New Generation Solar Lighting Solutions

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First Light Technologies Ltd.
455 Banga Pl., Suite 104
Victoria, BC V8Z 6X5
Canada
Toll-Free:1-844-279-8754
Email: info@firstlighttechnologies.com
Web: http://www.firstlighttechnologies.com

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Presented by: First Light Technologies Ltd.
455 Banga Pl., Suite 104
Victoria, BC V8Z 6X5
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Description: Solar lighting solutions require a level of due diligence to determine a good fit between customer, product, and vendor. This course provides an overview of the factors that require consideration when specifying an outdoor solar lighting system. Also discussed are the components, features, and benefits of the newest generation of off-grid, self-contained solar lighting that offers a cost-effective solution for an expanding number of applications.

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Purpose and Learning Objectives

Purpose: Solar lighting solutions require a level of due diligence to determine a good fit between customer, product, and vendor. This course provides an overview of the factors that require consideration when specifying an outdoor solar lighting system. Also discussed are the components, features, and benefits of the newest generation of off-grid, self-contained solar lighting that offers a cost-effective solution for an expanding number of applications.

Learning Objectives:

At the end of this program, participants will be able to:

- discuss the history, the market challenges, and the opportunities related to the solar lighting industry
- describe the components of solar lighting systems, including batteries, LEDs, optics, and types of solar lighting controllers
- state the economic advantages and the sustainable benefits of off-grid solar lighting and how it can contribute to the achievement of LEED® credits
- assess the right solar lighting solution based on site considerations, illumination requirements, and economics, and
- compare the installation considerations, costs, and aesthetics of distributed solar lighting versus self-contained solar lighting systems with predictive adaption technology.

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Introduction to Solar Lighting

History of Solar Lighting

In the 1990s, solar lighting emerged as a way of providing illumination to areas where it was not possible with traditional wired lighting. With high costs and limited lighting technology, the industry experienced minimal traction.

Around 2005, with the introduction of more capable white LED technology, the industry started to make the kind of improvements to lighting performance that one day might be able to capture mainstream appeal.

Today, advances in LED and control technology and battery development, reducing costs, and a maturing marketplace have the industry producing products that have finally gained mainstream acceptance.

Market

Solar lighting is a technically challenging field and, as such, requires significant focus and energy to not only produce quality solar lighting fixtures, but to apply the latest technology towards innovation and continuous improvement.

As with any technical product purchase, a level of due diligence is required to determine a good fit between customer, product, and vendor.

Throughout this course, we will review and evaluate the various technologies that exist, including recent advances in self-contained solar lighting. Also explored are the benefits that this new generation of solar lighting solutions provides that have made it a compelling design choice and cost-effective solution for an expanding range of applications and locations.

Self-Contained Solar Lighting: Luminaries and Bollards

Market

Today, there is a solar powered option for many outdoor lighting product categories; the industry is split into two common design approaches.

- **Distributed solar lighting** uses large solar panels, batteries, and fixtures that are housed independently; this system relies on an extensive modeling process to customize the light to its precise environment.
- **Self-contained solar lighting** has all of its (smaller) components contained within a single housing unit, including LEDs, batteries, solar modules, and controllers. Due to recent technological developments, these lighting products can use intelligent controls to adapt to their environments and maintain efficient operation.

Distributed Solar Lighting

Self-Contained Solar Lighting

Challenges

There is a lack of product and technical knowledge and education specific to outdoor solar lighting in the design and specification community. This lack of knowledge and education makes it difficult for the design and specification community to easily judge performance and quality of a solar lighting system.

Combined with this, a holistic consideration for the project site is critical to appropriately specify solar lighting products.

Challenges

As with any industry, there are good quality and poor quality products.

When researching potential solar lighting, it is wise to keep in mind that if the manufacturer’s claims seem too good to be true, they just might be. A good manufacturer should be able to fully explain and/or substantiate their product claims.

Architectural-quality products carry the perception of being cost-prohibitive. Although the purchase price of quality solar lighting fixtures may come at a premium compared to wired lighting products, the right solar solution in the right application will realize a net cost benefit largely due to savings achieved during installation.

Opportunities

Technology has been a significant enabler of solar lighting viability in recent years, and the improvements in performance, cost, and battery life will continue to enhance solar lighting's reputation as a mainstream product choice for an increasing number of projects.

In addition, there is a generational mind-shift reflected in all levels of government that recognizes the value in clean energy technology and is ready to embrace these alternatives more readily than in the past.

Driven by an upsurge in community infrastructure projects, pedestrian-scale solar lighting (as the most cost-effective lighting option) is the segment where the design community stands to benefit the most.

