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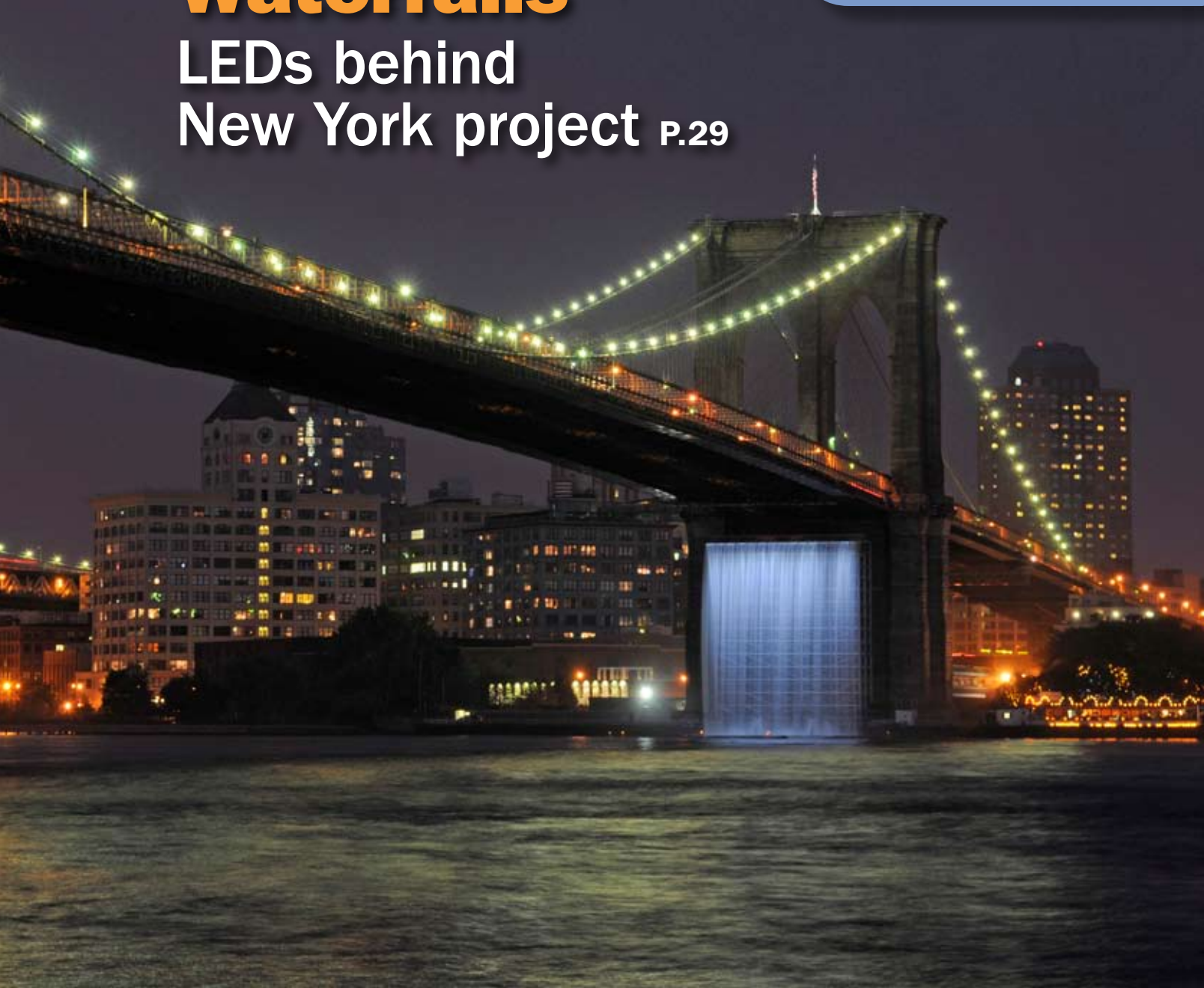

Solar power drives LEDs for ge

Thanks to rapid improvements in photovoltaic and LED lighting technology, solar-powered LED lighting is now suitable for a range of illumination applications, according to **SEAN BOURQUIN** and **ANTHONY TISOT** of Carmanah Technologies.

