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Photovoltaic Concentrators

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11.1 INTRODUCTION

Photovoltaic (PV) concentrators use lenses or mirrors to concentrate sunlight onto PV cells. This allows for a reduction in the cell area required for producing a given amount of power. The goal is to significantly reduce the cost of electricity generated by replacing expensive PV converter area with less expensive optical material. This approach also provides the opportunity to use higher performance PV cells that would be prohibitively expensive without concentration. As a result, concentrator modules can easily exceed 20% energy conversion efficiency. In the future, the use of multijunction cells is expected to increase this to over 30%. While the concept is simple, and has been examined since the time of the earliest interest in terrestrial photovoltaics, the practice has proven to be deceptively difficult. Concentrator research has focused much effort on the PV cells themselves, which are now largely developed and available commercially. The main remaining technical barriers, however, are due to the difficult cell packaging requirements stemming from the high heat flux and electrical current density, plus the need for more cost-effective and reliable tracking systems and module designs.

The main market barriers have been due to the fact that concentrating systems, which in most cases must track the sun, are not well suited to the existing PV market that serves small remote loads and, more recently, are building integrated applications. Concentrators were conceived of as a vehicle to generate large amounts of nonpolluting renewable energy. As yet, costs are still too high to compete with fossil fuel–fired generation, or even the most direct renewable competitor – wind power. The cost gap is narrowing, however, and there appears a strong likelihood that in the future concentrator systems will find cost-effective niche applications that will continue to expand as natural gas prices rise and concern over power-plant emissions increases. This chapter discusses the current state of the art in concentrating PV cells and systems and outlines issues remaining before full commercialization is possible.

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