Table 21.6 Annual performance and energy cost summary for central station plants [4] Constant 1990$, Carrisa Plains Site

	Fresnel lens	Central receiver	CIS flat plate
Average annual performance			
Energy output (MWh)	140 100	125 000	112 000
Capacity factor	32.0%	28.5%	25.8%
Annual energy efficiency	18.8%	11.3%	9.9%
Annual expenses (10^6)			
Capital charge	16.69	14.42	11.95
Operation & maintenance expense	0.61	1.197	0.18
Total	17.30	16.39	12.13
30-year levelized energy cost ($/kWh)			
Capital charge	0.119	0.115	0.106
Operation & maintenance costs	0.004	0.016	0.002
Total ($/kWh)	0.123	0.131	0.106

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the systems reflect both the efficiencies and the collector characteristics of the different system designs. The annual capital charge is the annualized amount of the total capital requirement, using a CRF of 10.2%. Levelized energy cost is the total annual expense divided by the annual energy output. It is interesting that the lowest LEC corresponds to the CIS flat-plate system that has the lowest efficiency and incorporates the simplest collector technology. (Cell efficiency for the CIS cell was taken as 15%.) The relationship among the LECs for the systems also points out that cell and module efficiencies, while very important in system performance, do not by themselves determine energy cost. Other system-design factors are also very important, and within limits, override the effect of efficiency on energy cost.

21.2.3.3 Gallium arsenide cells in power systems

GaAs cells have been developed and used extensively for space applications, but traditionally have been considered too expensive for terrestrial applications despite their high efficiency. These compound semiconductor cells are fabricated by epitaxial growth, either on GaAs wafers or on Ge wafers, the latter being a more recent development. The cost of GaAs wafers is a major factor in the cost of cells, and Ge wafers are projected to be less expensive by more than an order of magnitude. The question that arises is whether GaAs cells could be competitive with Si cells for utility-scale terrestrial systems, particularly if grown on Ge wafers. To address this question, the cost study in the previous section, as it relates to the Fresnel lens plant, was extended to determine the cost of energy for the same plant using GaAs cells of several different designs [5].

Two cells were considered: a single-junction GaAs cell, and a tandem-junction GaInP/GaAs cell. These GaAs cells are designed as concentrator cells, and could be considered for the same kinds of applications as the Si concentrator cells in the Fresnel lens