Solar Energy and the Parking Industry

White Paper

DIGITAL
PAYMENT TECHNOLOGIES

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Executive Summary

Solar industry revenues have reached $10.6 Billion.

The increased world focus on global warming has placed solar energy and its potential applications in the spotlight over the last few years. This focus is reflected in the surging global industry revenues in the solar industry which reached $10.6 billion in 2006.[i] While the parking industry may be considered an unlikely market space to utilize solar energy, it has actually been very proactive over the last few years in looking at solar energy to solve existing challenges and bring new value to how the industry does business.

The purpose of this White Paper is provide an overview of the different solar technologies available, their benefits and shortcomings, and how the parking industry is starting to take advantage of solar energy's promise. This document will also attempt to outline the challenges parking operators face in maximizing solar energy's effectiveness and how one company is making changes to its technology to address these challenges.

Evolution of Solar Technology

The earliest documented use of energy from sun dates back to the seventh century when solar energy was used with mirrors and glass to light fires.[ii] Many practical applications for solar energy continued to be adopted over the years, yet pure scientific research on solar energy didn't take place until the mid to late nineteenth century. This research had little commercial applications until the 1970s when funding to research commercially viable applications of solar energy began to truly intensify.

The turning point in solar energy research was reached during the 1973 oil crisis when members of the Organization of Arab Petroleum Exporting Countries (OAPEC) announced that they would no longer ship oil to nations that had supported Israel in its conflict with Syria and Egypt. Oil prices increased dramatically during this time causing world powers such as the United States, Western Europe, and Japan to seek out all new forms of energy that didn't depend on oil. This push led to the development of more powerful and cost-efficient solar devices to be utilized in a wide range of areas.

The primary areas of solar energy use have been in the production of food, heat, light, and electricity. For the generation of electricity—the largest use of solar energy—there are three areas of focus:[iii]

1. Concentrating Solar Energy (CSE)

CSE devices optically focus or concentrate the thermal energy of the sun to drive a generator or heat engine. Irrigation, refrigeration, and locomotion are the primary applications of this kind of solar energy, which have resulted in the development of complete concentrating solar energy plants.

2. Solar Water Heating

Solar water heating absorbs the sun's radiation with specially coated absorbers to heat air or water for use in a building. Solar water heaters are typically used in large commercial applications such as hotels or breweries.

3. Photovoltaic (PV)

PV devices are commonly used in the parking industry.

PV devices convert light into electricity using an electronic process that occurs naturally in certain types of materials such as crystals. Electrons in the crystals are freed by solar energy and can be induced through an electrical circuit powering any type of electronic device or load.

PV devices are the most common form of solar technology used to support applications in the parking industry, but like any technology, PV devices have a range of benefits and limitations.

Benefits of PV Energy

While alternative energy sources such as wind provide similar benefits, solar technologies such as PV energy appear to have the largest benefits. A few of these benefits are outlined below.

Massive Energy Supply

The sun generates 10,000 times the energy the world uses annually.

A report by America's largest grassroots environmental organization, Sierra Club, estimates that all of the energy stored in the earth's reserves of coal, oil, and natural gas is equal to the solar energy created from only 20 days of sunshine.[iv] When considering energy consumption, the sun generates more than 10,000 times the amount of energy the entire world consumes annually.[v] The challenge has always been how to turn this huge energy reserve into cost-effective technology.

Lower Costs

The problem with the earliest forms of solar energy technology was the cost of the devices themselves making large scale applications basically unfeasible as the costs were approximately 30 times current prices.[vi] Many of these cost hurdles have now been overcome as the number of PV generating devices has grown exponentially over the last few years. In 2007, it was reported in the PV Status Report by the European Institute for Environment and Sustainability that PV production grew by an average of 40 percent over a five-year period making it one of the fastest growing industries in the world.[vii] More importantly, access to solar energy is essentially free, resulting in cost benefits that are immediate and often dramatic.