Solar Lighting & Enabling Technologies

Solar Lighting & Enabling Technologies: Introduction

Next, we review the technology options and design approaches related to the solar lighting industry including:

- solar modules
- batteries
- LEDs
- optics
- solar lighting controllers (SLC), and
- a traditional design approach versus intelligent control.

Solar Modules

Solar modules are often judged by their efficiency.

Depending upon the quality and technology used, the efficiency of a solar module can range from as low as 8% to as high as 22%. A module with greater efficiency can generate more power for a given area than a lower efficiency module.

There is ongoing research into improving solar module efficiency (and there are some significant advances with multi-junction solar cells), but these are mostly limited to laboratories and are not yet commercially available.

The most important commercial improvements have come in the form of significant cost reductions. The Deutsche Bank has estimated the module cost has declined 60% since 2011 and expects a further 40% reduction through 2017.

Source: http://cleantechnica.com/2015/01/29/solar-costs-will-fall-40-next-2-years-heres/

Solar Modules: Technology Options

There are currently three main technology options available for solar lighting applications:

- Amorphous
- Polycrystalline
- Monocrystalline

Amorphous technology is the lowest efficiency option, often used for large-scale utility solar power systems where space is not a constraint. This option can yield flexible modules that can be used on curved surfaces. Amorphous modules are a less popular option today given the significant cost reductions seen for crystalline modules.

Polycrystalline modules are more efficient than amorphous modules, but less efficient than monocrystalline modules. This technology is less costly than monocrystalline, but the larger module size can increase the cost of other solar lighting system components (mounting structures, poles, foundations, etc.).

Monocrystalline is the most efficient solar module option commercially available. This technology is costlier than polycrystalline, but provides the most compact option and is the best choice for self-contained solar lighting.

Batteries

Solar lights must collect energy during the day, store the energy in a battery, and use this energy to power lights at night.

In addition to storing enough energy for one night, the batteries must provide additional storage for cloudy periods when the sun can’t fully recharge the battery.

The predominant battery used in solar lighting is lead-acid. Lead-acid is one of the oldest and most widely used and trusted battery technologies. Its strengths include low cost, wide availability, and good recyclability. Plus, they are easily charged and they hold their charge relatively well. If charged properly, lead-acid batteries can have a reasonable lifespan of three to five years in solar lighting applications.

While lead-acid batteries have many strengths, they also have weaknesses. Lead-acid batteries must be fully charged as often as possible. When a lead-acid battery is not fully charged, sulfation can result. Sulfation traps the battery’s storage capacity in small, insoluble crystals which reduces the capacity and efficiency of the battery. During extended periods of cloudy weather, lead batteries can’t fully charge. As a result, sulfation will eventually kill many batteries used in solar applications. Lead-acid batteries are also very heavy, and as most solar lights are on tall poles, this is a distinct disadvantage. Although easy to recycle, lead-acid batteries are toxic. However, much like motor oil and paint, most communities have long-established methods of safely disposing of these common but toxic substances.

Batteries

While there are many other battery technologies—such as nickel-metal-hydride and nickel-cadmium—lithium batteries are making the largest advances into the world of solar lighting. Now that electric cars are using vast numbers of lithium cells, the manufacturing costs are being driven down by increased manufacturing capacity.

Lithium batteries, with lithium iron phosphate ($LiFePO_4$) as the most common option, have many advantages over other battery options. The primary advantage is their lifespan. Lithium batteries often provide up to five times the cycles of a comparable lead-acid battery. In addition, lithium batteries do not need to be charged completely after every cycle. This makes them more suitable for the variability of solar charging. Although they cost more, the longer life more than offsets the added cost, resulting in lower lifecycle cost.

For a given capacity, lithium batteries are also significantly smaller and lighter than a lead-acid battery. This provides for new design freedom, helps reduce the size of a solar lighting product, and can also lower the costs of associated components, such as enclosures, poles, and foundations.

The temperature range of lithium batteries used to limit their applicability to areas with mild climates. However, given the advances in performance, they are now able to be widely used in different climates and are typically available with -20°C to 60°C (-4°F to 140°F) ratings. As a result of their many advantages, lithium batteries are the best choice for most solar lighting applications.

LEDs

LEDs have been responsible for a revolution within the lighting industry. They have quickly become the lighting technology of choice for almost all applications. The advantages of LEDs are widely known, and solar lighting has benefited tremendously based on the improvements and cost reductions that have been achieved over the last ten years.

