March (below) for the years 2020 (red) and the average of the years 2017 to 2019 (blue). In late March, a clear difference between 2020 and previous years can be observed.*

IV. Summary & Conclusions

Following measures to counter the spread of COVID-19, news about clear skies started to emerge. We wanted to explore, whether reductions in pollution levels could have an impact on solar energy generation. For this purpose, we explored how clear sky insolation before and after lockdown in Delhi compared, and found indications that insolation in 2020 was indeed significantly higher than in previous years. We found an insolation anomaly in late March of 8.3%, which far exceeds typical fluctuations within a typical year, and cannot be explained by statistical variation. We conclude that COVID-19 has an effect on the performance of PV systems and that higher than usual insolation and PV performance can be expected anywhere, where air pollution levels dropped.

Delhi is a special case. Because air pollution levels typically are very high, reductions in air pollution have stronger and more immediate consequences than elsewhere. Effects in other locations may be smaller, but we expect them to be noticeable and that more reports about unusual performances of PV systems will appear over time.

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Information about the Air Quality data measured by the U.S. Embassy and Consulates in India is provided here: https://www.airnow.gov/international/us-embassies-and-consulates/

