PDH-Pro.com

Central Solar Hot Water System Design

Course Number: SU-02-204

PDH: 10

Approved for: AK, AL, AR, DE, FL, GA, IA, ID, IL, IN, KS, KY, LA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OK, OR, PA, SC, SD, TN, TX, UT, VA, VT, WI, WV, and WY

State Board Approvals

Florida Provider # 0009553 License #868
Indiana Continuing Education Provider #CE21800088
Maryland Approved Provider of Continuing Professional Competency
New Jersey Professional Competency Approval #24GP00025600
North Carolina Approved Sponsor #S-0695
NYSED Sponsor #274

How Our Written Courses Work

This document is the course text. You may review this material at your leisure before or after you purchase the course.
After the course has been purchased, review the technical material and then complete the quiz at your convenience.
A Certificate of Completion is available once you pass the exam (70% or greater). If a passing grade is not obtained, you may take the quiz as many times as necessary until a passing grade is obtained).
If you have any questions or technical difficulties, please call (508) 298-4787 or email us at admin@PDH Pro.com.

Module 1: Introduction

Learning Objectives

By the end of this section, you will be able to:

- **Identify** the federal mandates and legislative requirements governing the integration of solar thermal systems in new and renovated federal facilities.
- **Evaluate** the economic and operational advantages of central solar hot water systems compared to decentralized, standalone configurations.
- **Differentiate** between "Central Solar Hot Water Systems" and small-scale solar applications within the context of building clusters and district heating.

Executive Summary: Federal law (EISA 2007) mandates that 30% of hot water demand in new or majorly renovated federal buildings be met by solar thermal technology if lifecycle cost-effective. Transitioning from standalone building systems to **Central Solar Hot Water Systems** for building clusters (e.g., barracks, gyms, hospitals) significantly improves reliability and economic viability by leveraging economies of scale and modern heating network innovations.

Regulatory Framework and Compliance

Solar thermal systems serve diverse roles including domestic water heating, space heating, industrial process heating, and cooling applications. For the Professional Engineer working on federal projects, compliance is driven by specific legislation:

- **Energy Independence and Security Act (EISA) 2007 SEC. 523:** This statute requires that at least **30% of the hot water demand** for each new Federal building or major renovation be met through solar hot water heaters, provided it is lifecycle cost-effective compared to other technologies.
- **Current Market State:** While NREL and ASHRAE provide robust guidelines for small systems, their complexity and the local costs of fossil fuels have historically limited solar adoption in the U.S.

The Shift to Centralized Systems

Recent innovations have proven that **integrated solar-supported heating networks** (common in Denmark, Germany, and Austria) offer higher reliability and better economics than small-scale, standalone units.

Central Solar Hot Water Systems

- **Centralized Fields:** Utilizing a large solar thermal field to serve multiple buildings.
- **Building Clusters:** Ideal for Army barracks, dining facilities, gyms, Child Development Centers (CDCs), and swimming pools.
- **Thermal Networks:** Integration with district or central heating systems to provide a unified thermal energy source.

Strategic Design Considerations

When planning for building clusters, engineers must weigh the benefits of centralized versus decentralized solar thermal systems.

Terminology and Scope

Throughout the industry, "district heating system" and "central heating system" are often used interchangeably. In this manual, **Central Solar Hot Water System** specifically denotes systems serving building clusters from a large centralized field. This guide provides:

- Optimal and reliable configurations across different climates.
- Planning principles and design specifications.
- Case studies and simulations based on real-world scenarios.

💡 **Design Tip:** When evaluating a large campus (like a hospital or military base), prioritize a centralized solar field over individual building units to improve the **lifecycle cost-effectiveness** required for EISA 2007 compliance.

Checkpoint Quiz

---

1. **According to EISA 2007 SEC. 523, what is the minimum percentage of hot water demand that must be met by solar thermal systems in new Federal buildings, if lifecycle cost-effective?**
   a) 15%
   b) 25%
   c) 30%
   d) 50%

Answer: (c). The text explicitly cites EISA 2007 SEC. 523 as requiring at least 30% of demand be met by solar if cost-effective.

2. **Which of the following facilities is identified as a primary candidate for Central Solar Hot Water Systems?**
   a) A single isolated administrative office.
   b) A cluster including Army barracks, dining facilities, and gyms.
   c) Small-scale residential family housing without a central network.
   d) Remote telecommunications towers.

Answer: (b). These facilities have significant DHW needs and benefit from centralized thermal fields.

3. **What is a primary driver for the increased economic viability of Central Solar Hot Water Systems in recent years?**
   a) Decreased cost of fossil fuels.
   b) Innovations in solar supported heating networks and integrated systems.
   c) Simplification of small-scale design guidelines.
   d) Elimination of lifecycle cost-effectiveness requirements.

Answer: (b). The introduction notes that innovations in these areas have proven these systems to be more economical and reliable.

Module 2: Solar Energy

Learning Objectives

By the end of this section, you will be able to:

- **Analyze** the impact of geographic location, latitude, and environmental factors on solar radiation intensity and system efficiency.
- **Determine** the optimal tilt and azimuth angles for solar collectors based on site-specific latitude and seasonal heating demands.
- **Calculate** minimum separation distances for collector rows to mitigate shading losses during peak and winter solar periods.

Executive Summary: The performance of a Central Solar Hot Water System is directly proportional to solar radiation intensity, which is mitigated by atmospheric scattering and cloud cover. For maximum annual energy yield in the Northern Hemisphere, collectors should be oriented due south with a tilt angle equal to the site's latitude. Engineering design must account for "global radiation"—the sum of beam and diffuse radiation—while strategically managing collector placement to avoid shading between 9 a.m. and 3 p.m.

