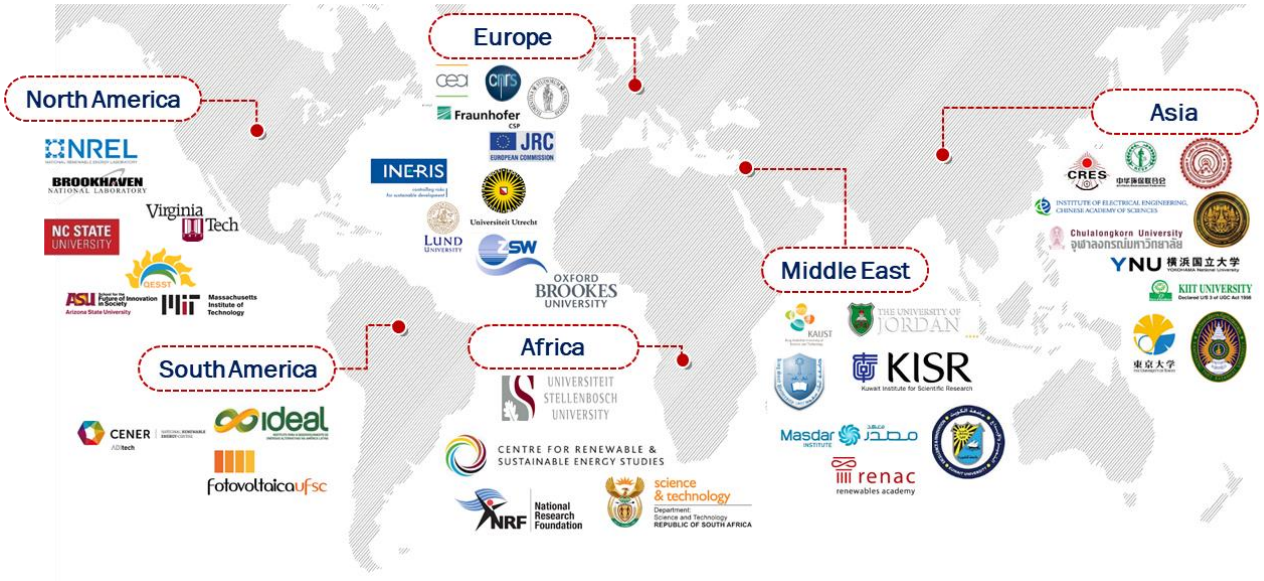
Summary of Environmental Health and Safety Studies of CdTe Solar

First Solar has a 20+ year history of safely manufacturing and supplying CdTe PV solar panels for global applications. During that history, the company has not had a single incident of semiconductor materials leaching out of the panels and contaminating the surrounding environment. Our long-standing track record of product safety is based on our use of stable materials in a durable design, and our commitment to product stewardship. 50+ Researchers have confirmed the benefits and safety of CdTe PV through 15+ Peer Review studies conducted in the U.S., Japan, India, Thailand, China, the Middle East, Chile, Brazil, South Africa, and Europe. Reports can be viewed and downloaded at: http://www.firstsolar.com/Resources/Sustainability-Documents.



Below is a sampling of key findings from third-party research reports considering the environmental health and safety impacts of CdTe solar panels over their entire life cycle; including during normal operation, foreseeable accidents such as fire or breakage, extreme weather events such as tornadoes and hurricanes, and through end-of-life recycling and disposal:

National Renewable Energy Laboratory/Brookhaven National Laboratory (2003, May). *CdTe PV: Real and perceived EHS Risks* - Retrieved from https://www.nrel.gov/docs/fy03osti/33561.pdf

- "No emissions of any kind can be generated when using [CdTe] PV modules under normal conditions."
- "In reality, PV, when it replaces coal-burning for electricity generation, will prevent Cd emissions in addition to preventing large quantities of CO2, SO2, NOx, and particulate emissions."
- "Thin CdTe PV end-of-life or broken modules pass Federal (TCLP-RCRA) leaching criteria for nonhazardous waste."

- "Although cadmium telluride is encapsulated between sheets of glass and is unlikely to leach out, the PV industry is considering recycling of these modules at the end of their useful life. Recycling will completely resolve any environmental concerns."
- "…the environmental risks from CdTe PV are minimal. Every energy source or product may present some environmental, health, and safety hazards, and those of CdTe are by no means barriers to scaling-up the technology."

The Virginia Center for Coal and Energy Research, Virginia Tech. (2019, March 8). *Assessment of the Risks Associated with Thin Film Solar Panel Technology*. Retrieved from https://vtechworks.lib.vt.edu/bitstream/handle/10919/90197/ThinFilmSolar_final.pdf

- "Based upon the potential environmental health and safety impacts of CdTe photovoltaic installations across their life cycle, it is concluded they pose little to no risk under normal operating conditions and foreseeable accidents such as fire, breakage, and extreme weather events like tornadoes and hurricanes."
- "…the environmental risks of CdTe and Cd cannot be assumed to be equivalent because the two substances are not chemically interchangeable. To draw a simple analogy, the properties of water (H2O) are not similar to those of hydrogen gas (H2) just because the two species both contain hydrogen. Just as it is improper to assume water can burn because hydrogen burns, it is invalid to treat CdTe as if it were as toxic as Cd."

Fthenakis, V., Athias, C., Blumenthal, A., Kulur, A., Magliozzo, J., & Ng, D. (2020). *Sustainability Evaluation of CdTe PV: An Update. Renewable and Sustainable Energy Reviews*. https://doi.org/10.1016/j.rser.2020.109776 (full report attached)

- *[Speaking in regards to module manufacturing]:* "Among all commercial of PV technologies, thin-film cadmium telluride (CdTe) PV emits the least amount of harmful air emissions as it requires the least amount of energy during the module production. More recent LCA articles comparing PV technologies across multiple indicators (e.g., cumulative energy demand, global warming potential, acidification potential, ozone depletion, particulate matter, human toxicity, ozone depletion, freshwater ecotoxicity, freshwater eutrophication, marine ecotoxicity, terrestrial acidification, marine acidification, land occupation, and resource use), also showed that CdTe PV is advantageous across all environmental impact categories, to currently commercial PV technologies."
- "It can also be argued that encapsulating cadmium as CdTe in PV modules is an important alternative to its current uses and would actually reduce cadmium waste."
- "Studies alerting to cadmium leaching risks used completely invalid assumptions, e.g., grinded and/or un-encapsulated modules, whereas the most comprehensive studies showed absolutely no risks during normal conditions and insignificant risks during extreme conditions like major storm events."
- "Cd transported from broken panels by rainwater is highly unlikely to pose health risks to residents, workers, consumers, or emergency responders. Like with fires, then, while there may be Cd emissions under extreme conditions, any such release would not pose a serious environmental, health, or safety concern at any given installation location."
- "In 2015, a tornado impacted a California PV facility which utilizes CdTe PV modules, damaging 1.8% of the modules. The damaged panels were collected, over 85% were recycled, and the remainder were disposed of based on composite sampling of soil and module pieces from the tornado event which passed TCLP tests."