

COVID-19 shutdown led to increased solar power output

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As the COVID-19 shutdowns and stay-at-home orders brought much of the world's travel and commerce to a standstill, people around the world started noticing clearer skies as a result of lower levels of air pollution.

Now, researchers have been able to demonstrate that those clearer skies had a measurable impact on the output from solar photovoltaic panels, leading to a more than 8 percent increase in the power output from installations in Delhi.

While such an improved output was not unexpected, the researchers say this is the first study to demonstrate and quantify the impact of the reduced air [pollution](#) on solar output. The effect should apply to solar installations worldwide, but would normally be very difficult to measure against a background of natural variations in solar panel output caused by everything from clouds to dust on the panels. The extraordinary conditions triggered by the pandemic, with its sudden cessation of normal activities, combined with high-quality air-pollution data from one of the world's smoggiest cities, afforded the opportunity to harness data from an unprecedented, unplanned natural experiment.

The findings are reported in the journal *Joule*, in a paper by MIT professor of mechanical engineering Tonio Buonassisi, research scientist Ian Marius Peters, and three others in Singapore and Germany.

The study was an extension of previous research the team has been conducting in Delhi for several years. The impetus for the work came after an unusual weather pattern in 2013 swept a concentrated plume of smoke from forest fires in Indonesia across a vast swath of Indonesia, Malaysia, and Singapore, where Peters, who had just arrived in the region, found "it was so bad that you couldn't see the buildings on the other side of the street."

Since he was already doing research on solar photovoltaics, Peters decided to investigate what effects the air pollution was having on solar panel output. The team had good long-term data on both solar panel output and solar insolation, gathered at the same time by monitoring stations set up adjacent to the solar installations. They saw that during

the 18-day-long haze event, the performance of some types of solar panels decreased, while others stayed the same or increased slightly. That distinction proved useful in teasing apart the effects of pollution from other variables that could be at play, such as weather conditions.

Peters later learned that a high-quality, years-long record of actual measurements of fine particulate air pollution (particles less than 2.5 micrometers in size) had been collected every hour, year after year, at the U.S. Embassy in Delhi. That provided the necessary baseline for determining the actual effects of pollution on solar panel output; the researchers compared the air pollution data from the embassy with meteorological data on cloudiness and the solar irradiation data from the sensors.

They identified a roughly 10 percent overall reduction in output from the solar installations in Delhi because of pollution—enough to make a significant dent in the facilities' financial projections.

To see how the COVID-19 shutdowns had affected the situation, they were able to use the mathematical tools they had developed, along with the embassy's ongoing data collection, to see the impact of reductions in travel and factory operations. They compared the data from before and after India went into mandatory lockdown on March 24, and also compared this with data from the previous three years.

Pollution levels were down by about 50 percent after the shutdown, they found. As a result, the total output from the solar panels was increased by 8.3 percent in late March, and by 5.9 percent in April, they calculated.

"These deviations are much larger than the typical variations we have" within a year or from year to year, Peters says—three to four times greater. "So we can't explain this with just fluctuations." The amount of

difference, he says, is roughly the difference between the expected performance of a solar panel in Houston versus one in Toronto.

An 8 percent increase in output might not sound like much, Buonassisi says, but "the margins of profit are very small for these businesses." If a solar company was expecting to get a 2 percent profit margin out of their expected 100 percent panel output, and suddenly they are getting 108 percent output, that means their margin has increased fivefold, from 2 percent to 10 percent, he points out.

The findings provide real data on what can happen in the future as emissions are reduced globally, he says. "This is the first real quantitative evaluation where you almost have a switch that you can turn on and off for air pollution, and you can see the effect," he says. "You have an opportunity to baseline these models with and without air pollution."

By doing so, he says, "it gives a glimpse into a world with significantly less air pollution." It also demonstrates that the very act of increasing the usage of solar electricity, and thus displacing fossil-fuel generation that produces air pollution, makes those panels more efficient all the time.

Putting solar panels on one's house, he says, "is helping not only yourself, not only putting money in your pocket, but it's also helping everybody else out there who already has solar panels installed, as well as everyone else who will install them over the next 20 years." In a way, a rising tide of solar panels raises all solar panels.

Though the focus was on Delhi, because the effects there are so strong and easy to detect, this effect "is true anywhere where you have some kind of air pollution. If you reduce it, it will have beneficial consequences for solar panels," Peters says.

Even so, not every claim of such effects is necessarily real, he says, and

the details do matter. For example, clearer skies were also noted across much of Europe as a result of the shutdowns, and some news reports described exceptional output levels from solar farms in Germany and in the U.K. But the researchers say that just turned out to be a coincidence.

"The air pollution levels in Germany and Great Britain are generally so low that most PV installations are not significantly affected by them," Peters says. After checking the data, what contributed most to those high levels of [solar output](#) this spring, he says, turned out to be just "extremely nice weather," which produced record numbers of sunlight hours.

More information: Ian Marius Peters et al. The Impact of COVID-19-Related Measures on the Solar Resource in Areas with High Levels of Air Pollution, *Joule* (2020).

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