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SITING SOLAR THERMAL POWER EXPERIMENTS

H.J. Holbeck
Jet Propulsion Laboratory
Pasadena, California

ABSTRACT

Solar thermal power experiments will provide experimental operation data bases leading to later full-scale demonstrations. The Small Community Solar Thermal Power Experiment will test a point-focusing, distributed receiver system in a small community, electric utility application. Site participation and system development for this experiment are being pursued in separate, coordinated efforts.

Site planning is becoming increasingly important for solar experiments as well as all kinds of development due to increased competition for desirable sites and increased complexity of regulatory requirements. Siting issues can be categorized as:
1) Resources and physical environment at this site
2) Acquisition, permits and regulations
3) Development requirements and costs.
In this paper these issues are addressed with respect to the unique requirements of solar thermal power experiments.

INTRODUCTION

Solar Thermal Power Applications Experiments

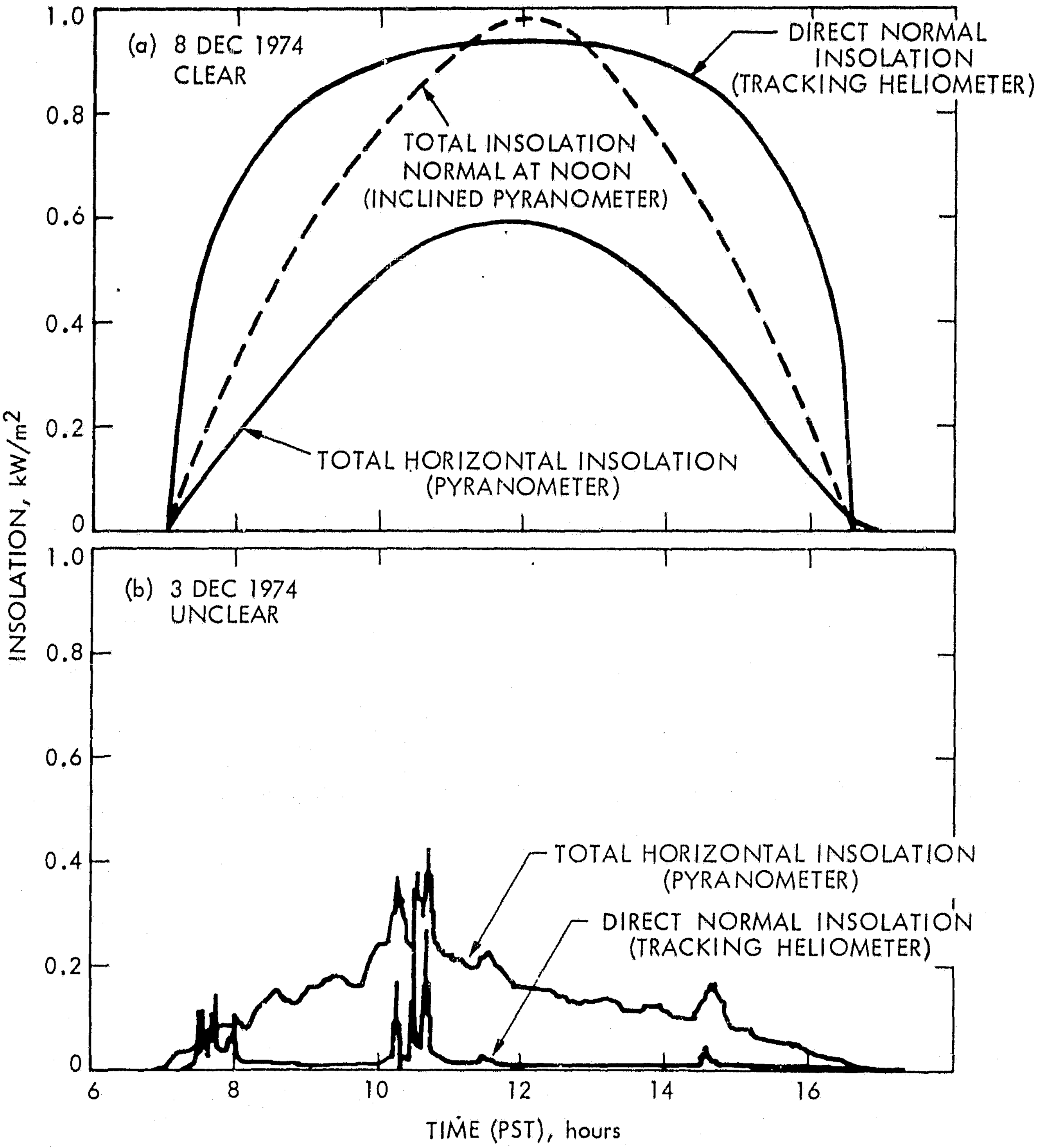
Purpose of Applications Experiments

Point-focusing distributed receiver system technologies and applications are being developed as part of a program to provide solar thermal power alternatives for future energy needs. Key elements in this development are system experiments which test technologies in representative user environments. These experiments provide realistic data bases for design modifications, user interfaces and extrapolations of experimental operation which will lead to full-scale demonstrations and then to commercial applications.

Application Experiment Plans

Applications for point-focusing distributed receiver systems include electric utilities, isolated loads and industrial thermal and electric power. Two applications experiments have been defined. The Small Community Solar Thermal Power Experiment will be on-line in 1983. Preliminary system design is underway, and site participation proposals are being evaluated by DOE. The Military Module Power Experiment is a cooperative project with the Navy and will also be on-line in 1983. The system development procurement is in process for a 100 KWe experiment at the Yuma Marine Air Station. Additional experiments are planned.

DIRECT AND TOTAL INSOLATION



Small Community Solar Thermal Power Experiment

