# Solar FAQs

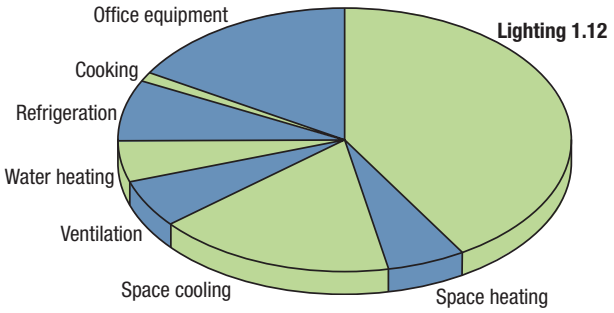
## Hybrid Solar Lighting

### What is hybrid lighting?

Researchers are exploring novel means of using sunlight directly to illuminate the interior of buildings. Hybrid lighting systems use both natural and electric light sources to co-illuminate these spaces. Control systems with photosensors continually monitor the level of natural light present and adjust the electric light output accordingly.

### Why consider hybrid lighting?

In commercial buildings, electric lighting is the greatest consumer of electricity.[1] Unfortunately, generating electricity by conventional power plants—to power lights and other end-use equipment—is the most significant cause of air pollution in the buildings sector. Hybrid lighting can help conserve electricity in proportion to the amount of sunlight available.




*Electricity use in U.S. commercial buildings (in quadrillion BTU per year).*

### Is hybrid lighting available today?

Yes. Hybrid lighting systems that use conventional skylights combined with dimmable fluorescent lamps are becoming commonplace for general lighting in buildings that have large, open areas and high ceilings, such as retail stores and warehouses. Unfortunately, general lighting in such buildings represents only a small fraction of the total commercial lighting market. And building owners are reluctant to include daylighting—strategies to use and incorporate daylight—in most other types of commercial buildings.

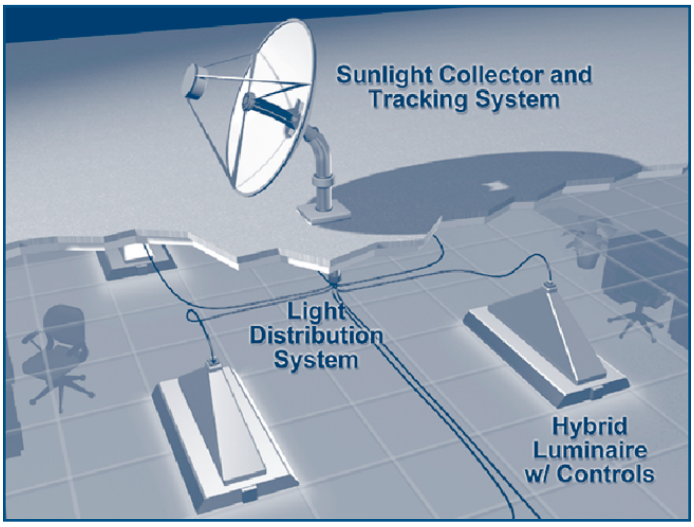
The same advantages of electric lighting—flexibility, convenience, reliability, and control—that marginalized the use of daylight in the 20th century will be vital to the resurgence of daylighting this century. Specifically, future hybrid lighting systems must be:

- *Multifunctional*—compatible with different electric lamps and light fixtures used for several lighting applications beyond general illumination.
- *Reconfigurable*—easily modified as lighting needs change.
- *Seamlessly integrated*—to ensure that undesirable disruptions in lighting do not occur on cloudy days or at night.
- *Architecturally compatible*—designed to eliminate architectural design hassles and maintenance problems limiting the use of daylight; and
- *Affordable*.

A new strategy called hybrid solar lighting (HSL) is a logical pathway for achieving these goals because it uses small, flexible optical fibers. HSL eliminates most skylight-related problems, is applicable to more building types, and can be used for more than just general lighting. Consequently, the potential near-term energy savings of HSL is enormous.