LEDs

Summary of benefits:

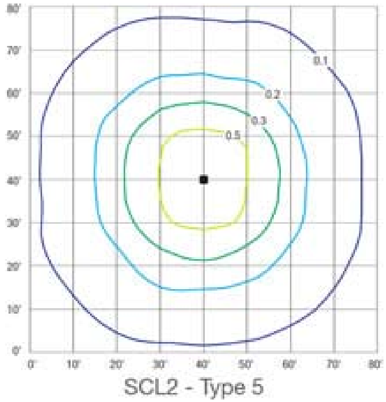
- LEDs are the most efficient choice today, and performance is still expected to significantly improve over the foreseeable future.
- A DC device is controllable and dimmable; given that the solar modules and the batteries are also DC devices, there is no need to convert to AC which sacrifices efficiency and reliability.
- A variety of color temperatures are available to provide the most appropriate light output depending on project needs.
- Life and lumen maintenance exceed all other options.
- Costs have come down significantly and it is expected they will continue to decline.

Optics

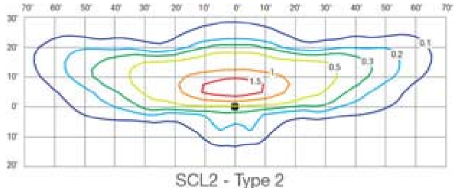
All lighting technologies require optics to shape the light to suit the application.

Fortunately, LEDs have another large advantage here too. LEDs are directional and very small, and they do not get as hot as many other light sources, such as incandescent. As a result, plastic can be used to create very precise and inexpensive optics that fit closely over the LEDs. These optics can shape the light more precisely than the typical reflector used with traditional light sources.

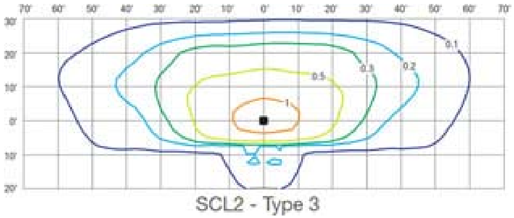
A good optical design can compound the great efficiency of LEDs to create an extremely effective luminaire. For solar lighting products, the absolute number of lumens available may be less than a wired light fixture. However, it's important to judge performance based on application illuminance versus metrics such as power or lumen output.



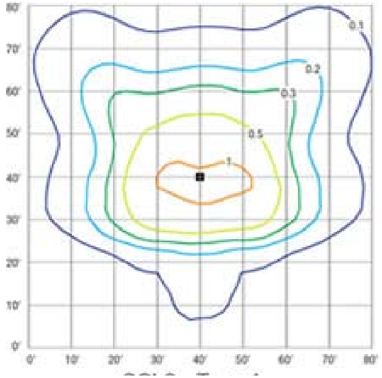
Self-Contained Solar Lighting Luminaire Type 5



Self-Contained Solar Lighting Luminaire Type 2



Self-Contained Solar Lighting Luminaire Type 3


Self-Contained Solar Lighting Luminaire Type 4

Solar Lighting Controllers: Components

The heart of any solar lighting product is the solar lighting controller (SLC), sometimes called an energy management system (EMS). The SLC is responsible for all functions, including charging the batteries and controlling the LEDs. An SLC is typically composed of the following building blocks:

- Charge controller
- LED driver
- System management
- Interfacing/communications

A review of each component follows, beginning with charge controllers.

Charge controllers regulate and optimize the charge from a solar panel to the battery bank, and they come in a variety of types:

- Shunt
- Pulse-width modulation (PWM)
- Maximum power point tracking (MPPT)

Solar Lighting Controllers: Charge Controllers

Shunt Controllers:

- Offering the lowest efficiency, a shunt controller is the simplest type of SLC and is only used on the lowest-performing solar lighting products.
- The solar module is directly connected to the battery.

Pulse-Width Modulation (PWM) Controllers:

- The solar module is directly connected to the battery, but it modulates charging via variable width pulses.
- Better efficiency than shunt controllers, but highly dependent on having the solar module and battery voltage match.
- Commonly used for distributed solar lighting systems.

Maximum Power Point Tracking (MPPT) Controllers:

- The most complex and efficient design (best choice for solar lighting).
- The solar module and battery are not directly connected, which provides design freedom to optimize the performance of the solar module and the battery.
- The maximum power of the solar module varies based on the intensity of the sun and the temperature.
- MPPT tracks this power point and converts the voltage to the best charging voltage for the type of battery being used; this can yield 25% more power than a PWM controller.

Solar Lighting Controllers: LED Driver

The next component for discussion is the LED driver.

LEDs are most efficiently used with a current-controlled LED driver.

Voltage-controlled drivers—used with the lowest-performing solar lighting products—are inefficient, as they waste power using a current-setting device such as a resistor.

Careful consideration needs to be paid to the efficiency of the driver when dimming is used, as efficiency can decrease dramatically over the dimming range. Current-controlled drivers can be very proficient, and using PWM control can effectively dim LEDs across a wide range with excellent color consistency. Analog dimming can also be used but often causes color shifts within the LEDs.

Attention to driver design is key, and the LED driver should be specifically designed for the LED light engine being used.

