Solar Panel Shade and Potential Health Impacts

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Farmworkers are a particularly vulnerable population for heat-related illnesses because they perform manual labor outdoors, in direct sunlight, often in heavy, impermeable work clothing, during the hottest season (Association of Farmworker Opportunity Programs, 2024; El Khayat et al., 2022; EPA, 1983; Bethel and Harger, 2014). The trend of increasing temperatures globally will lead to an increase in heat-related deaths, heat stroke, and dehydration, as well as cardiovascular, respiratory, and cerebrovascular disease, particularly in sensitive populations (USGCRP, 2016). The United Federation of Farm Workers has called for workplace protection because farmworkers "are at the frontlines of climate change as extreme heat continues to expose them to more danger" (UFW, 2023). The workplace mortality rate for farmworkers from heat-related illness is 20 times higher than the U.S. civilian working population and this trend is increasing, as shown in Figure 1. A separate study by the National Institute of Health showed agricultural workers suffered heat-related mortality at a rate 35 times higher than all industries in the United States during the 10-year period of 2000 to 2010 (Gubernot et al., 2015).

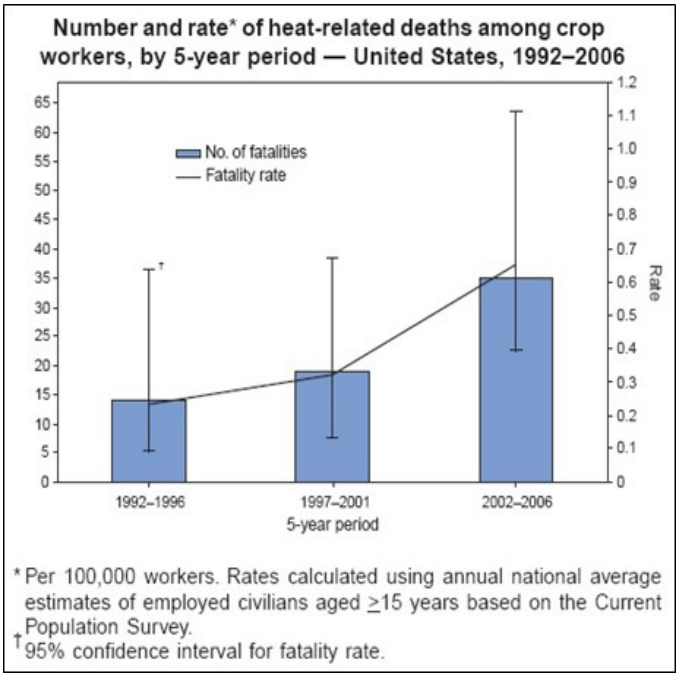
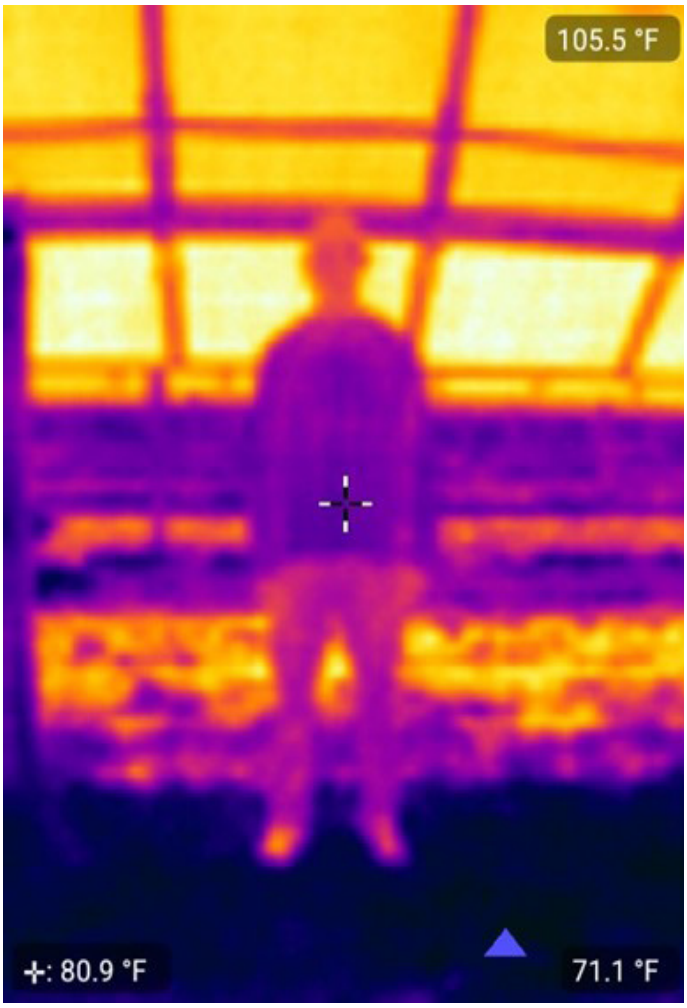


