that can compete in the standard flat-plate market and that use existing silicon solar-cell manufacturing infrastructure. The second is to focus on large installations and relentlessly seek lower cost through high-concentration, high-performance cells and designs that benefit from the economy of scale of large systems through artifices such as on-site assembly, automated installation, and the like. The goal must be to get large system costs below \$2.00/W. Attaining this goal is necessary, but not sufficient. Other market requirements are capturing some measure of social costs into the value stream, supportive utility transmission environment that enables renewable generators to effectively provide service, and eventually the development of new storage technologies and energy transport vectors such as hydrogen or global superconducting grids. Seen in this light, concentrators are not an immediate solution, but rather a long-range option of vital importance to the energy security of the world. Cost analyses indicate that it certainly has the possibility of becoming the low-cost PV approach in large installations. It is likely to find attractive niches initially in sun-resource-rich areas with little wind. Considerable risk investment will be needed to make it a reality. How the energy and investment climate evolves over the next few years, in the face of pollution concerns, global warming, and eventual fossil fuel depletion, is likely to dictate whether such capital will actually become available. It is hoped that this chapter helps guide researchers, policy makers, and investors to make it a reality.

This chapter begins by presenting an overview of the various types of concentrators. Then the history of concentrators is covered, followed by a section on the optical theory of concentrators, and finally a section on current concentrator research. Concentrator cells themselves operate by the same principles as nonconcentrating cells. Because of this, as well as space limitations, the design of concentrator cells is not covered in this chapter. The reader interested in the details of cell design specifically for concentrator applications is referred to the relevant literature [1, 2]. The methodology of concentrator cost projections is also not covered, although some results of this type of analysis are quoted. Further information on costs can be found in [3], as well as in many of the cited references.

11.2 BASIC TYPES OF CONCENTRATORS

Concentrators may be divided into different classes, depending on the optical means used to concentrate the light, the number of axes about which they move to track the sun, the mechanical mechanism that effects the tracking, and so forth. The major types are discussed below to acquaint the reader with the terminology. Detailed analysis of the operation of these devices can be found in Section 11.4.

11.2.1 Types of Optics

Most concentrators use either refractive lenses or reflective dishes and troughs. Lenses of any size over 5 cm in diameter will be too thick and costly to be practical; therefore, Fresnel lenses are usually chosen. A Fresnel lens may be thought of as a standard plano-convex lens that has been collapsed at a number of locations into a thinner profile. The facets may be either flat, if they are small and numerous enough, or actual sections of a curved lens surface. Fresnel lenses may be made either point-focus, in which case they