Purpose-built solar lighting products will use high-efficiency LED drivers matched to the LED light engine.

Solar Lighting Controllers: System Management

An SLC can use a number of approaches to provide control and system management.

- The simplest method uses basic timers to turn LEDs on and off.
- More sophisticated SLCs are microcontroller-based to provide intelligent control and system management. Features—such as data logging, dimming lighting profiles, and robust day and night determination—are available without the use of a photocell.
- More recently, SLCs have integrated different adaptive lighting schemes in order to provide better performance and greater reliability through more active control of the LED light engine.

Solar Lighting Controllers: Interfacing/Communications

SCLs can also integrate user interface features including:

- switch inputs
- motion sensors
- wired communications interfaces (i.e., USB), and
- wireless communications interfaces:
    - Bluetooth
    - Infrared
    - Wi-Fi
    - Global System for Mobile Communications (GSM), 900MHz
    - General Packet Radio Service (GPRS), 900MHz

Solar Lighting Controllers: Off-the-Shelf Components

Many solar lighting systems use off-the-shelf components to create an SLC. This can provide a functional product, but will always lead to compromises in performance.

Off-the-shelf components are usually designed for solar power applications where cost and flexibility are more important than maximizing performance.

The SLC is a critical component and should be purpose-built to maximize the performance of a given solar lighting product.

Now that we have an understanding of the components of a solar lighting system, we'll move on to discuss the various design approaches used in the industry.

Self-Contained Bollard Solar Lighting

Traditional Design Approach

When cloudy weather blocks the sun, we still expect a solar light to operate. Additionally, seasonal variation reduces the energy available even further.

To address these issues, the traditional approach for designing a solar light is to have the solar module collect sufficient energy during the worst solar time of the year. In addition, the battery is selected to operate the light through the longest expected cloudy periods. The light output is then limited based on these typical worst-case conditions.

This approach works well, but results in using much more solar panel and battery than is required for most of the year. In turn, this dramatically increases the system cost. During the spring and summer, most traditional solar lights harness less than one-fifth the energy available from the sun through the over-sized solar panel and limited light output.

Intelligent Control

There are options to introduce more intelligence to solar lighting products. For example, there are a number of ways to enable adaptive performance based on real world conditions.

The simplest and most common form of adaption is for a light to dim its output based on the state of charge of the battery. This can allow a light to function for longer periods during cloudy weather while maintaining usable light output.

The most advanced form of adaptive lighting enables the light with predictive capabilities to auto-configure and self-learn about the prevailing conditions of a specific location. This predictive form of adaptive solar lighting provides the ability to make a system with much smaller solar panels and batteries, resulting in a more compact, less expensive system. It also provides for a significant increase in reliability, as the solar light can adapt to conditions that are unusual or unforeseen during the specification stage. Systems with predictive adaption can adjust their light output to match the amount of energy received from the sun, rather than being overbuilt and fixed to the limitations of the worst-case time of year. Lights with predictive adaption can outperform other lights almost all of the time, as they can significantly increase their brightness during seasons with good solar charging.

Benefits of Solar Lighting

Benefits of Solar Lighting: Introduction

Environmentally friendly solar lighting is an alternative energy source that offers a myriad of benefits.

An exploration of these benefits is presented in this section of the course.

- Sustainable benefits
  - Low-impact installation
  - Sustainable material selection/lifecycle
  - Government support/rebates
  - LEED credits
- Economic benefits
- Independence from the grid
- Design freedom

Sustainability: Low-Impact Installation

Consideration should be given to the impact that the installation of certain types of solar lighting will have: installation can be very complex and disruptive, or simple and relatively benign.

The stand-alone nature of most off-grid solar lighting allows for low-impact installation in almost any environment; this is particularly important in areas identified as ecologically sensitive. With off-grid solar lighting, there is no trenching/ conduit installation, and no utility permitting or connection is required.

Sustainability: Material Selection / Lifecycle Considerations

Material selection and lifecycle considerations are key to overall environmental impacts.

Components should be produced with recycled and/or recyclable materials wherever possible, and the products and components should have robust lifecycles that ensure minimum environmental impact.

Note that off-shore factories operate with energy that, by North American standards, is considered dirty energy and has an ecological impact that is difficult to measure.

Sustainability: Global Warming

Most of the world's electricity is generated using high-emission-producing fossil fuels.

The burning of fossil fuels releases CO_2 into the Earth's atmosphere, and the growing concentration of this heat-trapping gas is the primary cause of climate change.

As solar lights generate their own power using the limitless energy of the sun, the use of off-grid solar light can save tonnes of CO_2 emissions every year.

Sustainability: Government Support & Rebates

LED lighting is linked to significantly reducing fossil fuel energy consumption, and therefore receives government support in the form of rebates.