Easier Installation

Remote locations requiring electricity demonstrate a clear benefit of solar energy. Trenching, cabling, and construction associated with delivering electricity to remote locations are extremely expensive. In the parking industry, the savings are especially clear for on-street parking operations, multi-space meters require electricity to re-charge batteries.

Reduced Maintenance Costs

A significant part of the maintenance cost for many electrical devices involves the supply of electricity and the transmission of the electricity to the core of the equipment. Solar-powered devices remove these costs.

Less Environmental Impact

The planet has begun to wake up to the environmental impact of relying on oil for its energy needs. Renewable sources of power like solar energy are clean, renewable, and have very little environmental impact. A typical business using solar power will offset 2.3 million pounds of greenhouse gases over the next 30 years, and would be the equivalent of planting over 5,700 mature trees.[viii]

Government Incentives

States such as California, Colorado, and New Jersey are supporting successful solar programs.[ix] These incentives are leading many businesses to consider solar energy over traditional and more expensive alternatives.

With so many benefits, the obvious question arises as to why solar energy isn't more prevalent?

Solar Energy is not Perfect

There are clearly numerous benefits to solar energy, but turning these benefits into commercially viable applications has been challenging. There are three primary reasons for solar energy's continued relegation as an emerging energy technology as opposed to one that is more pervasive in society:

1. Requires Sunlight

For all of us who review the world weather forecasts, we know that most parts of the world have a climate where the sun can disappear for days and weeks at a time behind cloudy and raining skies. In addition, downtown high-rises can provide a permanent blockage of the sun on some city streets. These conditions can make solar energy an unreliable energy source for many applications, especially those with a high and/or stable energy requirement.

2. Aesthetics

Many people do not like the aesthetics of solar energy technology. Some applications require multiple large panels spread out over a large area to generate enough energy to make an application work. While design improvements in solar panels have lessened the visual impact solar technology can have on a home, commercial structure, or piece of equipment requiring energy, the majority of people have avoided the technology simply because of its poor aesthetics.

3. Limited Applications

Solar energy accounts for only 0.04 percent of global energy production.

Solar energy has immense potential and promise, but as of today, solar energy just provides 0.04 percent of global energy due to high production costs and low efficiency rates.[x]

A large segment of modern technology requires high levels of energy to operate. Equipment manufacturers trying to work with solar technology have often attempted to address this issue by lowering equipment capabilities. The parking industry has seen these limitations in the design of many multi-space parking meters with small screens, restricted online applications, and limited payment options.

Increasing the effectiveness of solar technology itself is one way to address these limitations, but due to slow advances in these areas, most manufactures are forced to look at ways to make their equipment more energy efficient so that the hurdles are not insurmountable.

Solar Energy in Parking

The parking industry is using solar energy and seeing its benefits.

Road infrastructure projects have shown many of the earliest uses of solar energy such as solar traffic warning lights, road markers, and warning signs; however, the parking industry is slowly catching up. There are now several visible examples of where the parking industry is using solar energy and leveraging its benefits.

Lighting

Lighting for signage, surface lots, and garages is an important consideration when designing an effective and safe parking environment. A lack of adequate lighting in these areas results in under utilized parking facilities as parkers perceive them to be unsafe. Using solar energy to support these lighting systems is becoming more popular as it provides the environmental benefits in addition to making energy available in a broader range of areas.

Solar energy is especially effective in surface lots where there is generally wide exposure to the sun. Signage for lighting is also a popular application as the energy draw is generally low and installation is simple. Even when there is an adequate and cost-effective access to the existing energy grid, solar can assist where the original lighting layout created unanticipated dark spots.[xi]

The early critics of these solar lighting systems complained that the lights were not as bright, didn't project as far, and had a bluish tint. However, continued improvements are being made by manufacturers to overcome these issues. The efficiency of these lighting systems also enables them to operate from dusk till dawn, even when there are several cloudy days.

Power

The parking facilities themselves are demonstrating some of the boldest applications for solar energy. These applications are taking place in existing facilities and in newly designed facilities.

