SERI/SP-271-2581

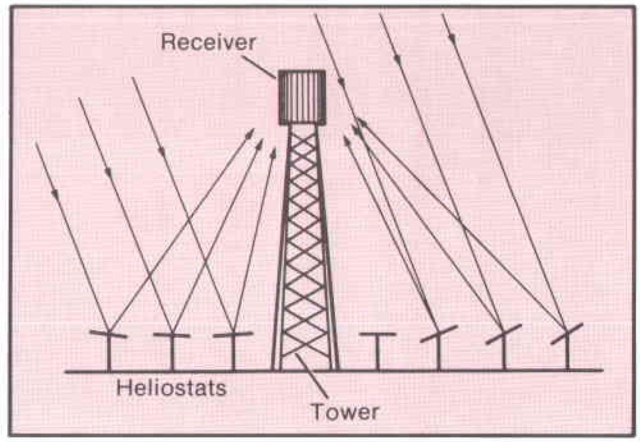
Fact Sheet

Central Receiver Systems

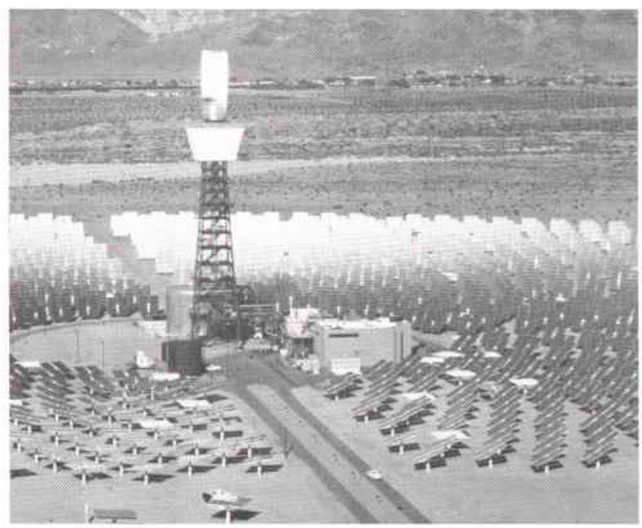
A Solar Thermal Concentrating Collector Concept

Central Receiver Systems

Central receiver systems are one of several concentrating collector technologies under development by the U.S. Department of Energy. In a central receiver system, a field of sun-tracking mirrors (heliostats) reflects sunlight onto a receiver located on a tower, heating a fluid that circulates within the receiver. The principal advantage of central receiver systems is their ability to collect energy at high temperatures and favorable costs.



A central receiver system has five main components: (1) heliostats, (2) a receiver, (3) heat transport and exchange system, (4) thermal storage (optional), and (5) controls. The heliostats track the sun automatically during the day, reflecting the sun's radiant energy onto the receiver. The concentrated energy is absorbed efficiently by a fluid circulating within the receiver. The resulting thermal energy, which can be collected at temperatures up to 1100°C, can be used directly or indirectly to drive a turbine to produce electrical power, as process heat in industrial applications, or to produce fuels and chemicals. If a storage subsystem is incorporated, energy can be stored for use when the sun is not shining. Automatic operation and subsystem interactions are accomplished by a master control system.



A summarization of research and development issues currently being addressed for central receiver systems and subsystems follows.

Systems. System efficiency is being evaluated, and operations and maintenance procedures, experiences, and costs are being assessed at the 10-MWe water/steam central receiver pilot plant (Solar One) near Barstow, California. Two smaller scale system experiments are being conducted to evaluate advanced technologies: (1) a 0.75-MWe molten salt experiment at the Central Receiver Test Facility in Albuquerque, New Mexico and (2) a 0.5-MWe liquid sodium experiment near Almeria, Spain (sponsored by the International Energy Agency). Conceptual system designs are also being performed to assess feasibility and identify research and development needs for central receiver fuels and chemicals production.

Heliostats. Emphasis in this area is on developing lightweight designs and selecting materials that will result in low-cost heliostats. Current designs for commercial heliostat production use back-silvered glass mirrors. Performance is presently being determined. Alternatives to back-silvered glass, such as reflective membranes and metallized polymers, are under investigation. Increasing durability and reflectivity while reducing costs are the key issues in the search for alternate materials for heliostat surfaces.

Receivers. Receivers must operate efficiently at temperatures as high as 1100°C. Of concern are heat loss mechanisms, which are not well characterized for objects as large as receivers. They must be evaluated if overall system efficiency is to be established. The effects of intermittent sunlight, single-side heating of receiver tubes, and creep-fatigue must also be addressed. Materials and fabrication processes will need to be selected to yield more cost-effective designs.

Heat transport and exchange. Working fluids for a central receiver system must be able to absorb and transport high-temperature heat efficiently. A fluid must maintain its properties under thermal cycling conditions and not be corrosive to containment materials. Working fluids being examined in detail include water/steam, gases, molten salts, liquid metals (e.g., sodium), and solid particles (e.g., spherical bauxite).

Thermal storage. As with all solar thermal systems, central receiver systems can store energy by heating a suitable medium. Central receiver systems, because of their high-temperature collection capability, can achieve large temperature differences between the heated and unheated storage media. Thus, more energy can be stored with less storage media, yielding an economical storage subsystem. Storage media under consideration include heat-transfer oils, molten salts, liquid sodium, and solid particles (e.g., rocks, spherical bauxite). Economical containment of storage media is a prime technical issue.

Controls. The sophistication of central receiver system controls depends upon the application. The control of a central receiver system is expected to be more complex than that of a conventional energy system because of the intermittent nature of sunshine and the substantial number of moving heliostats. Automatic controls that will permit unattended operation of central receiver systems are being studied.

Further information on central receiver systems and other solar thermal concentrating collector technologies can be obtained from the Solar Central Receiver Department, Sandia National Laboratories, Livermore, CA 94550. Telephone (415) 422-2566.

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