Solar Radiation Intensity

The efficiency of solar water heating systems depends heavily on a site's solar resource. This resource is measured by radiation intensity, though latitude and cloud cover are critical variables in the purchase and design decision.

- **Geographical Variance:** Tilted flat plate collectors at an angle equal to the latitude receive the highest sunlight levels in the Southwest U.S. and the lowest in the Pacific Northwest and Northeast.
- **Efficiency vs. Temperature:** While output is proportional to sunlight intensity, efficiency decreases as the collector temperature rises relative to the ambient environment.

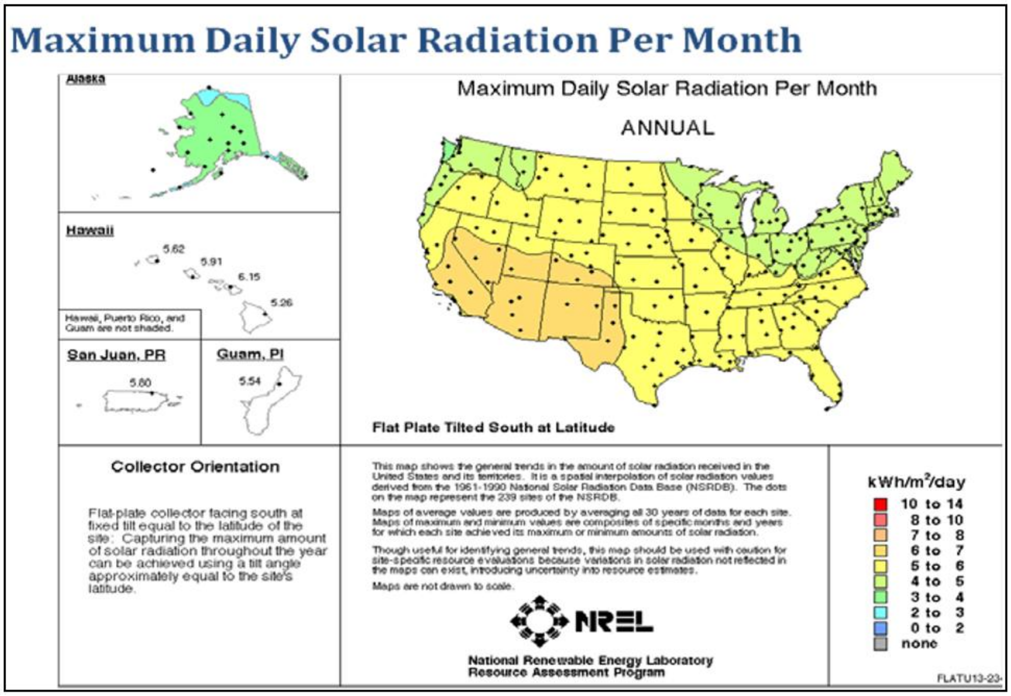

Figure 2.1: Map showing the maximum daily solar resource available for tilted flat plate solar collectors in the United States.

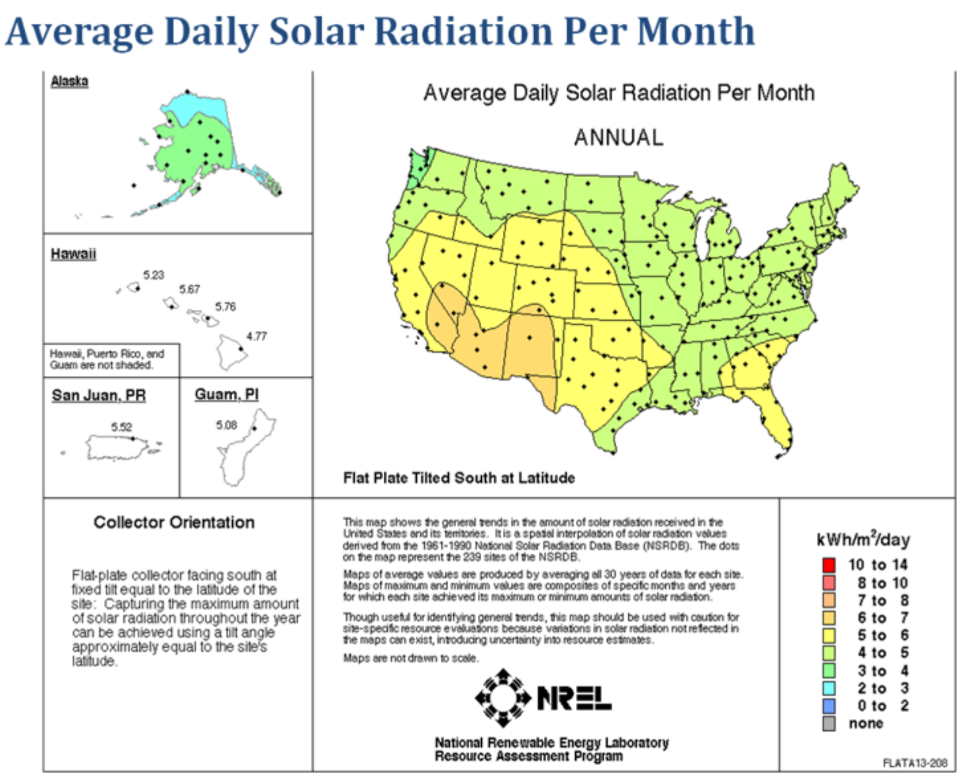

Figure 2.2: Map showing the average daily solar resource for tilted flat plate collectors in the United States.