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FUNDACIÓN CENER CIEMAT

Project: 21.1885.0-02

"First Solar CdTe Photovoltaic Technology: Environmental, Health and Safety Assessment"

Executive Summary

SOLAR PHOTOVOLTAIC ENERGY DEPARTMENT

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Title:	"First Solar CdTe Photovoltaic Technology: Environmental, Health and Safety Assessment". Executive Summary
Report no.:	21.1885.0-02

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EXECUTIVE SUMMARY

I OBJECTIVE

The object of the work is to evaluate, from an independent point of view, the environmental, health and safety (EH&S) aspects of First Solar's CdTe photovoltaic (PV) technology across all stages of the product life cycle, from raw material sourcing through end-of-life, and to compare the environmental impacts of CdTe PV technology to other electric supply options on a life cycle basis as well as the advantages and disadvantages of using a CdTe thin film semiconductor in the fabrication of PV modules. In particular, the risk of potential exposure to cadmium or cadmium compounds will be assessed from an environmental, health and safety perspective across all product life cycle stages and First Solar's process technology will be analyzed, including all aspects going from the raw materials used until the final recycling steps, with specific attention to the environmental, health and safety aspects of using Cd in a commercial product.

II SCOPE

The report was based on the review of the most recent bibliography related to these subjects as well as on the information provided by First Solar on their specific technology and management systems. This information was analyzed by CENER to assess the environmental, health and safety aspects of First Solar's CdTe PV technology across all stages of the product life cycle and to compare the environmental impacts of CdTe PV technology to other electric supply options on a life cycle basis.

III CONCLUSIONS

After the in-depth analysis of the most recent scientific articles related to these subjects as well as the specific information provided by First Solar, the extracted conclusions are summarized below:

III.1 EH&S aspects of First Solar CdTe PV module manufacturing

- Cadmium is obtained as a by-product of zinc refining (and to a much lesser extent of lead and copper refining); therefore, its production does not depend on PV market demand. First Solar's CdTe PV modules provide a beneficial and safe use for cadmium, a heavy metal considered a hazardous substance, that would otherwise be stored for future use or disposed of in landfills as hazardous waste.

- First Solar manufacturing facilities are equipped with the state-of-the-art technology to control emissions of cadmium compounds into the indoor and outdoor air. First Solar manufacturing facilities also have appropriate technology to treat waste effluents for all manufacturing operations, including module recycling. Actual air emission and wastewater effluents are well below the local regulatory limits. Specifically, air emissions of cadmium compounds are orders of magnitude below local regulatory limits. First Solar has comprehensive environmental policies, programs and management systems in place as evidenced having all manufacturing plants ISO 14001 certified.

- First Solar has established comprehensive safety and industrial hygiene programs to monitor and prevent any H&S risk in their manufacturing facilities. The systematic medical surveillance data indicate that no employee has ever exhibited a negative health effect associated with exposure to cadmium compounds due to their employment at First Solar. First Solar's Perrysburg (Ohio) facility has received the OHSAS 18001 Health and Safety Management System certification and certifications for other facilities are planned by the end of 2010.

- First Solar is very proactive in developing and improving safety programs to further reduce risk and encourages the active participation of all employees.

III.2 EH&S aspects of First Solar CdTe PV modules during operation

- Under normal operating conditions, First Solar CdTe PV modules, like other PV modules, do not generate any air pollutant emissions, in contrast to fossil fuel-burning energy sources which produce air emissions of CO_2, SO_2, NO_x particulate matter and heavy metals. In addition, the generation of electricity by PV produces no waste and uses little if any water, in contrast to the combustion of fossil fuels, nuclear generation and CSP

solar technologies. First Solar's CdTe PV technology presents a very positive environmental profile.

- In the event that CdTe modules are exposed to fire or become broken for any reason, the emissions of cadmium or cadmium compounds from CdTe PV modules to the air, water and soil have been proven, through scientific studies, to be negligible and therefore do not represent any risk to human health or the environment.

- First Solar is the first PV company to implement an unconditional pre-funded Collection and Recycling Program for damaged and end-of-life modules.

III.3 Life cycle environmental impact of First Solar CdTe PV modules

- The carbon footprint of First Solar CdTe PV modules is about 15 g CO_2-eq/kWh which is one of the lowest carbon footprints among the commonly used energy sources. Besides that, First Solar CdTe modules have a lower carbon footprint than the other current PV technologies.

  The energy payback time of First Solar CdTe PV modules is less than one year. Energy payback time is an important parameter to consider for achieving rapid scalability and CO_2 reductions.

- Life cycle atmospheric cadmium emissions are around 0.25 g/GWh for First Solar CdTe PV modules. Direct emissions (i. e. atmospheric emissions during life cycle) represent 0.02 g/GWh, whereas indirect emissions (i.e. emissions due to the energy usage in the life cycle) account for 0.23 g/GWh, being the dominant cadmium atmospheric emissions for First Solar CdTe PV technology.

  CdTe PV actually has lower life cycle cadmium emissions than the silicon wafer based PV technologies, due primarily to the lower energy used for module production.

- On a life cycle basis, First Solar's CdTe PV technology has among the lowest atmospheric cadmium emissions of commonly used energy sources.

In summary, First Solar's CdTe PV technology has the lowest carbon footprint, pollutant emissions (including cadmium) and energy pay back time among all current PV technologies. During normal operating conditions, First Solar's CdTe PV modules emit zero pollutants to the air, water and soil. In the exceptional case that an accident like fire or breakage involving CdTe modules occurs, the emissions of cadmium or cadmium compounds have been proven to be negligible and do not represent any risk for human health nor for the environment. Consequently, the use of CdTe PV can contribute to the mitigation of greenhouse gases emissions to the atmosphere with a negligible risk. Concerning manufacturing operations, First Solar has continuously implemented outstanding policies, practices, procedures and management systems in order to protect workers' health and safety as well as the environment.