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## Impacts of Air Pollutant Emissions on Solar Energy Generation

Fei Yao<sup>1,2</sup>, Paul Palmer<sup>1,2</sup>, Jianzheng Liu<sup>3</sup>, Hongwen Chen<sup>4</sup>, and Yuan Wang<sup>5,6</sup>

<sup>1</sup>National Centre for Earth Observation, University of Edinburgh, Edinburgh, UK

<sup>2</sup>School of GeoSciences, University of Edinburgh, Edinburgh, UK

<sup>3</sup>School of Public Affairs, Xiamen University, Xiamen, China

<sup>4</sup>School of Tourism, Nanchang University, Nanchang, China

<sup>5</sup>Department of Architecture, National University of Singapore, Singapore

<sup>6</sup>Asian School of the Environment and Earth Observatory of Singapore, Nanyang Technological University, Singapore

Particulate matter (PM) in the atmosphere and deposited on solar photovoltaic (PV) panels reduce PV energy generation. Reducing anthropogenic PM sources will therefore increase carbon-free energy generation. However, we lack a global understanding of the sectors that would be the most effective at achieving the necessary reductions in PM sources. We combine well-evaluated models of solar PV performance and atmospheric composition to show that deep cuts in air pollutant emissions from the residential sector substantially benefit Asian PV power output. Specifically, halving residential emissions of PM would lead to an additional 10.3 TWh yr<sup>-1</sup> and 2.5 TWh yr<sup>-1</sup> of PV energy generation in China and India in 2020, respectively. Compared to the 2020 electricity generation of 261.6 TWh yr<sup>-1</sup> and 54.4 TWh yr<sup>-1</sup> from solar PV technology in China and India, respectively, these unrealised sources of energy generation represent an improvement of approximately 4-5%. While anthropogenic PM sources originate mainly from producers, they are responding to changes in domestic and international consumer demand. This raises a critical question about the extent to which consumers, who benefit from the emission process, should be responsible for the resulting unrealised, cleaner PV energy generation. Focusing on Northeast Asia (NEA), we investigate the source-receptor relationship of PV energy losses attributable to PM pollution among China, South Korea, and Japan by incorporating a new input-output model into the combined models of solar PV performance and atmospheric composition. Our findings reveal that the solar energy generation losses attributable to PM pollution in NEA caused by emissions produced in China surpass those linked to China's consumption that stimulates emissions in China and elsewhere, with the disparity amounting to 9.3 TWh yr<sup>-1</sup>. Conversely, a reverse pattern is observed for solar energy generation losses linked to emissions produced versus induced by consumption in South Korea and Japan, where the disparities are found to be -0.023 TWh yr<sup>-1</sup> and -0.231 TWh yr<sup>-1</sup>, respectively. In other words, when we consider international trade across NEA, we find there is diminished (augmented) responsibility for China (South Korea and Japan) in explaining PV-related energy losses attributable to PM pollution.