Figure 1. Mortality Rate of Heat-Related Deaths Among U.S. Crop Workers (CDC, 2008)



Thermal image of farm worker under solar panel, showing external body temperature of 80.9°F with outdoor temperature of 90°F. Photo: NCAT

Sheep grazing in the shade of solar panels. Photo: NCAT

In addition to mortality, many farmworkers experience heat-related illnesses such as heat exhaustion, heat stress, heat stroke, cramps, and rashes (Association of Farmworker Opportunity Programs, 2024). Several strategies can successfully alleviate heat stress and mortality. A consistent recommendation is providing farmworkers with access to shade (OSHA, 2023; EPA, 2023). However, farmworkers do not always have consistent access to shade (El Khayat, 2022). Solar arrays could provide this consistent shade, if designed to accommodate farmworkers, with a panel heigh of 6 to 8 feet.

Heat stress also affects farm animal health. In a study of the thermal comfort and wellbeing experienced by dairy heifers provided solar panel shade, researchers showed that shade provided by the solar panels efficiently relieved heat load on the cattle, cooled off their body surface and skin temperatures by 10.8°F, and decreased the costs of thermoregulation (Faria et al., 2023). A study of heat stress, solar panels, and dairy cattle in Minnesota found a decrease in heat stress in dairy cattle under solar panel shade, corresponding to a decrease in body temperature (Sharpeet al., 2020).

A separate study on heat stress and sheep with access to solar panel shade found a decrease in wool-surface temperature in ewes ranging from 44.6°F to 46.4°F and a decrease in skin temperature of 33.8°F to 34.7°F (Fonsêca et al., 2023).

POTENTIAL SOLAR SHADE HEALTH IMPACTS

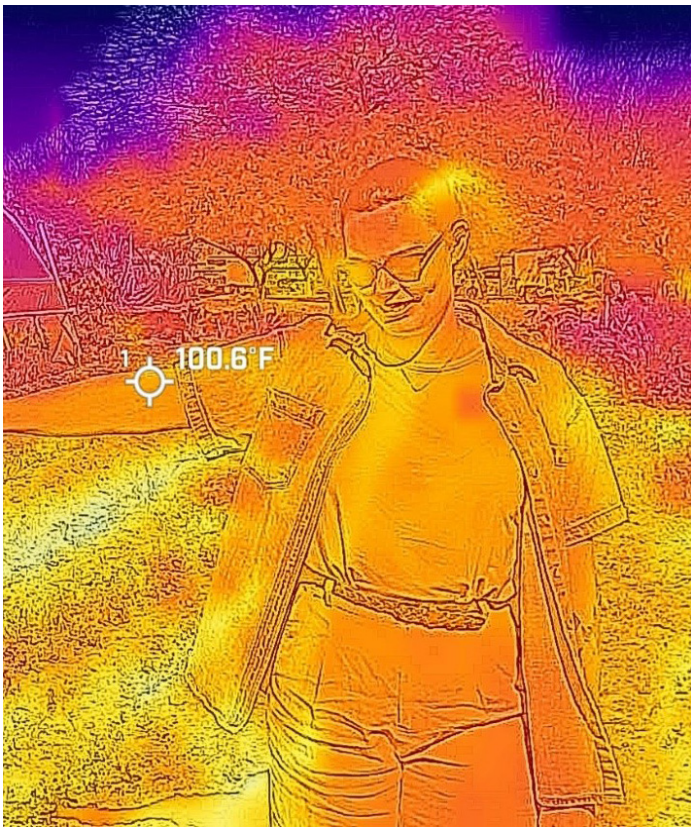
While touring agrisolar sites, the AgriSolar Clearinghouse team performed skin temperature readings under solar panels and in full sun. Table 1 shows the consistent decrease in skin temperature throughout the country, ranging from 7.8°F to 20.8°F, and the subsequent photos show infrared reading and skin temperature of a