The first experiment in the electric utility application area will use near-term point-focusing distributed receiver technologies. The experiment will be located in a distinct urban or rural community, preferably, with a peak electric power requirement of less than 20 MWe served by an electric distribution system owned and operated by its own utility. The construction of the experimental solar thermal power plant will be accomplished by a system contractor in a parallel but separate action to site participation. The site participant as a cooperative partner will provide support including:

1. A suitable 10 acre site with appropriate zoning and permits for experimental plant activities.
2. Access roads and utility service to the site.
3. An electrical interface to the participant's distributional network.
4. Various data, maintenance and operational support services.

<u>Site Development Trends</u>

Increased competition for the most desirable sites is resulting in higher costs and the use of marginal sites. Regulatory requirements are also increasing, and the involvement of more agencies is leading to increased permit acquisition time. At the same time construction costs are rising more rapidly than general inflation. Further, local authorities are imposing additional development requirements including peripheral and off-site development. These trends increase the importance of site planning.

SITING FACTORS

Factors for any kind of site development can be considered within three categories. Resource availability includes not only the resources important to the development, but also those environmental factors which mitigate the effectiveness of the resources. Site availability includes the actual acquisition of the site together with the regulatory environment which affects the timely availability of the site for the intended development. The remainder of this paper addresses these siting categories as they affect an experimental solar thermal power plant.

<u>Site Resources</u>

Solar Thermal System Requirements

The most important resource required by a solar thermal power plant is direct normal insolation. While this is primarily a regional resource it also varies with local atmospheric shading conditions. Environmental factors such as wind impact the effective utilization of the solar resource while dust and pollutants can degrade the ability of the system to utilize the solar resource.

Direct Normal Insolation

The solar resource includes direct and diffuse components. Flat plate, low temperature technologies utilize both components, and most solar data is measured as total insolation on a horizontal surface. Point-focusing solar thermal systems track the sun and concentrate the solar energy to produce high temperatures. Since the diffuse insolation component cannot be effectively concentrated, these systems utilize only the direct normal insolation component.