Oberlin College in Oberlin, Ohio, built one of the first solar parking structures in 2006. Named a solar parking pavilion, the pavilion's 8,800 square foot roof collects sunlight through 336 PV panels. The facility generates 145kWs of power, which is the equivalent amount of power needed to meet the energy needs of nearly 15 single family homes.[xii]

The City of Santa Monica, CA, also finished construction of an 882-space $29 million garage with rooftop solar panels in 2007. The cost per space for these types of solar parking utilities is very high; however, the long-term energy efficiencies, price reductions in solar technology, and government incentives to "go green" have helped encourage similar facilities to be built in the future.[xiii]

One of the more unusual examples of using parking facilities to generate energy comes from the Netherlands. Solar energy collected from a 200-yard stretch of road and a small parking lot helped to heat a 70-unit four-storey apartment building in the northern village of Avenhorn, Netherlands. A Dutch company is developing technology to siphon the heat from roads and parking lots to heat homes and offices and may represent another innovative solution that could come to North America in the future.[xiv.]

Multi-Space Parking Meters

North American cities are slowly catching up to their European counterparts. They are replacing older single space parking meters with multi-space parking meters that provide more payment options and advanced functionality such as wireless communications and integration with third-party Internet-based applications. These parking meters operate on batteries, but require either direct AC power or solar energy to keep the batteries fully charged.

Solar energy generation is the most desirable solution for on-street operations as most municipal infrastructures do not have the conduit required to deliver AC energy to the new multi-space meter installations. In addition to simplifying the installation and the associated costs, using solar panels to keep these meters charged also eliminates the ongoing utility charges.

The challenge with all of these applications is how to maximize the potential of the sun and still deliver all of the features clients want. These issues will be discussed in the next section and in the case study at the end of this white paper.

Maximizing the Potentail of the Sun

The effectiveness of sunlight can be impacted by many variables.

There are many issues that should be taken into account when considering how to provide solar energy to all forms of technology, especially unattended parking equipment. Because there are so many variables that can impact the effectiveness of sunlight, it is very difficult to predict how a solar panel will perform and whether or not it will be sufficient to keep a battery charged. Some of the key variables are:

Environmental Variables

Latitude

Latitude or the distance north or south of the equator will impact the effectiveness of the solar panel. The further north a solar panel is installed, the less effective it will be both because of the increase in the amount of atmospheric sunlight needed to pass through and also because of the length of days in the winter.

Climate

Clear, dry climates are better than wet, cloudy climates. A dry climate can have a significant beneficial affect and increase the success rate of a solar installation in northern latitudes.

View Corridor

Trees, buildings, signs, and other obstructions will have a significant impact on the amount of sunlight reaching the solar panel. As much as possible, a clear view south should be allowed to maximize the efficacy of the solar panels. If even a small portion of the solar panel is in shade, the amount of energy generated drops significantly.

Non-Sunlight Light Sources

Unfortunately, there are few artificial sources of light that can be converted by a solar panel into usable electricity. Standard street lights will not work. Electrical lighting should not be considered a source of energy for charging batteries via the solar panel.

Indirect Sunlight

Indirect sunlight is converted by the solar panel into electricity. Therefore, during cloudy days or if light is reflected from a building onto a solar panel, charging will occur. However, the amount of energy collected is significantly reduced.

Time of Day

If transactions are concentrated in a specific time of the day, this will have an affect on the ability of a battery to meet the energy requirements. For example, commuter lots where all of the transactions are in a short time period early in the morning are not good candidates for solar energy unless there is enough battery to sustain the equipment through the morning and then recharge all day. Most on-street applications have turn-over throughout the day meaning that the battery will not be significantly depleted at any one time.

Time of Year

In combination with the latitude, the time of year can have a significant impact on the charging ability of a solar panel. In the winter when days are short and the sun is low to the horizon, one may encounter a situation where normal usage patterns result in batteries being depleted whereas this is not the case in early spring or late fall.

