The interest in multijunction cells has been reawakened by the requirements of space cells, where price is less relevant than the performance in many cases (Chapter 10). However, they can be used in terrestrial applications provided they are operating at very high concentration. There is a trend to develop cells operating at 1000 suns. Efficiencies up to 26% with a single band gap GaAs solar cell [77] and of over 29% with a double band gap GaInP/GaAs cells [78] have been achieved (Chapter 9). Also, the development of low-cost concentrators able to operate at 1000 suns is a subject of current research [79]. The prospects are very promising because such technologies predict in the long-term to produce electricity competitive with conventional sources. A cost estimate is presented in Table 1.5. In the 1-J no learning case, the costs are similar to those in Table 1.4. However, in the learning case the costs are, in extremely good locations (EGL), very competitive with conventional electricity, provided that we achieve very high efficiencies. In this calculation, the experience factor for the cells is the same as in microelectronics; for the rest of the elements the learning curve is same as the present one for modules [80].

The role of the experience factor has been stressed when describing Figures 1.6 and 1.7. Conventional cells have a relatively low experience factor, we think, because they are limited in the maximum efficiency they can reach. Multijunction cells, in contrast, have a much higher efficiency limit and therefore they can progress in efficiency for a longer time. This is one reason to attribute to them a faster experience factor.

Multijunction cells are also crucial to the success of the thin-film photovoltaics. In the a-Si thin-film PV technology, the highest cell and module efficiencies being reported for the past decade are for triple junctions as described in Chapter 12. The use of multijunction cells in thin films might lead to a faster learning curve and hence reduced costs. The band gap of various polycrystalline alloys of Cu(InGa)Se_2, Cu(InAl)Se_2, Cu(InGa)(SeS), or CdZnTe can be varied with alloying. The theoretical efficiency of a tandem device with a 1.6 to 1.8 eV band gap top cell and a 1.0 to 1.2 eV band gap bottom cell exceeds 30%. In all cases, the top cell must provide the majority of the power.

Table 1.5 Costs for very high-efficiency 1000 suns-concentrating systems [80] for one junction (1-J) and four junctions (4-J) cells. NDI stands for Normal Direct Irradiation. EGL stands for extremely good location with NDI = 2700 $W\cdot m^{-2}\cdot year^{-1}$. "No learning" means with present costs (2002) while "learning" means they are reduced by a learning curve with experience factor of 0.32

Cost element	1-J, no learning	4-J, learning
Cells (\$ per cm^2 cell area)	13.4	4.43
Module (\$ per aperture area)	265	113
Cell efficiency (%)	23.1	45
Module efficiency (%)	19.0	37.1
Plant price (\$ per m^2 aperture area)	526	271
Madrid NDI ($W\cdot m^{-2}\cdot year^{-1}$)	1826	1826
Performance ratio	0.606	0.606
Electricity costs in Madrid (\$ per kWh)	0.186	0.050
Electricity costs in EGL (\$ per kWh)	0.131	0.035