Against a climate of rising energy costs and escalating environmental concerns, today's advanced LED technology is creating new opportunities in solar-powered area lighting. Thanks to a new generation of bright and efficient LEDs, solar-powered lighting is expanding from its role in signal lights and flashing beacons to offer a renewable energy alternative for general illumination applications.

Early applications of solar-powered LEDs

Among the earliest widespread applications of solar-powered LED technology, self-contained marine lanterns were introduced in the early 1990s as a cost-effective replacement for higher maintenance, solar-powered, tungsten-incandescent marine lights. Designed and built by Canadian manufacturer Carmanah Technologies for the United States Coast Guard, the powerful all-in-one lanterns could be transported easily, installed in minutes, and left to operate reliably for years, maintenance free.

Unlike the large mechanical lights they replaced, the new solar-powered lanterns integrated all components (including photovoltaic modules, batteries, lenses, electronic controls and sensors) within a compact and durable watertight housing. Free from external components and impervious to water damage and corrosion, the solid-state lanterns proved to be an effective and reliable alternative. Operating on low-voltage current and generating only a small amount of heat, the stand-alone units were rugged, watertight and resistant to shock, vibration, and environmental extremes.

FIG. 1. Solar-LED marine lanterns mark buoys, such as this one being towed, in all conditions.

Throughout the years, self-contained solar LED lanterns have survived prolonged submersions under ice, category-five hurricanes, collisions with cruise ships and container vessels, and in the case of one wandering buoy, a year-long 5,800-kilometer journey across the Atlantic Ocean — all while continuing to operate flawlessly. Easy to transport and deploy at a moment's notice, solar-powered LED lanterns quickly became a popular backup that could be relied upon when conventional systems failed. For example, following the devastation of Hurricane Charley in Punta Gorda, Florida in 2004, solar-powered lanterns were the only points of light on an otherwise blacked-out river.

Later, modified versions of this original design gained popularity as aviation lights for runways, taxiways and helipads; roadway flashers for school zones and pedestrian crossings; and warning flashers for line-maintenance projects and uncontrolled railway crossings. In each new capacity, this versatile technology continued to uphold the fast-growing reputation for convenience, durability and reliability. User testimonials described solar LED aviation lights continuing to work even after being hit by vehicles, or struck into an adjacent field by an aircraft propeller — one solar LED obstruction light was even

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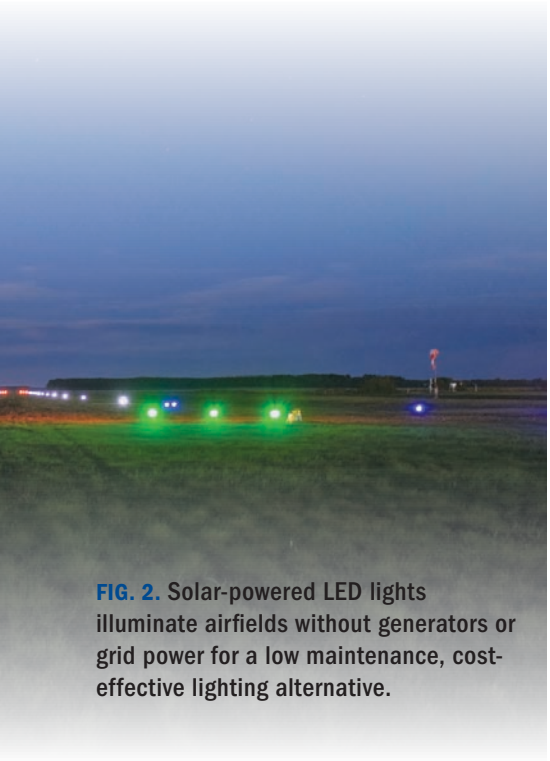

FIG. 2. Solar-powered LED lights illuminate airfields without generators or grid power for a low maintenance, cost-effective lighting alternative.

crushed into the ground under a falling tower only to emerge fully functioning and ready for the next challenge.

Solar-LED units for general illumination

Although integrated solar-LED units proved indispensible as signal lights for a growing range of industrial applications, larger-scale general illumination applications were still a ways off. While delivering impressive results as a light source for lanterns and beacons, the combined solar-LED technology was not yet suitable for illuminating larger outdoor areas in an efficient, cost-effective manner.

