Global Response GR-2

Photovoltaic Heat Island Effects

A number of commenters stated the Proposed Project's photovoltaic (PV) panels would create a photovoltaic "heat island" effect that would raise ambient air temperatures. The photovoltaic heat island effect is similar to the "urban heat island" effect which occurs when cities replace natural land cover with dense concentrations of pavement, buildings, and other surfaces that absorb or retain heat and contribute to higher temperatures as compared to undeveloped areas.

The normal operating temperature for PV panels is approximately 20 degrees Celsius (°C) [1] above ambient temperature; therefore, on a typical summer day at 40°C (104 degrees Fahrenheit (°F)), the panel temperature would be approximately 60°C (140°F). When accounting for irradiance (a measure of solar radiation energy received on a given surface area in a given time), wind, and PV panel type, it is expected that the peak PV panel temperatures in the summer would be between 65°C and 70°C (149°F and 158°F), and the peak PV panel temperatures in the winter would be between 35°C and 40°C (95°F and 104°F). Although the PV panels would be hot to the touch as a result of solar energy absorption, the PV panels are designed to absorb light energy to produce electricity.

A study has shown that the annual average of air temperatures in the center of a PV project can reach up to 1.9°C (approximately 3.5°F) above the ambient temperature measured at 2.5 meters above ground surface (about 8 feet), and that this thermal energy completely dissipates to the environment at heights of 5 to 18 meters (16 – 60 feet) above ground surface. The study also found temperatures approaching (within 0.3°C) the ambient at about 300 meters (984 feet) away from the perimeter of the solar facility. Further, the study found that temperature differences between the modules and the surrounding air vary throughout the year, but the module temperatures are consistently higher than those of the surrounding air during the day (e.g., at the roads between panel arrays), cool to temperatures below ambient at night, and would not induce a day-after-day increase in ambient temperature. (See Fthenakis and Yu, Columbia University, "Analysis of Potential for a Heat Island Effect in Large Solar Farms" (2013) ("Columbia PV Heat Island Study"). The Columbia PV Heat Island Study concludes: "analysis of 18 months of detailed data showed that in most days, the solar array was completely cooled at night, and, thus, it is unlikely that a heat island effect could occur . . . access roads between solar fields allow for substantial

[1] The formula to convert Celsius to Fahrenheit is (X°C *9/5) + 32 = Y°F, where X = the temperature in Celsius, and Y = the temperature in Fahrenheit. One degree Celsius is approximately 1.8 degrees Fahrenheit.

cooling, and therefore, increase of the size of the solar farm may not affect the temperature of the surroundings."

The study discussed above is available at: http://www.clca.columbia.edu/13_39th%20IEEE%20PVSC_%20VMF_YY_Heat%20Island%20Effect.pdf (last visited Jan. 13, 2021).)

One commenter cites to a study by researchers from the University of Arizona and University of Madison-Wisconsin that sought to evaluate whether there is a heat island effect from a PV solar project. (Scientific Reports, "The Photovoltaic Heat Island Effect: Large Solar Power Plants Increase Local Temperatures" (October 2016) ("PV Heat Island Study"), available at https://www.nature.com/articles/srep35070 (last visited Jan. 7, 2021).) The PV Heat Island Study measured air temperatures underneath solar panels (2.5 meters, or about 8 feet) over unvegetated ground and compared those temperatures to an undisturbed desert environment and a parking lot located close by. The study found that air temperatures under the panels exceeded the air temperature above both the parking lot and desert environment, with the greatest difference occurring at night. Average annual temperature was 22.7 + 0.5 °C within the solar facility, while the nearby desert ecosystem was only 20.3 + 0.5 °C, indicating a photovoltaic heat island effect. Temperature differences between areas varied significantly depending on time of day and month of the year, but the solar facility was always greater than or equal in temperature to the other sites analyzed in the study . The photovoltaic heat island effect delayed the cooling of ambient temperatures in the evening, with the most significant difference in overnight temperatures across all seasons. Annual average midnight temperatures were 19.3 + 0.6 °C in the PV installation, while the nearby desert ecosystem was only 15.8 + 0.6 °C. This effect was more significant in terms of actual degrees of warming (+ 3.5 °C) in warm months.

The Proposed Project differs from the solar project analyzed in the PV Heat Island Study in that the solar facility will be revegetated after the completion of construction. The PV Heat Island Study posits that the solar panel heating effect could be reduced through targeted revegetation under the solar panels, which would reduce heat island effects through the heat-dissipating effect of transpiration from vegetation. A study conducted at the National Renewable Energy Laboratory's National Wind Technology Center resulted in successful establishment of revegetation beneath solar panel. (See Beatty, B. J. Macknick, J. McCall, G. Braus, and D. Buckner "Native Vegetation Performance under a Solar PV Array at the National Wind Technology Center" (May 2017) available at www.nrel.gov/publications.) In addition, the PV Heat Island Study found that the biggest difference between the desert air temperatures and air temperatures under the solar panels was at night. Unlike the Columbia PV Heat Island Study, the PV Heat Island Study did not attempt to measure whether the solar facility raised ambient temperatures at a distance from the solar facility.

The two studies discussed above found air temperatures within solar facilities were greater than the ambient temperature at a height of 2.5 meters (about 8 feet) between 1.9°C to 2.4°C (approximately 3.4 to 4.2°F), although they differed in whether there was a heating effect that persisted overnight. Further, the PV Heat Island Study did not calculate how far off-site the photovoltaic heat island effect persisted, while the Columbia PV Heat Island Study found dissipation of thermal energy with distance from the solar facility, with the air temperatures approaching (within 0.3°C) the ambient at about 300 meters (984 feet) away from the perimeter of the solar facility.

Given that there are no significance thresholds for the photovoltaic heat island effect and given the limited number of studies regarding this effect, there is no evidence any possible increase in ambient temperature from the Proposed Project would significantly impact human health or the environment.

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