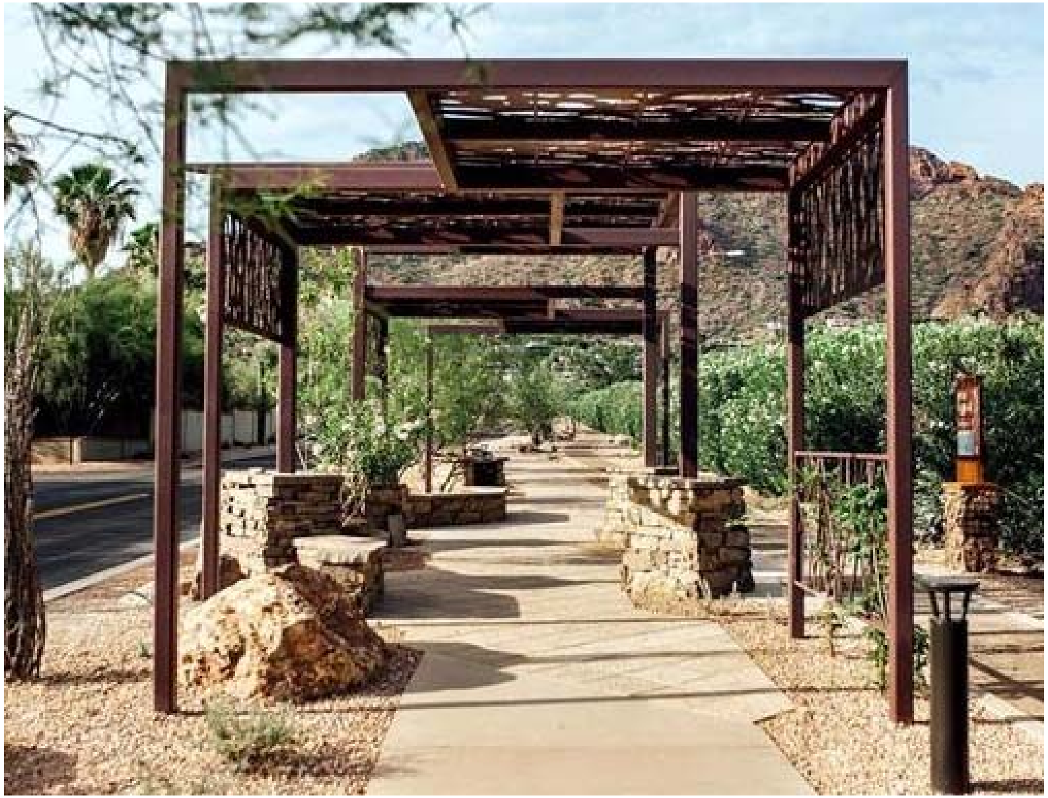
However, the cost benefits for solar lighting are primarily linked to savings associated with installation costs. So, while there are energy cost benefits realized with solar lighting, those benefits are limited and, as such, the government support is correspondingly limited.

This linked resource below can help you determine if your project might be eligible for rebates: http://www.dsireusa.org/.

Sustainability: LEED Credits

Some solar lighting products contribute to the achievement of the following LEED credits:

- SS Credit 8: Light Pollution Reduction
- EA Credit 1: Optimize Energy Performance
- EA Credit 2: On-Site Renewable Energy
- MR Credit 4: Recycled Content



Economics of Solar Lighting: Total Light Cost

Next, we'll examine the economics of solar lighting by comparing the costs of wired lighting, distributed solar lighting, and self-contained solar lighting.

The figures presented in our example are based on a 2,500 linear foot, multi-use trail installation using a luminaire mounted on a 20′–25′ pole.

This chart breaks down the total light costs for each lighting solution.

Type of Lighting	Mounting Height	Light Spacing	Lights Required	Cost Per Light	Total Light Cost
Wired	20′	100′	25	$600	$15,000
Distributed Solar	25′	125′	20	$3,600	$72,000
Self-Contained Solar	20′	100′	25	$1,800	$45,000

Although the cost of solar lighting fixtures can be higher than wired lighting, the cost savings realized in the simplification of the design process and the installation typically offset the initial equipment investment for the system. Depending upon the solar lighting approach used, the cost savings can be significant.

Shown on subsequent slides are the costs for poles, footings, trenching, equipment, and labor, followed by a summary of the total costs.

Economics of Solar Lighting: Total Pole / Footing Cost

The pole and footing costs are slightly higher ($1,750) for distributed solar lighting versus wired lighting and self-contained solar.

This is due to the larger EPA (effective projected area) and weight of the distributed solution.

Distributed solar lighting often requires custom poles and custom design for footings.

Self-contained solar products are comparable in terms of EPA and weight to wired lights, and therefore do not require custom poles or footings.

