Figure 11.12 Entech 100-kW line-focus concentrator system in Fort Davis, Texas. Reproduced with permission by Entech, Inc.

University in 1975. At first this was targeted toward ThermoPhotoVoltaic (TPV) conversion [26]. The concept was to use highly concentrated sunlight to heat a radiating surface to incandescence, and to use the resulting thermal radiation to produce electric power with a PV device. This was shown in principle to permit very high efficiencies, perhaps over 50%. The laboratory conversion of radiant energy to electric energy reached a high of 26% [27].

The concept in TPV conversion is to have the solar cell absorb light only for photon energies near the semiconductor band gap. The remainder of the spectrum is reflected back to the radiator. This creates the concept of "photon recycling" whereby photons with energies less than optimum for conversion are sent back to the radiator for recycling until they come back at the proper energy.[11] This recycling can be effected by several means, such as having a selective filter between the cell and the radiator or by having a reflector behind the cell and making the cell as transparent as possible to below–bandgap photons. In the EPRI/Stanford program, the latter approach was taken. Experiments showed that major losses in below band gap reflectance came from free carrier absorption in the doped junction regions as well as from absorption in the metal-semiconductor contact area. It was found that when the metal back contact was separated from the silicon by a thin, one-fourth-wavelength silicon oxide layer, the reflectance was very high. This led to the concept of the "point-contact cell" shown in Figure 11.13. The doping has been removed from the base, that is, very high resistivity silicon is used for the starting material and the diffused, highly doped junction regions are made as small as possible to reduce free carrier absorption to a minimum.

It was found that the point-contact cell structure had many unanticipated advantages, the understanding of which emerged over the following years. It was ideal for promoting light trapping in the silicon because of the reflective back contact, and contact-area recombination is reduced by restricting the contact coverage fraction. In addition, the

[11] The reader can see the reason for the requirement for a radiator in between the sun and the cell. If this was not present, nonoptimal photons would be reflected back to outer space. Interestingly, if the cell was at the focus of an optimal concentrator (Section 11.4), the reflected photons would be returned to the sun. This would be a reasonable proposition if we were paying to fuel the sun, but of course we are not. It can also be seen that the radiator and cell area must be large compared to the entrance aperture for concentrated light so that energy lost through the entrance will be small.