### What is recent progress on HSL systems?

HSL prototypes developed by a research consortium led by the U.S. Department of Energy's Oak Ridge National Laboratory are proving that the concept is viable both technically and economically.[2] The latest prototype provides lighting practitioners with unprecedented design flexibility and control over where and how sunlight is used inside buildings. A sun-tracking solar collector located on the rooftop uses a large primary and small secondary mirror to concentrate sunlight into a high-performance, polymer-fiber-optic bundle consisting of 126 optical fibers, with each fiber 3 mm in diameter. Each fiber can distribute about 350 lumens of light to several different hybrid luminaires (or light fixtures) on a sunny day, which makes possible numerous new daylighting applications. For example, some hybrid luminaires being developed allow HSL to be used with linear and compact fluorescent lamps and with incandescent/halogen lamps.




*A schematic of the hybrid solar lighting (HSL) concept. The collector (dish) on the roof gathers sunlight into optical fibers that distribute the light to hybrid luminaires illuminating interior spaces.*

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*This second-generation HSL collector incorporates single primary and secondary mirrors and one bundle of 126 polymer fibers, each 3 mm in diameter. Three such fibers can distribute as much light as that from a 60-watt incandesent light bulb.*

## What are HSL's advantages and disadvantages compared to conventional skylights?

The main drawback compared to skylights is that HSL requires motors, electronics, and sophisticated control algorithms to continually align the solar collector with the sun.

However, numerous advantages exist for using HSL instead of skylights:

- Roof penetrations are small and minimal, reducing the potential for leaks.
- Infrared and ultraviolet energy in sunlight is separated from the visible light, rather than being transmitted into buildings. Heating, ventilation, and air-conditioning loads (HVAC) loads are thus reduced by 5% to 10%, compared to electric lighting systems.
- HSL systems are readily adaptable to commercial buildings with multiple floors, relatively low ceiling heights, and interior walls. A single system can distribute enough sunlight to co-illuminate several rooms in a typical office building.
- Large portions of precious plenum space—the area between the roof and drop ceiling—are not needed, so there is little competition with other building services, such as HVAC ducts, sprinkler systems, and electrical conduits.
- HSL can be used in direct, ambient lighting (as in sky lights), but also, for indirect, task, and accent lighting applications.
- In retrofit markets, HSL is easily incorporated into existing building designs, and the optical fibers can be rerouted to different locations as lighting needs change. By intentionally misaligning the solar collector from the sun, occupants can even dim or curtail distributed sunlight.

## What is the future of HSL?

Much work lies ahead before HSL's potential is fully realized. For example, one concern is the long-term aging of the polymers used in optical fibers to distribute concentrated sunlight. Another issue for several lighting applications described above is that new luminaires and control strategies must be developed to provide seamless transitions between natural and electric illuminants on partly cloudy days. Interestingly, recent studies show quantifiable improvements in student performance, worker productivity, and retail sales in buildings where daylight replaces electric lighting. These studies should be extended to determine if similar benefits are realized by hybrid solar lighting.

## What will be the initial market for HSL?

The first HSL market will likely be on the uppermost two floors of commercial buildings having the following characteristics: (1) located in the Sun Belt and in areas where daytime electricity prices are highest, (2) occupied every day, including weekends, and (3) in lighting applications where lighting quality (or color rendering) is important and less-efficient electric lamps are currently used.

## References

[1]Data from the Energy Information Administration, *www.eia.doe.gov*

[2]Hybrid Lighting R&D Program, *www.ornl.gov/hybridlighting*

*Optical fibers, both large and small, distribute collected light to hybrid light fixtures.*

*This halogen lamp in a track-lighting application is a hybrid luminaire that includes three smaller solar light sources.*

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**Contact Information:**
Jeff Muhs
Solar Energy R&D Program
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, TN 37831
865-574-9328
muhsjd@ornl.gov

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