Type of Lighting	Pole Cost	Footing Cost	Total Pole/Footing Cost
Wired (25 lights)	$350	$500	$21,250
Distributed Solar (20 lights)	$400	$750	$23,000
Self-Contained Solar (25 lights)	$350	$500	$21,250

Economics of Solar Lighting: Trenching Costs

Here we begin to see the significant savings of the solar solutions as they don't require any trenching, cabling, or wiring.

Type of Lighting	Trenching Cost per Foot	Utility Home Run	Utility Meter & Switch Gear	Utility-Related Costs	Trenching Costs
Wired	$25	$2,500	$5,000	$7,500	$62,500
Distributed Solar	$0	$0	$0	$0	$0
Self-Contained Solar	$0	$0	$0	$0	$0

Economics of Solar Lighting: Equipment & Labor Costs

This chart shows the equipment and labor costs associated with each lighting solution. Not all solar products are ready to install out-of-the-box. Product assembly would be completed on-site or at the shop, and installations will incur an additional cost as a result.

Type of Lighting	Bucket Truck Cost per Hour	Bucket Truck Labor Time per Light	Equipment Cost	Assembly Labor Rate	Assembly Labor Hours	Assembly Labor Cost
Wired	$150	0.50	$1,875	$50	0	$0
Distributed Solar	$150	1.00	$3,000	$50	3	$3,000
Self-Contained Solar	$150	0.50	$1,875	$50	0	$0

Economics of Solar Lighting: Total Cost Summary

The total costs (lights, poles/footings, utility, trenching, equipment, and labor) for each type of lighting are summarized on the right column of this chart and illustrate the substantial savings realized by the self-contained solar solution.

Type of Lighting	Light Cost	Total Pole/Footing Cost	Utility-Related Costs	Trenching Cost	Equipment Cost	Assembly Labor Cost	Total Cost
Wired	$15,000	$21,250	$7,500	$62,500	$1,875	$0	**$108,125**
Distributed Solar	$72,000	$23,000	$0	$0	$3,000	$3,000	**$101,000**
Self-Contained Solar	$45,000	$21,250	$0	$0	$1,875	$0	**$68,125**

Independence from the Electrical Grid

Another benefit of an off-grid solar lighting solution is independence from the electrical grid. Because solar lighting fixtures are not dependent on the grid, they are immune from power failures. Furthermore, in typical installations, they are entirely autonomous, so the failure of one fixture does not affect the other fixtures within the installation.

Design Freedom

This independence from the grid provides design freedom to place lights in a variety of locations without grid restrictions. The lack of wiring can also significantly streamline the design and permitting process.

Right Light, Right Site

Right Light, Right Site: Introduction

There are times when a solar lighting solution works best, and there are certain applications where a grid-powered (wired) lighting solution is the optimum choice for a project.

Determining the right solution requires consideration of the following factors:

- Economics
- Site considerations
- Illumination requirements

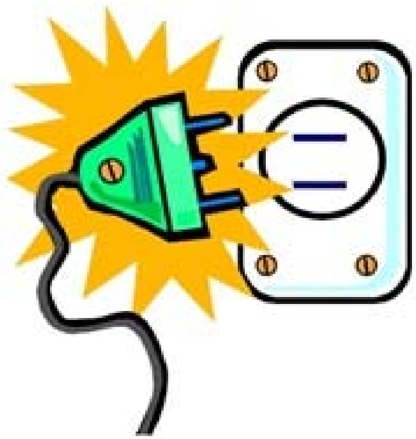
This section of the course provides a review of the above bullet points in order to better understand how to match the “right light with the right site.”

Economics

Is your project site NOT currently connected to the electrical grid? These are some instances when that would be the case:

- New construction
- Aging infrastructure
- Site retrofit (putting lights into a site where none currently exist)

If your site has easy and/or inexpensive access to the grid, solar lighting is probably not a good option. If your site is not served by the grid today, solar lighting will typically be the cost-effective choice.



Site Considerations

Does your project site receive sufficient levels of sunlight?

A solar lighting installation location should receive between two to six hours of direct sunlight per day. It's important to realize that different fixtures will have different requirements, so aligning your site needs with your solar products is imperative.

Note that solar lights should be considered with all other relevant project details (i.e., don't place them in heavily shaded areas, and don't plant trees directly south of the solar light).

A holistic approach to project site planning and lighting choice will yield the best results.

Illumination Requirements

Are your illumination requirements appropriate for solar lighting?

The Illuminating Engineering Society of North America (IESNA) provides the recommended illuminance levels for pedestrian walkways and bikeways.

Following their recommended practices (see sample table at right) typically means that solar lighting can be an effective lighting solution. If in doubt, a reliable manufacturer can assist with validating feasibility.

