

SUMMARY REPORT

Peer Review of Major Published Studies on the Environmental Profile of Cadmium Telluride (CdTe) Photovoltaic (PV) Systems

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A peer review of major published studies on the environmental profile of cadmium telluride (CdTe) photovoltaic (PV) systems took place in Berlin in August 2005. These studies were conducted by researchers at Brookhaven National Laboratory (BNL), New York, University of Chicago, and the Fraunhofer Institut für Festkörpertechnologie, München. The review was organized by the European Commission's Joint Research Centre (JRC) and moderated by the German Federal Ministry of Environment (BMU). The reviewers were prominent professors in European universities that were selected by the BMU and the JRC. None of the reviewers had a specific interest on CdTe PV, since their research interests are related to other PV technologies (e.g., silicon based solar cells, chalcogenide semiconductors and polymer-based solar cells). Non-voting scientific and public policy experts from the German Ministry of Environment (BMU), Brookhaven National Laboratory (BNL), Projektträger Jülich (PTJ), Joint Research Centre of the European Commission (JRC) and the German Industry Association for Solar Energy (BWS) also participated in the review.

Three out of the four reviewers gave high rankings to the published studies. The overall conclusions of the review process were that the environmental risks of CdTe PV are minimal, if materials are recycled and/or end-of-life systems and policies are in place. The emissions produced during the life-cycle of the modules are extremely low, and large scale use of CdTe photovoltaic modules does not present any risks to public health and the environment. In addition, recycling of the modules at the end of their useful life would resolve any remaining environmental concern.

In summary it has been stated and evaluated that

- *Cd is produced as a by-product of Zn production and can either be put to beneficial uses or be sequestered and stored in a way that won't allow for any releases into the environment. CdTe used in PV is in an environmental stable form that doesn't leak into the environment during normal use or foreseeable accidents and therefore can be considered the environmental safest current use of cadmium.*



- *Air emissions of cadmium from the whole life-cycle of CdTe PV (including mining, smelting and purification) are 100-360 times lower than cadmium emitted into air routinely from coal and oil power plants that PV displaces. The potential accidental emissions occurring during residential fires are five (5) orders of magnitude lower than the routine emissions during the operation of coal and oil power plants. Thus, the minor environmental issues related to CdTe PV are by far outweighed by the environmental benefits that PV displacement of fossil would generate.*
- *Photovoltaics systems have distinct environmental advantages for generating electricity over conventional power technologies. Every PV technology has some environmental, health, and safety (EHS) issues, but the industry is proactive in controlling them, and these issues should not restrict the commercial viability of any of the current PV technologies.*
- *PV technologies should be evaluated on their potential for low-cost electricity production and life-cycle externalities (e.g., energy payback times, life cycle CO₂ emissions). Recent European studies showed that current production CdTe PV modules have shorter energy pay back times and lower life cycle CO₂ emissions than other PV systems, e.g. crystalline silicon (c-Si) or CIGS. A low production cost technology like CdTe PV could accelerate PV inroads in the energy market. A significant market penetration of any technology will help the whole PV industry by improving the installation infrastructure and reducing the installation cost of solar electricity.*
- *In addition, First Solar and Deutsche Solar who are investing in recycling, help the whole industry by setting-up an infrastructure that the whole industry will eventually need. The need for recycling is not limited to single PV technologies, but recycling would be needed for all types of PV modules, when gigawatts (GW) of photovoltaics are installed annually.*
- *First Solar employs satisfactory industrial hygiene and environmental programs. The transparency of First Solar and the announced offer to take back the modules and recycle them is excellent.*

The conclusion of this review was that First Solar's CdTe modules do not represent an environmental risk under normal operating conditions. The potential environmental impacts in the case of fire and landfill deposition are extremely low according to standard test protocols and standards. Nevertheless, a recycling option should be favoured to uphold an environmental friendly image of the CdTe PV technology.

The “cadmium” discussion concerning photovoltaics is an emotional one, not always based on facts. This is maybe the reason, why the risks of CdTe exposure are overestimated, and it would be valuable to launch an international study on the toxicity of CdTe itself in order to have a scientific rather than an emotional basis.



All industrial processes have some environmental impacts that have to be taken into account. To create a levelized playing field for all energy technologies Life Cycle Analysis (LCA) should be used in order to evaluate the technologies technical potential and the possible risks in a balanced way. Recent European studies (e.g., PVAccept) showed that CdTe PV has the lowest energy payback and the lowest emissions of CO₂, SO₂, NOX and particulates carbon dioxide, sulphur dioxide, among all commercial PV technologies (e.g., mono and polycrystalline silicon, copper indium selenide and cadmium telluride).

Finally, it was mentioned, that the CdTe solar cell technology is only one of many PV technologies. The success of PV technologies in the market place will be determined by the capability of manufacturers to offer a cost-effective product to the customer. As more solar systems are produced and installed, the cost of such systems and installations is reduced. Therefore, every PV technology that makes inroads in the energy market helps to increase market penetration of solar electricity in the energy market.