For Carmanah, the next logical step was to illuminate smaller areas in remote locations such as stand-alone bus stops and transit shelters. A new generation of white, high-flux LEDs made this possible by enabling a solar-powered light source to provide a brighter and more effective, yet natural and aesthetically pleasing, output.

To further maximize efficiency, an intelligent onboard energy management capability adapted from the company's marine technology ensured each light could provide ample illumination throughout the night, in all weather, all year long. The ability to automatically monitor and manage available energy "on the fly" helped make the new bus stop lighting system a popular upgrade across North America, and notably, throughout challenging solar environments such as London, England, where Transport for London equipped transit routes with more than 3,000 user-activated illuminated bus stops and 650 transit shelter lighting systems.

As an alternative to hardwired grid-based lights, solar-powered LED lights offered a range of practical advantages, including a simple and cost-effective installation, years of reliable low-maintenance operation, and no electricity bills, ever.

Pedestrian-scale general illumination

Although proven effective as a means of illuminating smaller outdoor areas, the challenge of extending this technology to larger applications presented some considerable roadblocks. For example, to ensure a consistent level of bright and effective light, most general illumination applications would have required a level of LED efficacy (measured in lumens per watt or lm/W), that was not yet readily available. To compensate, a solar-powered LED light fixture would have required a much larger photovoltaic array, additional battery capacity, and more LEDs per fixture. While the added cost of these components would quickly make a large-scale lighting application an expensive proposition, the ungainly size and weight of these materials also presented engineering challenges affecting the mechanical, structural and design characteristics of the proposed lighting solution.

Fortunately, ongoing advances in LED technology have provided the higher-efficacy product needed to address these challenges. Combined with a range of corresponding innovations in fixture design that has enabled engineers to maximize the capability of the new LEDs through optimized thermal and optical design, the technology is now available to produce an efficient and cost-effective solar-powered area lighting solution.

FIG. 3. A durable solar-LED taxiway light continues to operate even after being run over by an airfield service truck.

New technology presents new opportunities

Along with improvements in photovoltaics, energy storage, and lighting fixture and lens design, increased LED efficacy has had a dramatic effect on reducing the overall size requirements and associated costs of a solar-powered general illumination system, making solar-LED technology a viable alternative for

larger pedestrian-scale outdoor applications.

In a recent example of community-wide "greening" with solar LED technology, the City of Kelowna in British Columbia has begun equipping parks, paths and other public spaces with 100 solar LED lighting systems. Unlike traditional lighting technology, each of the new area lights is powered by an EverGEN™ solar engine — a stand-alone energy source that's completely self-contained, with all components (including solar modules, rechargeable batteries and electronic controls) integrated within a compact pole-mounted enclosure.

In choosing suitable locations, the project team started with a list of 200 potential sites, and selected the final 100 spots based on a list of factors including technical and geographic considerations (such as access to sunlight), distribution throughout the community, functional variety, and distance from an existing power supply. The final list identified a variety of buildings, parks, trails, crosswalks, municipal facilities, parking lot kiosks and transit facilities.

A government grant is helping to support the Kelowna solar lighting project as part of the Canadian government's commitment to help communities reduce energy costs, increase energy efficiency, and develop cleaner energy technologies.

In another recent example, the Dockside Green development in Victoria, British Columbia is working with the City of Victoria to illuminate the community's harbor ferry dock and pathway access with solar-powered area lights (see Fig. 5). Each of the solar-powered lights at Dockside Green features a pole-mounted solar engine, powering a BetaLED The Edge™ light fixture (developed specifically for the company by Beta Lighting).

Thanks to the optimized industry-standard design of the BetaLED fixture, each fully-shielded solar-powered area light directs light only where needed, for an efficient, uniform output that is also "dark-sky friendly," in accordance with the International Dark-Sky Association (IDA).

While providing impressive area lighting performance from a stand-alone solar-powered device, each new lighting system is also eligible for Leadership in Energy and Environmental Design (LEED) Renewable Energy Credits. As part of the LEED Green Building Rating System™, Dockside Green's first residential phase,

FIG. 4. Solar-powered transit stop provides LED down lighting, edge-lit schedule illumination, and user-activated signal light.

