beginning, was the responsible thing to do and would ultimately result in reduced costs. The international nature of the PV industry introduces some variability in the standards which must be met.

Hazards can be classified by whether they affect workers at a PV manufacturing plant, customers with photovoltaics on or near their homes, or the public who consumes air and water near the PV plant. The population with greatest potential health risks are employees in PV manufacturing. Very little risk is associated with the public or the PV owner or installer. Among the most heavily studied issues unique to the PV industry is the potential toxicity of semiconductor CdTe and the safe usage of hydride gases AsH_3, SiH_4, GeH_4, PH_3, B_2H_6, and H_2Se, which are used in the growth of GaAs, a-Si, a-SiGe, and $Cu(InGa)Se_2$ layers. There has been considerable research and risk analysis of CdTe as a PV material [12–14]. The general conclusion is that CdTe in modules does not pose a risk to the public. Similarly, procedures and hardware ensuring safe usage of the hydride gases listed above have been well established in both the electronics and PV industries [15].

Environmental monitoring of the workplace for hazardous levels in the air or on surfaces, and biological monitoring of the employee for evidence of exposure should be routine. Once the module is manufactured, the only way for the public to be exposed to hazardous materials existing in some kind of modules is by absorbing them via ingestion or inhalation. Accordingly, accidental human absorption is not at all likely. Even in event of a house fire, studies have shown that PV modules do not release any potentially hazardous materials [16].

A related issue is what to do with thin film PV modules at the end of their projected 25- to 30-year life. An excellent strategy is to recycle the modules. This solves two problems at once, namely, keeping potentially hazardous materials out of the environment and reducing the need for additional mining and/or refining of new materials. Semiconductor vendors have indicated a willingness to accept used modules, and to extract and purify the CdTe, CdS, or $Cu(InGa)Se_2$ for resale and reuse [17, 18].

Thus, we can say with confidence that photovoltaics is nearly the cleanest and safest technology with which to generate electricity. It is especially true of the present Si technology.

6. *PV modules never recover all of the energy required in making them, thus they represent a net energy loss*:

The focus of photovoltaics is on generating energy (specifically electrical energy) with many beneficial characteristics as noted in Table 1.1. Among those who envision photovoltaics having an increasingly larger role in producing the world's electricity, there is awareness that photovoltaics must produce much more energy than was required to produce the PV system. Otherwise, it would be a net energy loss not a net energy source. The "energy payback" has been widely studied. It is described in terms of how many years the PV system must operate to produce the energy required for its manufacture. After the payback time, all of the energy produced is truly new energy.

This topic is discussed in Chapter 21. An excellent review has been given by Alsema [19]. In general, results of several studies have arrived at some general conclusions. Specific payback times have ranged from 3 to 5 years for crystalline Si and 1 to 4 years for thin films. For crystalline Si, forming the crystalline Si wafers is