Performance Variables

As outlined earlier, the multi-space parking meter is one of the most visible examples of where solar panel technology is used. There are numerous performance variables specific to the multi-space parking meter that will impact the effectiveness of a solar panel.

Number of Transactions

The number of transactions performed per day will have a significant impact on the success of a solar panel to replenish the batteries.

Payment Type

The type of payment used by a customer has a significant impact on the amount of energy used per transaction. Existing installations have shown that the lowest energy payment method is using a magnetic stripe card such as a credit card or SmartCard. Encouraging customers to use these payment methods will increase the success rate of solar installations. After the card reader, the second lowest energy consumption payment method is the coin acceptor. The bill acceptor consumes the most energy of the three payment methods.

Number of Coins/Bills

When customers pay using cash, the more bills or coins that are inserted will affect the energy consumption. Rounding rates to the nearest dollar or half dollar will reduce how many coins and bills are used and also limit the energy drain on batteries.

Equipment Variables

The options made available with a multi-space parking metering will have a large impact on energy consumption.

Online or Offline
The real-time communication capability will increase energy consumption unless the connection is hard-wired. However, the amount of energy used by modems is similar to adding a payment option such as a bill acceptor or coin acceptor.

Communication Type
Of the communications options available, hard-wired Ethernet consumes the least amount of energy. A modem on the GSM/GPRS network is slightly better than a CDMA modem. The 802.11 option currently has the greatest energy consumption of the wireless communication methods presently available.

Sleep Timer
Configurable through the software, the Sleep Timer is the amount of time the parking meter waits before powering down if there is no activity. Generally, the longer this amount of time the greater the energy consumption. However, some amount of time (30 seconds) should generally be the minimum to allow for customers who are lined up behind one another.

Battery Age
Most multi-space meters use sealed, lead-acid batteries. The charging and discharging of these batteries is regulated by the manufacturers' specifications. As a result, units should see a three- to five-year battery life, under normal operating conditions. As the battery approaches its end-of-life, the performance will be degraded.

Installation Considerations

When installing solar panels, it is very important to take the following into account:

Signs
Any signage must be placed below or to the north of the solar panels. Signage blocking the solar panel for even part of the day can have a significant affect on the amount of light collected.

Plants
When planning installations, it is important to take into account plants not only as they are but also as they will be. Leaves and growth significantly affect the degree to which plants can block solar panels at different times of the year and in future years.

Direction
In almost all situations, solar panels should be facing towards the equator—due south or north.

The solution is to make technology more energy efficient.

As these points illustrate, there are numerous factors to consider when using solar energy in parking applications. While the benefits of solar technology are clear and improvements to the technology are taking place, these improvements are still incremental and will unlikely address the major problems discussed earlier. The solution, therefore, lies in making technology more energy-efficient while still enabling new features to be made available to the parking public. The case study that follows demonstrates how one parking manufacturer is approaching this challenge.

Case Study – A New Power Management System

Digital Payment Technologies (DPT) is a manufacturer of multi-space parking meters and online management systems that provide parkers with flexible payment options and operators with more information and control. These meters have traditionally been used in parking lots and garages, but there is now a growing trend to using the same technology on municipal streets.

Europe has been using multi-space technology on its city streets for years, but North America has only begun to embrace the concept in the last few years, despite the numerous benefits over older, single head parking meters. These benefits include the acceptance of multiple payment options, reduced maintenance, less street clutter, and more intelligent operations through sophisticated software and connectivity to the Internet. As referenced earlier, multi-space meters can operate either on AC power or solar energy, with solar having the clearest benefits from an installation and ongoing operational cost standpoint.

The problem is that solar energy is unable to meet the growing demands of municipalities for more advanced functionality. The traditional multi-space meters that dominate the market today usually have small two-line monochrome screens, coin and credit card payment only, and limited real-time applications as credit cards are usually batch processed a few times a day. Adding bill acceptors, real-time credit card processing, large color screens, and integration with third-party technologies over the Internet all combine to have high energy requirements that result in some locations requiring battery changes or an undesirable limitation of features.