FIG. 5. (a) Solar-powered LED area lights illuminate harbour ferry dock in Victoria, British Columbia. (b) Installation of solar-LED light fixtures.

Synergy, has already been certified as built to LEED Platinum standards, with the developers targeting LEED Platinum certification for the entire 15-acre harbour front community.

While providing a convenient and versatile source of outdoor lighting for new installations, each solar-powered area light also conveys a positive environmental message, day or night, as an attractive and immediately recognizable symbol of the community's commitment to renewable energy, green technology and sustainable development.

Suitable locations for solar-powered area lighting

As solar-powered LED area lights increase in capability, they present an increasingly attractive lighting option for a range of locations. While particularly well suited to areas without access to utility power, solar lighting is also a good choice for anywhere grid-based electricity would be too costly or inconvenient to access. As a stand-alone solution, a solar-powered area light requires no trenching, cabling or connection to the electrical grid, making it an ideal solution for a growing list of pedestrian-scale applications in remote locations, green spaces or urban environments:

Area lighting: for parks, campuses, marinas, bike paths, and parking kiosks

Security lighting: for industrial sites, ports, harbors, airports and fenced perimeters

Architectural or accent lighting: for buildings, shelters, displays and landscaping

Aside from the considerable "green" appeal of implementing a solar-powered lighting solution, key incentives include freedom from utility power, quick and low-cost installation (both in rural and urban environments), versatile deployment, low maintenance, long component life, and — as a stand-alone light source that is unaffected by power outages — impressive reliability.

Although the list of potential sites for solar-powered lighting is growing fast, some locations can present specific challenges. Significant shade from buildings or trees throughout the day can affect performance, as well as distance from the equator. For example, as Los Angeles receives almost twice as much winter sun as Toronto, a solar lighting system in Toronto would require more energy collection and storage capacity (through larger panels and batteries) to compensate for less available energy during the day, and longer operating times during the night.

Fortunately, these obstacles are not insurmountable; today's solar-LED technology provides a range of built-in energy management and control capabilities — from basic on/off control, to adaptive dimming and sensing, and

advanced energy management techniques — that can help to balance the relationship between lighting requirements and available energy resources.

Some solar LED lights can be programmed to shine brightest whenever the need is anticipated to be the greatest — for example, during times of highest usage — and conserve energy outside of peak usage hours. Others may monitor environmental conditions and dynamically adjust light output to match the level of solar charging available.

In these ways, a solar LED light can utilize the available energy as efficiently as possible to ensure light is available when needed — an especially significant capability during times of low solar charging (such as low light or winter conditions) or in challenging geographic locations.

Advantages of solar-powered LED area lighting

Durable construction: Solid-state components offer greater resistance to impacts, vibration and environmental extremes.

Versatile placement: Free from grid connections, stand-alone lights can be added just about anywhere there's access to sunlight.

Low-cost installation: With no trenching, cabling or grid access required, solar LED lighting can be installed quickly and affordably, with minimal disruption to traffic flow, businesses or landscaping.

Cost-effective operation: Solar LED lighting can save money with quick implementation, low maintenance, long life, and no electricity bills, ever.

Energy efficiency: high-efficacy LEDs that efficiently convert energy to light enable solar lighting to surpass many traditional light sources for a green choice.

Dark Sky friendly: directional optics and shielding ensure light is directed only where needed.

Adjustable output: light output can be dynamically adjusted for brighter or dimmer illumination to accommodate user preferences and energy requirements. ◄

Looking ahead

At a time when technological, economic and political factors are converging to provide an unprecedented level of support for renewable energy alternatives, solar-powered area lighting is well positioned for large-scale adoption in pedestrian-level lighting applications. The continued drive towards standardization in the LED and photovoltaic industries, along with ongoing improvements in product quality, reliability and effectiveness, can do much to support the widespread adoption of this technology. Much as luminaires are validated and standardized for performance, standardization of solar LED components can help encourage the adoption of LED general lighting.

Solar-powered LED lighting has come a long way, and thanks to ongoing improvements in the efficiency and effectiveness of the key component technologies involved, it is fast becoming a popular lighting alternative for forward-thinking organizations and communities around the world.