Daylighting Systems

The NDCEE investigated energy-efficient interior daylighting technologies. Daylighting systems use sunlight to illuminate interior workspaces and may provide cost benefits while improving the quality of the work environment. The NDCEE worked with Fort Bragg, North Carolina, to assess three types of daylighting systems as alternatives to the current lighting technologies.

Problem Statement

The Directorate of Public Works (DPW) at Fort Bragg estimated spending for all types of lighting energy at $3.8 million annually.

Executive Order 13423, "*Strengthening Federal Environmental, Energy, and Transportation Management*," the Army Energy Strategy, and Army Regulation 420-49, "*Utility Services*," mandate that Army installations reduce energy consumption and promote indoor environmental quality. Since lighting uses high-cost electrical energy, it provides an attractive target for energy reduction efforts.

Technology Description

Daylighting systems reflect sunlight through an opening in the roof or sidewall of a building into the desired room or space, thereby replacing the light required from electric sources. In rooms or areas that require a certain amount of light throughout the day, the daylighting system uses sensors to detect changing light patterns. The system controls then adjust electrical light fixtures to augment light levels if the system falls below a pre-determined threshold. The daylighting systems also contain a light baffling system to reduce or eliminate daylight should the user desire a darkened room during daylight hours. The technologies investigated have two primary differences: (1) how they capture sunlight; and (2) how they transmit the light into the building.

- **Capturing sunlight**. Daylighting systems capture daylight on a building's roof or sidewall either passively with a stationary mirror/prism or actively via a mirrored mechanism that tracks the angle of the sun throughout the day.
- **Transmitting sunlight.** The daylight captured on the roof or sidewall must be transmitted to the desired area. Daylighting systems accomplish this either: (1) directly by redirecting sunlight into a space using architectural features, (2) indirectly through tubes using mirrors to enhance light transmission, or (3) through fiber optics.

The specific daylighting technologies that the NDCEE investigated were:

- **SunTracker ONE by Ciralight Corp**. This system actively collects light using sun-tracking mirrors and transmits the light to an interior location through an opening in the roof.
- **Hybrid-Solar Lighting (HSL) 3010 by Sunlight Direct, Inc.** A roof-mounted active mirror collection device is used in this system. Light is then transmitted to the room-level hybrid solar lights via fiber optic cables.
- **SolaTube™ System by SolaTube International, Inc.** The SolaTube system passively collects daylight using a light-bending reflector mechanism and transmits the light through an opening in the roof to room level.

Environmental, Safety, and Occupational Health (ESOH) and Cost Benefits

- **ESOH Benefit**. The impact of natural light over artificial light on worker wellness is well documented. Light is a key factor (rivaled only by air quality) in a healthy and productive work environment. Therefore, daylighting technologies may provide Department of Defense (DoD) installations to offer the wellness benefits of natural light to workers.

NDCEE

National Defense Center for Energy and Environment

DoD Executive Agent
Office of the Assistant Secretary of the Army (Installations and Environment)

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- **Cost Benefit**. Electric lighting consumes a large portion of electrical energy, and introducing daylight can help DoD sites reduce energy costs. Fort Bragg, for example, estimates current spending for all types of lighting at $3.8 million annually. Daylighting systems could displace some energy cost.

Technology Benefits and Advantages

- Provides an alternative to high-cost electrical energy
- Contributes to improved worker wellness, which may result in improved productivity, better performance, higher-quality work, and increased employee retention

Technology Limitations

- Some daylighting technologies have long economic payback periods
- A conventional lighting system is still required to augment the daylight system during dark periods
- Some of the lighting technologies are new and require some improvements to overcome issues, such as flickering
- Many of the roof-mounted technologies are only viable for the top floor of a building, or at most, down one level from the top floor

Accomplishments

For this effort, the NDCEE: (1) investigated several technologies, (2) selected three candidate technologies for evaluation; and (3) installed the three candidates at Fort Bragg where DoD personnel are continuing to assess performance.

Technology Transition Opportunities

The ESOH benefits of daylighting technologies offer potential benefits to most, if not all, DoD installation. Additionally, because high energy costs result in increased cost savings and shorter paybacks for daylighting technologies, the implementation could be especially beneficial at DoD installations with higher electricity rates.

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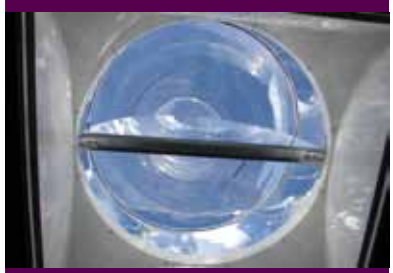
SunTracker ONE

The dome, mirror, and tracking mechanism of a SunTracker ONE system is mounted on the roof of the DPW building at Fort Bragg, NC. A solar cell powers the tracking mechanism that controls the mirrors to optimize the sunlight transmitted to the lobby below.

Hybrid Solar Lighting

The HSL-3010 active tracking mirror (shown above) collects light and transmits it through fiber optics into the conference room. For the HSL Daylight system, two additional solar-powered lighting tubes are introduced to the conventional four-tube fluorescent tubes to keep light in the room constant and to optimize the use of solar power (shown below).

SolaTube



The picture above shows the SolaTube installed in Fort Bragg's Customer Service Conference Room before the diffuser was installed. The SolaTube is segmented for easy installation. The baffles here are in the open position.