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IMSA JOURNAL

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IMSA Journal Issue: July/August 2002

Wireless Traffic Control Solutions (cover story)

By Joe Wise, Solar Traffic Controls

About eight years ago, I saw the need for solar electric to meet the requirements of a niche market: traffic controls. Since then, I've been developing solar-powered traffic control systems for city, state and federal Departments of Transportation. My goal was to build complete packages incorporating solar panels with radio and computer controls. Solar flasher systems were designed with the end user's capabilities and skill set in mind to make them easy and quick to install.

What follows is a step-by-step explanation of the basic system design for solar-powered flasher systems. When proper consideration is given to the type of equipment and the resources available at the project site, solar presents a viable and affordable alternative to utility power.

Some of you may think solar is best suited for rural applications where utility power is unavailable and costly to obtain. To the contrary, solar is most often used in urban settings as evidenced by the solar-powered crosswalk flasher on the front cover of this issue. Solar is applicable to all settings making it an everywhere technology.

Why use solar flashers?

With solar flashers, you eliminate the need for an AC connection to your equipment, thereby minimizing installation costs. Deadlines can be met with a solar installation as most solar flasher projects can be installed in one day. Today, the bulk of underground utility lines has become an issue in accessing service points in urban settings. Even if the AC line is 50 feet away, you can't go underground due to those restrictions. In new residential developments, zoning laws also restrict you from going overhead. Solar circumvents these problems.

Solar flasher systems are self-contained- independent of the power grid-there's no concern with blackouts. Traffic safety continues when the power goes out. Your car is not subject to the grid. Should your traffic control systems be dependent on the grid? Probably not. Many cities have installed backups. For instance, the City of Santa Monica, California has battery backups on every one of its traffic cabinets, so they can go to red flash while the power is down.

Another cost-saving factor is little or no maintenance because it is self-contained; parts are highly reliable and a properly-designed system will run by itself for years. You may need to check the batteries every three to five years, or replace a controller due to a lightning strike. Also check the height of trees around the site. As they grow, they could impair a system's full functioning by casting shade on the solar module.

Applications for traffic flashers
The typical applications for solar flashers are: School Zone Beacons; 24-hour Hazard Beacons; and HighWater/Flash Flood Warning Systems.

Specifying a flasher system
Solar flasher systems can be fielded reliably and affordably by taking into consideration all the design parameters. These include: (1) load; (2) duty-cycle; and (3) location.

Basic system design parameters
When considering any type of solar-powered traffic system, it's important that the specifying agency fully understand two basic items: The electrical loads and the duty-cycle for the loads. In electrical jargon, the "load" consists of any equipment in the system which draws electrical power. For example, LED lamps, radios, microprocessors, sensors or modems, all constitute electrical loads since at some time during the day, they consume power for operation. Some loads may have different operating modes changing the power drawn by the load during the day. An example would be a radio link having a transmit power draw and a standby power draw.

The duty cycle is the amount of time a load draws power each day. This may be measured in hours, minutes or seconds. The duration a specific load is on or active, along with its power draw, allows the system designer to determine how much power the system consumes daily. Different operating modes also affect the duty cycle. How long a radio remains in transmit or receive adds to the duty cycle and must be taken into account. Duty cycles on a load may also be dependent on the day of the week. A school zone flasher's duty cycle would most likely be five days a week; a high-water flasher would be subject to the seasons.

Specifying a flasher - load tabulation
Load tabulation is the process where the customer defines the number and types of loads to be run in the system and the duty cycles for each load. Typically, this will include:

- LED beacons (size and color affect the load profile)
- Control logic devices
- Communication devices (in standby, transmit and receive)
- System sensors (if used in the unit)

The duty cycle for each item must be included as part of the load tabulation process in order to develop an accurate picture of how much power the system will consume on a daily basis.

Specifying a flasher - projected duty cycle
There are two types of projected duty cycles: (1) Those with well-defined hours of operation such as school zones and 24-hour flashers; and (2) Intermittent-use systems: wireless crosswalk and sensor activated systems. Intermittent-use systems are more difficult to characterize as you don't know how many hours per day they will run.