Table 6: Recommended Maintained Illuminance Levels for Pedestrian Ways
(Taken from Table 2 IESNA DG-5-94; Recommended Lighting for Walkways and Class 1 Bikeways)

Walkways and Bikeway Classification	Mimimum Average Horizontal Illuminance Levels on Pavement* (lux/footcandles)	Average Vertical Illuminance Levels for Special Pedestrian Security** (lux/footcandles)
Sidewalks (Roadside) and Type A Bikeways:		
Commercial Areas	10/1	20/2
Intermediate Areas	5/0.5	10/1
Residential Areas	2/0.2	5/0.5
Walkways Distant from Roadways abd Type B Bikeways:		
Walkways and Bikeways	5/0.5	5/0.5
Pedestrian Stairways	5/0.5	10/1
Pedestrian Tunnels	20/2	55/0.5

*Uniformity ratios should not be greater than 10:1 maximum to minimum
**For pedestrian identifaction at a distance. Values are specified at 1.8 meters (6 feet) above the walkway.
Scotopically rich light should be used




Distributed Solar Lighting Systems

Distributed Solar Lighting Systems: Introduction

The features of distributed solar lighting systems are presented in this section of the course, including their specification and installation considerations, cost, and aesthetics.

Suitability:

Distributed solar lighting solutions should be considered for street light and parking lot applications where mounting heights are 25′ or greater, or where lumen output requirements exceed 3,000 lumens.

Specifying distributed solar lighting:

Typical distributed solar lighting solutions depend heavily on a modeling process to ensure the solution will deliver the required reliability and performance. You will want to work very closely with your provider during this process to ensure the detailed analysis is accurate. Depending on your inputs, it is possible for the modeling assumptions of your project to result in a wide variety of outputs or product-based solutions. Note that this is not an off-the-shelf purchase; approaching it as a custom project, based on your site-specific needs, will yield the best results.

Aesthetics

Typical distributed solar lighting has a utilitarian appearance that is easily recognizable as being solar powered. While some designs have more aesthetic appeal than others, all distributed solar lighting systems will have “visual clutter” and daytime appearance considerations.

It’s also important to note that solar lighting can be the target of theft and vandalism.

- Thieves are attracted by the large solar modules, heavy-duty batteries, and large enclosures that store power for the lights (and other components).
- Vandals are usually drawn to the fragile nature of the solar panels.

The aesthetics of distributed solar lighting are such that it should only be considered if you are not concerned that:

- your lighting fixtures detract from the overall design aesthetic, or
- your site location might be vulnerable to a theft/vandal attack.

Installation Considerations

Distributed solar lighting systems generally have complex installations relative to wired and self-contained solar products, and may require the following:

- On-site assembly
- A dedicated staging area
- Specialized vehicles (scissor lift and/or bucket trucks)
- An installation team of three to six people, including an electrician
- Independent system commissioning report

Note that if your lighting system's power source and lighting fixture are not co-located on a single pole, they will likely require trenching.

Also, it is good practice to confirm with your vendor that your lighting system includes the balance of system (BOS) components, so that all required parts, wires, and cables are on-hand at the time of installation.

Costs

Recall that the product cost for a distributed solar lighting system is significantly higher than wired lighting.

However, without the need to trench or the need for cable access to the electrical grid, the labor costs required for installation of distributed solar lighting systems typically achieve savings that offset its higher product cost.

Both the product and installation costs are lower for self-contained solar lighting, but as previously mentioned, if you have high lumen output prerequisites beyond IES requirements for pathways and parking lots, a distributed lighting system may be a cost-effective choice.

Distributed Solar Lighting: Summary

Summarized below are the important points related to distributed solar lighting.

- High lumen outputs and large area lighting are achievable at a greater value than wired lighting.
- Distributed solar lighting provides total project cost savings versus wired lighting.
- Compared to self-contained solar lighting, a distributed solar lighting product is more expensive and has a more complex installation process.
- Distributed solar lighting requires a time-consuming specification process (location-specific modeling required, project-based).
- The performance and reliability of distributed solar lighting are strongly dependent on the site conditions and specification process.
- A distributed solar lighting system's fundamental form makes it vulnerable to vandalism and theft.

Self-Contained Solar Lighting Systems

Self-Contained Solar Lighting Systems: Introduction

Cost-effective, efficient, and simple to use, self-contained solar powered LED bollards and luminaires offer a myriad of benefits for pedestrian-scale and site lighting applications.

In this section, we review the features of self-contained solar lighting systems, beginning with the applications for which they are commonly used.

Variety of Applications

Listed below is the variety of applications of self-contained solar lighting products.

