The Safety of Photovoltaics

Photovoltaics is safe! It has far fewer risks and environmental impacts than conventional sources of energy. Nonetheless, there are some environmental, safety, and health (ES&H) challenges associated with making, using and disposing of solar cells.

Is Today's PV Safe to Make and Use?

Yes conditionally.

Today's chief PV technology is based on silicon, the same semiconductor material that dominates the electronics and computer industries. Although silicon is essentially quartz—the main ingredient in glass—there are some things to be careful of:

- The most notable ES&H risk posed by the PV industry is hazards for its workers. This stems mostly from using solvents, toxic or explosive gases and, to a lesser degree, from inhaling dust. By using well-designed industrial processes and careful monitoring, PV manufacturers have minimized these risks to a level that is less than those in almost any other industry. All of these risks fall well within the range already protected by OSHA and similar regulations.
- Other than falling off a roof or being electrocuted because of improper practices, hazards associated with installing, using, and disposing of PV modules are nil. PV manufacturers have already minimized these risks by certifying their components and making systems in accordance with national safety regulations.

Is PV Safe for Our Environment?

Again yes!

Especially when compared to conventional (fossil) sources of electricity, which are among the biggest contributors to environmental degradation. Fossil fuels produce acid rain, particulates, noxious fumes, carbon dioxide, and small amounts of heavy metals. In addition, the industries used for extracting fossil fuels present substantial ES&H concerns.

PV, on the other hand, produces no pollutants during operation, making it a preferred option for offsetting emissions that result from fossil fuel use. In fact, an EPA study (Demonstrating Pollution Reduction Capability of Photovoltaic Systems) showed that 1 kW of PV could offset between 600 and 2300 kg of CO₂ per year, as well as substantial amounts of other pollutants.

And PV manufacturing only produces modest impacts, almost all from the energy needed to manufacture PV modules and systems. This energy is a problem only because it comes from conventional energy sources! In fact, the initial energy cost of PV systems can be paid back by PV-generated electricity in under 5% of a PV system's lifetime hours. (See, for example, our FAQ: "Energy Payback: Clean Energy from PV.")

Will Tomorrow's PV be Safe, too?

Once more yes!

New PV technologies, being developed to meet long-term, low-cost demands, use materials and techniques that pose new
ES&H challenges, which the NCPV is already addressing. Although the PV industry will always use far smaller amounts of hazardous chemicals than many other industries, such chemicals are responsible for the industry's major occupational hazards. So, the industry is adopting technologies and procedures to minimize risk.

- **Amorphous Silicon.** Silane, an explosive gas, is used to make amorphous silicon. Toxic gases such as phosphine and diborane are used to electronically "dope" the material. Manufacturers use sophisticated gas-handling systems.

- **Copper Indium Diselenide.** Toxic hydrogen selenide is sometimes used to make copper indium diselenide, a thin-film PV material. Manufacturers use gas-handling systems, careful engineering and administrative controls to prevent exposure to the public. Careful system design and gas detection systems can effectively prevent exposure.

- **Cadmium Telluride.** Cadmium and its compounds, used to make cadmium telluride cells, can be toxic at high levels of lung exposure. Inhalation of fine fumes or particles, more than ingestion or skin absorption, is the primary exposure of concern. Manufacturers have effectively minimized exposure with engineering controls, personal protective equipment, and work practices. Biomonitoring of contaminants in workers is also a key defense against chronic toxicity.

**Disposal and Recycling.** Because solar cells have useful lives of 20-30 years, waste generation will lag behind industry growth. Landfill leaching is a modest concern only, because PV materials are largely encased in glass or plastic and many are insoluble. Because of dispersed use, and small amounts of semiconductor material per cell, PV recycling will be challenging. Machinery for dismantling modules for recycling has been developed, and recycling systems for batteries and electronics provide useful models.

### Where Can I Find More Information?

The NCPV's Photovoltaic ES&H Project at Brookhaven National Laboratory has researched PV related safety issues. A bibliography of more than 100 articles can be found at http://www.pv.bnl.gov/biblio.html. The Project can also be contacted at 516/344-2830 (4486 fax).


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