Figure 1 illustrates the difference between direct and total insolation for two winter days in the California desert. On a clear day the direct normal insolation exceeds the total horizontal insolation because of the cosine of the sun's inclination angle. On the unclear day the situation reverses. The total horizontal insolation remains at about half of the clear day levels, consisting primarily of the diffuse component. However, there is little effective direct normal insolation. This difference between direct and total insolation results in different regional distributions. There is a dominant latitudinal variation in total horizontal insolation while there is a dominant longitudinal variation in direct normal insolation, primarily due to cloud cover.

Local Obscuration and Shading

Local available direct insolation may differ significantly from the indicated regional values. Fog or clouds can reduce the indicated regional insolation while regional insolation may be understated if there are local cloud conditions at the nearby measuring station. The local insolation resource can also be reduced by shading from nearby topographic features or buildings which interrupt the solar view in southerly directions above a 10 degree angle from the horizontal. North facing slopes on the site require greater spacing between concentrators to preclude shading from adjacent concentrators. Future land uses adjacent to the site must be considered, and this may involve easements for solar access.

Environmental Factors

The effective availability of the insolation resource may be mitigated by various environmental factors. Concentrator structures are designed to withstand 100 mph winds when stowed, but they will not operate at full efficiency in winds exceeding 30 mph. Dust and air pollution require more frequent concentrator cleaning and may lower the efficiency of concentrator surfaces.

Site Availability

Site and Permit Acquisition

Competition for land has led to the increased use of sites with some kind of development problem. Indeed, some land may not be available for development at any reasonable cost or effort. Additionally, the acquisition of title is no guarantee that the land will be available for the intended development. Zoning and land use plans are becoming increasingly important factors, and proposed developments proceed more smoothly if they are compatible with these plans rather than in opposition. This can mean the difference between a minimum permitting effort and costly, time-consuming public hearings.

Environmental Impact

One of the advantages of solar thermal power is the renewable, clean nature of the solar energy resource. Hence, solar thermal power will have less environmental impact than fossil or nuclear power plants. In addition solar power is perceived by the public to be environmentally desirable. However, potential environmental impacts cannot be ignored. Any development project disrupts the env ironment on and around its site. Washing of collectors and potential spills of heat transfer fluids could affect nearby aquifers. The visual impact of collectors may be offensive to some. These potential impacts and alternative land uses need to be considered not only with respect to the permitting of the experimental plant, but also with respect to public perception of eventual large-scale solar thermal development.

Site Development

Solar Thermal Land Requirements

The dispersed nature of the solar resource leads to rather large land area requirements for solar thermal power plants. Land requirements for near term technologies are approximately 10 acres for a plant with a peak power output of 1 MWe. As system efficiency increases it is expected that this will be reduced to about 3 acres per MWe, still a large area compared to direct fossil plant requirements.

Site Preparation Costs

Because of the large area requirements, site preparation is an important part of the total cost of a solar thermal power plant. Site preparation includes clearing, grading, drainage, access and perimeter improvement. These activities are part of a mature construction technology with little opportunity for cost reduction through technology improvement.

Site preparation costs are also significantly affected by size. The land requirements for a plant are non-linear because of the unused area around the plant perimeter. Unit costs for clearing and grading are fairly constant with size but perimeter costs vary with the square root of area because of the geometric relationship. Perimeter development requirements for architectural walls, landscaping, et cetera cannot be overlooked, particularly when the plant is located in or near town close to the end user.

Potential Reduction of Site Preparation Costs

As solar thermal system costs are reduced, site preparation and construction becomes proportionally a more important cost factor. Several approaches to cost reduction have been considered. Higher system efficiency with the resulting lower area requirement has an obvious effect as does the selection of sites with minimum development requirements. Beyond this, collector foundation construction similar to that for transmission towers is being considered to reduce the grading at each collector location and to minimize access requirements to construction equipment. Field layouts can be considered which utilize a site primarily in situ. This may increase collector spacing but could still considerably reduce site preparation efforts.