Agrisolar Location	Full Sun Skin Temperature (Fahrenheit)	Solar Shade Skin Temperature (Fahrenheit)	Skin Temperature Decrease (Fahrenheit)
Lake Pulaski, Minnesota	100.5	80.6	19.9
Monson, Massachusetts	101.3	93.5	7.8
Boulder, Colorado	90.7	75.4	15.3
Butte, Montana	101.2	81.8	19.4
Phoenix, Arizona	100.6	79.8	20.8
Champaign, Illinois	102.5	94.1	8.4

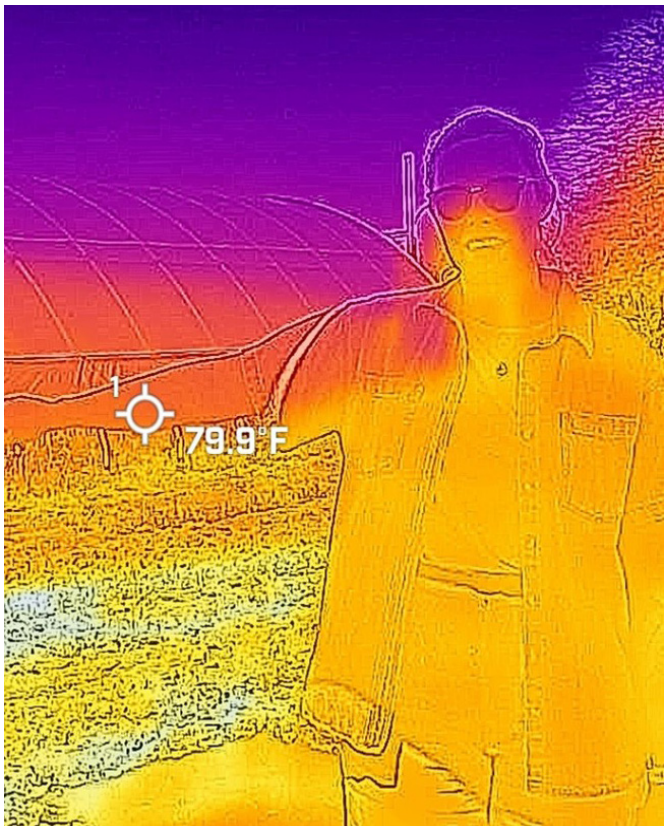
Table 1. Skin Temperature Readings in Full Sun and Under Solar Panels.

farm worker in Phoenix, Arizona.

Based on skin temperature tests and animal testing at solar arrays, there is a potential for solar panels to provide shade to farmworkers and help alleviate heat stress. While other farmworker safety measures can and should be incorporated, such as water, rest, and acclimatization, a decrease of 10°F to 20°F could potentially alleviate heat-related illnesses and curb heat-related mortality. Additionally, timing agricultural work to coincide with the full shade of the solar panel and designing panel heights to accommodate farmworkers and animals, meaning a panel height of 6 to 8 feet, would ensure consistent access to the shade and its benefits.



Skin temperature of 100.6°F in direct sunlight in Phoenix, Arizona.



Skin temperature of 79.9°F in the shade of a solar panel in Phoenix, Arizona.

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This material is based upon work supported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) under the Solar Energy Technologies Office Award Number DE-EE0009372.