In designing its first pay station for on-street operations, DPT recognized this conflict. It moved forward with creating a highly advanced technology platform to meet the needs of the future, while offering the opportunity to scale back features or utilize AC energy in specific installations where solar energy was not viable. For example, the City of Houston deployed 750 of DPT's LUKE pay stations with solar panels using all of the advanced power draining features mentioned earlier; however, some locations with poor sunlight or extremely high transaction volumes required the move to a monochrome screen or the manual swap-out of batteries every few weeks.

DPT recognized that the long-term objective of its client base was to provide unattended operation of these pay stations without the need to swap out batteries or reduce features. As a result, the company undertook 10 person years of development and over $1 million dollars in investment to review and re-design every component of the pay station. As solar technology was not developing fast enough to create the power levels required, DPT's engineering team focused on finding ways to reduce the overall energy consumption of the pay station itself.

Several areas needed to be addressed to achieve the overall energy saving goal. First, the pay station application needed to be re-designed to provide better peripheral control, improve modem communications, expand sensor logging, and incorporate new features like remote, wireless software updates. Next, new microcontroller firmware was developed and the operating system was upgraded so that it could be customized for low energy and to help utilize unique features of the controller, the computer system that drives all applications in the pay station. A custom solar regulator was also designed to automatically optimize energy based on solar panel input. Finally, new peripheral devices were sourced and new firmware created to enable a low energy sleep mode setting.

RADIUS reduces the amount of energy LUKE uses by 75 percent.

The result of this effort has been RADIUS, a new energy management system for the LUKE pay station. RADIUS reduces the amount of energy used by the LUKE pay station by up to 75 percent and eliminates the need to spend money on labor to replace discharged batteries while still maintaining all existing features. In sleep mode, the pay station energy draw has been reduced by over 95 percent. To support future installations of this platform, DPT has also created a pay station energy consumption tool that downloads actual historical solar data for specific pay station locations so that it can simulate exactly how the pay station should perform over a two-year period.

This concentrated effort to create a product that maximizes the energy of the sun has gone beyond the initial expectations. The benefits include:

More Energy Efficient

RADIUS eliminates the issues often associated with indirect lighting conditions or limited AC energy availability. RADIUS allows LUKE to function without battery replacement in areas with long stretches of no sunlight or locations with indirect lighting conditions.

Increased Location Flexibility

By designing a pay station with minimal energy requirements, RADIUS allows a solar powered LUKE to be installed virtually anywhere and maintain all the features municipalities demand.

Better User Experience

Paid advertising, community announcements, contact information, or additional instructions to your parkers can all clearly be displayed with color pictures, graphics, and text. RADIUS provides an improved user experience with a new, brighter, and high resolution color display, and a new hardware/software combination that provides faster transaction times. RADIUS makes it easier for parkers to park, pay, and go.

Lower Costs

The flexibility to deploy solar energy-powered on-street pay stations without losing features allows municipalities to eliminate costs associated with manual battery swap-out or the installation and monthly costs of AC energy.

More Features

RADIUS uses less energy and adds many new features.

Beyond being energy-efficient, RADIUS adds many new features that benefit operators and parkers. Operators now have access to more pay station information, from energy level monitoring to temperature and humidity sensors. RADIUS even allows operators to update the pay station software remotely.

DPT's RADIUS project illustrates how manufacturers in the parking industry are taking bold steps to harness the benefits of solar energy while still addressing the customer demands for more features. As solar technology improves and costs go down, one can expect a broader set of technologies in the parking industry and elsewhere to tap into the unlimited and environmentally friendly energy resources of the sun.

About Digital Payment Technologies

Digital Payment Technologies (DPT) is an innovative leader in the design, manufacture and distribution of electronic multi-space parking meters, parking management software, and online services for the multi-billion-dollar parking industry. The company's products provide complete financial tracking, control and reporting for parking revenue collected by municipalities, universities, parking management companies, and national parks, from customer payment through to bank deposit.

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