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Integrated Science Assessment for Fine Particulate Matter ($PM_{2.5}$)

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Good morning, and thank you for the opportunity to provide comments today. I am Coco Liu, an environmental epidemiologist, and am speaking on behalf of the Electric Power Research Institute. The purpose of my testimony today is to bring to the Committee's attention two issues in air pollution epidemiology, one of which is drawn from the written comments on the PM ISA that EPRI submitted to the docket on December 10th.

First, current epidemiological studies estimate the *association* between ambient PM and human health. However, association is not causation. Characterizing the *causal* effect of PM on human health is critical for informing policy-making on ambient PM. Air pollution has unique characteristics that make causal studies challenging; for example, air pollution cannot be randomized, and it is a time- and space-varying exposure. To estimate the causal effects of air pollution on human health in an epidemiological setting, innovative causal study design and statistical approaches are needed. Development and application of causal methods in this area is a relatively young field that warrants more effort. To explore the use of causal inference methods suitable for air pollution epidemiology, EPRI, along with a number of other organizations, helped to support a symposium on this topic in October 2018. The symposium aimed to create innovative causal methods and advance the understanding of the causal effects of ambient PM on human health in an epidemiological setting. The symposium had three take-home messages. First, there is a critical need for robust, focused causal research in the field of air pollution epidemiology. Second, we need to use caution when categorizing studies as causal; developing a framework of causal methods for air pollution epidemiology may help in this regard. Finally, while traditional association-based epidemiological studies are important, to increase confidence in results and gain additional insight these studies should be considered together with causal studies.

The second issue I would like to comment on is the potential presence of unmeasured confounding in long-term air pollution epidemiology studies, despite the fact that most studies strive to control for potential confounders. In the past several years, EPRI has been supporting a number of studies that have applied a method developed by Greven and colleagues to diagnose the presence of unmeasured confounding. This method decomposes PM association estimates into a "global" estimate that reflects the association between national trends in PM and mortality, and a "local" estimate that measures the location-specific trends adjusted for the national trends. Results from the EPRI-supported body of work suggest that unmeasured confounding may be present in long-term studies of PM, ozone, and NO_2; additional research in this area is critical to ensure that effect estimates are unbiased. Furthermore, in separate analyses that controlled for time using three different methods, mortality risk estimates for PM were reduced by about 50%, suggesting that temporal confounding is extremely important in long-term air pollution epidemiology studies and should be controlled for in future studies.