markets most often use building-integrated or roof-mounted panels, for which concentrators have been found generally unsuitable. Meanwhile, fossil fuel prices have remained low in the face of abundant supply, and the international inability to seriously confront global warming and the external costs associated with pollution have limited the market for large PV power plants.

Several additional interesting factors have compounded the hurdle facing concentrators. First, semiconductor silicon material costs have declined in inflation-adjusted dollars to a level that is only 50% more than the long-term DOE goal for "solar grade silicon" set in 1975. Second, wire sawing has evolved as a far more cost-effective wafering solution than imagined at the onset. Third, nonconcentrating cell efficiencies are higher than envisioned because of the development of cost-effective back-surface fields, screen-printed grids, and the like. Standard modules have evolved as a more competitive power source than it was thought possible. In short, the incumbent technology, wafered silicon flat-plate modules, has been enjoying the benefits usually associated with an incumbent technology.[1] Continued improvements can be expected as manufacturing experience grows ever more rapidly. Finally, electric power markets have evolved in a manner that supports small amounts of nonpolluting distributed generation as opposed to large central plants, be they fossil-fueled or PV.

Today, developers of concentrators face a dilemma – what market to target. There are two possibilities: develop highly reliable systems for smaller applications or continue with the quest for large systems that displace significant power. Several major difficulties face the small remote market. One is that the module cost is only a fraction of the total installed system cost. Having a dollar per watt less module cost, as a concentrator module might offer, results in perhaps only a 10 to 20% overall reduction in total installed system cost. Second, the requirement for tracking structures restricts installation options and applications (for instance, it limits rooftop applications that are the biggest market for grid-connected systems), and begs the need for periodic maintenance. Another is the need for the manufacturer or installer to maintain a service network that can provide periodic maintenance. The prospects do not look too good for small concentrator installations, unless cost-effective low concentration static concentrators are developed, which eliminates the need for tracking. For large installations, the issue is more closely *cost*. Here installations compete with standard generation technologies (which have established low cost, but are vulnerable to fossil fuel depletion, cost escalation, and perhaps pollution concerns) and other renewables such as biomass and wind. Wind clearly has the lead with energy costs less than 5 cents/kWh at good sites. PV can easily coexist alongside the other options owing to its unique capabilities, competitive cost, and widespread applicability and scalability. Against wind, however, PV must look more to its particular advantages. These are easier siting close to the load, more distributed resource availability, less visual impact, and the like. Can concentrating PV get costs close enough to wind to compete, given its other advantages? This is a technology and market issue that is yet to be sorted out.

It is the author's opinion that concentrator developers can beneficially focus efforts on two approaches. The first is to continue to explore for cost-effective static concentrators

[1] In fairness, it should be noted that the other major alternative to wafered silicon, namely, thin film modules, has suffered from the same force.