Resource	Current use	Technical potential	Theoretical potential
Hydropower	9	50	147
Biomass energy	50	>276	2900
Solar energy	0.1	>1575	3900000
Wind energy	0.12	640	6000

Units: exajoule per year

Figure 2.1 Current use and current potentials of selected renewable energy sources [1]. For comparison: global primary energy demand 402 exajoule/annum (1998). The electricity part of "current use" has been converted to primary energy utilising an efficiency factor of 0.385

Nevertheless, two important conclusions may be drawn from Figure 2.1: (1) even under strong area restrictions (e.g. utilisation of a small percentage of the land area) and guarded assumptions of overall technical efficiencies, solar energy conversion alone could in principle produce considerably more technical energy than is consumed today and (2) compared to other renewable sources, solar radiation is by far the largest. A sustainable global energy system that is strongly based on renewable sources will in the long run mainly be a solar energy system. With respect to the technology of solar electricity production, this means solar thermal power plants and photovoltaics. The application of thermal power plants is restricted to areas with high and direct insulation; flat-plate (standard) PV modules may be applied practically everywhere in the world since they convert diffuse and direct (beam) radiation with approximately the same efficiency.

Photovoltaic energy conversion meets the important requirements of a sustainable energy production in an obvious way. During operation there is no harmful emission or transformation of matter (generation of pollutants), nor any production of noise or other by-products. PV energy conversion is a technologically elegant one-step process avoiding conventional thermodynamic or mechanical intermediate steps. On the other hand, production of PV modules and system components will – as any industrial device production – include material transformation and the production of wastes. Thus, it is extremely important to realise PV conversion technologies that comply with the requirements of environmentally benign production schemes.

Though characterised by the high global potential given in Figure 2.1, the area-specific power density of solar radiation is relatively low, that is, approximately 100 W/m^2 on the average. This means that the global harvesting of solar resources necessarily requires a large-area production of energy converters. Appropriate recycling strategies will thus be essential for the energy-relevant application of photovoltaics. Already today standard silicon-wafer PV-technology meets in principle the requirements with respect to recycling and sustainable production.

Photovoltaic energy conversion is highly modular. Installations may vary between milliwatts for consumer products (watches) to megawatts in the case of grid-connected power plants. From a market point of view, this gives rise to a broad variety of PV applications. For the professional energy supply business, modularity is especially important with