

the USA having 13% efficiency [34]. Also in 1973, a crucial nontechnical event occurred called the *Cherry Hill Conference*, named after the town in New Jersey, USA, where a group of PV researchers and heads of US government scientific organizations met to evaluate the scientific merit and potential of photovoltaics. The outcome was the decision that photovoltaics was worthy of government support, resulting in the formation of the US Energy Research and Development Agency, the world's first government group whose mission included fostering research on renewable energy, which ultimately became the US Dept. of Energy. Finally, in October 1973, the first World Oil Embargo was instituted by the Persian Gulf oil producers. This sent shock waves through the industrialized world, and most governments began programs to encourage renewable energy especially solar energy. Some would say this ushered in the modern age of photovoltaics and gave a new sense of urgency to research and application of photovoltaics in terrestrial applications.

In the 1980s, the industry began to mature, as emphasis on manufacturing and costs grew. Manufacturing facilities for producing PV modules from Si wafer *pn* junction solar cells were built in the USA, Japan, and Europe. New technologies began to move out of the government, university and industrial laboratories, and into precommercialization or "pilot" line production. Companies attempted to scale up the thin-film PV technologies like a-Si and CuInSe₂, which had achieved >10% efficiency for small area (1 cm²) devices made with carefully controlled laboratory scale equipment. Much to their disappointment, they found that this was far more complicated than merely scaling the size of the equipment. Most large US semiconductor companies, gave up their R/D efforts (IBM, General Electric, Motorola) lacking large infusions of private or government support to continue. One common result was the purchase of American companies and their technologies by foreign companies. In 1990, the world's largest solar manufacturer was Arco Solar (CA, USA), owned by oil company Atlantic Richfield, which had c-Si and thin-film a-Si in production and thin-film CuInSe₂ in precommercialization. They were sold to the German firm Siemens and renamed Siemens Solar (in 2001, the Dutch company Shell Solar would buy Siemens, becoming another large internationally based company with multiple PV technologies in production). Also in 1990, Energy Conversion Devices (MI, USA) formed a joint venture called United Solar Systems Corp. with the Japanese manufacturer Canon to commercialize ECD's roll-to-roll triple-junction a-Si technology. In 1994, Mobil Solar Energy (MA, USA), which had developed a process for growing solar cells on Si ribbon (called the Edge defined film growth or EFG process) instead of more costly wafers, was sold to the German company ASE and renamed ASE Americas. The British solar company BP Solar acquired patents to electrodeposition of thin-film CdTe solar cells in 1989, when it's parent company purchased the American oil giant Standard Oil of Ohio. At the same time, it acquired the patents of the University of New South Wales (Australia) to fabricate the Laser-Grooved Buried-Grid (LGBG) cells, which became the most efficient silicon cells in fabrication. In 1996, it signed a license agreement with the Polytechnic University of Madrid (Spain) to exploit the Euclides concentration technology that used their LGBG cells as concentrator cells. In 1999, BP Solar acquired Solarex from Enron (another huge fossil-fuel energy company) that had crystalline and amorphous Si solar cell technology. Thus, BP Solar established themselves with manufacturing interests in all three technology options (standard Si wafers, thin films