- Pathway lighting
- Bikeway lighting
- Multi-use trail lighting
- Municipal park lighting
- Campus lighting
- Egress lighting
- Landscape lighting
- Commercial area lighting
- Public area lighting
- Homeowner’s Association (HOA) lighting
- Parking lot lighting
- Security lighting and perimeter security lighting
- Street lighting

Specifying Self-Contained Solar Lighting

Typically, self-contained solar lighting will require up to six hours of direct midday sunlight daily, and some limited modeling may be needed to ensure appropriate performance and reliability.

However, new generation, self-contained solar lighting products can auto-configure to their environment on installation, thus eliminating the requirement for extensive modeling and configuration.

These products also have self-learning capabilities to maximize site-specific performance with a more achievable two hours of direct midday sunlight daily. At the same time, predictive adaption features can enhance reliability, making this lighting choice particularly efficient.

Self-Contained Solar Lighting: Aesthetics

Without the need for multiple separate system components that create visual clutter, self-contained solar lighting fixtures can be designed to match the look and feel of many wired products, which typically means a more discreet and versatile daylight appearance.

These types of designs have the benefit of allowing the fixtures to more easily integrate within a variety of sites.

The inconspicuous design of self-contained solar products also draws far less attention from vandals and thieves versus the utilitarian design of distributed solar lighting systems.

Self-Contained Solar Lighting: Installation Considerations

Generally, self-contained solar lighting products are an easy install, requiring basic hand tools and an installation team of one to two people.

Compared to distributed solar lighting, the fixtures of a self-contained solar lighting solution are fully assembled, lighter, and less complex. Products that are equipped with auto-configuration feature plug-and-play capability.

It is good practice to confirm with your vendor that your lighting system includes the balance of system (BOS) components, so that all required parts, wires, and cables are on-hand at the time of installation.

Self-Contained Solar Lighting: Costs

The product cost for self-contained solar bollard products is comparable to wired lighting, but is substantially less than distributed systems. The product cost for self-contained luminaires is about three times that of wired luminaires and again, is substantially less than distributed systems. That said, the plug-and-play nature of the self-contained products has a distinct installation advantage over the competing options that easily make it the most cost-efficient.

Self-Contained Solar Lighting: Summary

Summarized below are the important features of self-contained solar lighting.

- It is the most cost-efficient lighting option for solar-qualified sites versus wired lighting or distributed solar lighting systems.
- The total of product and installation costs is typically much lower than either wired lighting or distributed solar systems.
- Installation is easy—virtually plug-and-play; no specialized trades or equipment required.
- Auto-configuration eliminates the time-consuming specification process.
- Self-learning capabilities can maximize site-specific performance.
- Predictive adaption provides enhanced reliability.
- Performance and reliability are strongly dependent on the site and specification process.
- Inconspicuous design can easily integrate into overall site design and minimize vandalism and theft threats.

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Questions to Ask Your Solar Lighting Vendor

When selecting a supplier for a self-contained solar lighting solution, it is important to complete your due diligence to ensure you choose a quality supplier that offers customer and technical support throughout the specification process.

Questions to ask:

- Do you have photometrics for your products?
- Can you assist with lighting design for my site?
- How do you provide customer support?
- Can you provide local area case studies?
- How much time does your specification process take?
- How much time do you require to quote a project?
- How much time is required to install a project?
- How do your products deal with unusually poor weather?
- What's the useful life of your batteries? What is the cost for replacement?
- Do your products have intelligent control features such as: predictive adaption, auto-configuration, and self-learning capabilities?



Summary

Important Points

- A variety of technology improvements have significantly elevated solar lighting's performance and reliability.
- Solar lighting provides sustainability and economic benefits, as well as design freedom and independence from the grid.
- The solar lighting industry is split into two common design approaches: distributed solar lighting and self-contained solar lighting.
- Distributed lighting systems can offer high lumen output sometimes required for parking lots and streets.
- Disadvantages of distributed lighting systems: utilitarian appearance, specification/installation challenges, and vulnerable to theft and vandalism.

Important Points

- Self-contained solar lighting systems have all their components housed in a single unit, and are available with intelligent control options and a plug-and-play set-up.
- Self-contained solar lighting is often the best choice for pedestrian-scale applications, providing discreet design choices, easy installation, and substantial capital cost savings versus wired and distributed solar lighting solutions.
- For solar lighting applications, lithium batteries have surpassed lead batteries as the go-to battery technology, and a maximum power point tracking controller (MPPT) is the most efficient design option.
- A solar lighting controller (SLC) is typically composed of the following building blocks: charge controller, LED driver, system management, and interfacing/communications. SLCs should be purpose-built for the solar lighting solution, not an off-the-shelf product.
- Determining the best lighting solution requires consideration of the following factors: economics, site considerations, and illumination requirements.
- Careful consideration should be given to the specification process and choosing a solar lighting vendor.

Conclusion

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