Well-defined operations, such as school zones are fairly well fixed throughout the year. Twenty-four-hour flashers run continuously. Intermittent systems may run 20 minutes per day, every day or they may come on and run for 20 minutes per day at certain times of a season or they may run for two to three days depending upon what inputs they're receiving. In any event, a projected duty cycle must be agreed upon as part of the design process.

Specifying a flasher's location
Location data need not be to the GPS coordinates of the actual application site but merely the nearest town on a map. Nevertheless, location of the solar flasher is critical in determining the solar resources for the project. Latitude is a key factor as it affects the number of sun hours available per day in the winter. The farther north, the shorter the daylight hours in the winter, hence less solar radiation. Altitude also impacts solar radiation levels since there is 5 percent more solar output per 1,000 feet over a minimum elevation.

Geographic factors, such as proximity to bodies of water, are graphically illustrated in the solar radiation patterns for everything east of the Great Lakes in what they call the "snowbelt" region. All of western New York, parts of western Pennsylvania, Ohio and New Hampshire are affected by this regional phenomenon. This geographical factor in a weather pattern must be considered in the design. Statistical data exist for many areas and are available from such agencies as the National Renewable Energy Laboratory in Colorado.

The all-critical sizing report (see below)
Ask for a sizing report from your prospective vendor as part of their proposal. This report details why you are being offered a specific solution for your system and has five segments:
A. Load tabulations with duty cycles
B. Physical location data for the system
C. Solar array: number and type of solar modules offered to create the array
D. Battery subsystem: number and type of batteries and projected days of backup
E. Estimated performance based upon average solar data available for the location throughout the year

Of primary importance is the last column of Section E, headed "Array:Load Ratio" which should be 1:1 or higher to indicate a viable system. The column "State-of-Charge" (SOC) is the projected charge of the battery for a year.

The state-of-charge should consistently hit 100 percent, indicating your system can be recharged by your solar array.

Conservative design practice requires that real-world losses be considered part of the calculations. Losses from dirt, mismatch, and wiring must be accounted for in the design.

Dirt losses represent a degradation of solar array output due to accumulated dust and dirt on the solar module. Modules are tilted to allow maximum exposure to the sun and for rainwater to wash off the dust and dirt. Two modules connected together do not automatically produce an output equal to the sum of the two. A "mismatch" loss occurs when module electrical characteristics vary; the actual output of the two modules could be less than expected. Undersized wiring, loose or dirty connections at terminals can cause "wiring losses."

Technological improvements which make specialty flashers practical
The power draw for LEDs, radios and sensors has been reduced. Pricing for electronic controls has decreased because of minia-
turization and state-of-the-art manufacturing with robotics. Labor prices have dropped.

Solar modules-now more of a commodity item instead of a specialty item-are selling for less. The price per watt has decreased from $10 per watt to a wholesale cost of approximately $3.75 per watt. Sealed, battery technology specifically targeted for solar applications has improved and decreased significantly in price.

Advanced electronic controls
As electronics technology continues to produce more advanced equipment at lower prices and in smaller physical packages, it's possible to offer more features in solar flasher systems as well. Many of these components are field-programmable which allow the designer to incorporate multiple features in firmware-on the fly if necessary. Some advanced electronics assemblies include:

- Integrated charge/flasher controls with night dimming and options for remote control
- Low-cost logic controls such as PLCs
- Low-cost communications devices such as simplex and half-duplex radios and pagers

Advances in LED lamp technology
Continued improvements in AC LED lamps have spurred progress in DC LED lamps. A pivotal element is the increased efficiency in the LED element. With less power being drawn by the lamp, more power can be diverted to run the system's improved features. The benefit is passed to the user as there is no increase in the size of the solar power system.

A viable solution

When a traffic control project is defined correctly, i.e., all the equipment in the load and each component's duty cycle identified, solar clearly offers a cost-effective and feasible alternative-almost a set-it-and-forget-it type of product.

T: 480-449-0222 F: 480-449-9367 www.solar-traffic-controls.com
PVCAD VERSION 2.10

Load	Description	Load Profile	Amperes	Average Hours/day	Weekly Profile Days of Week On
1	2X12 AMBR FLSHR	24 hours	2.750	6.00	1 2 3 4 5 - -
2	DPC	24 hours	0.050	24.00	1 2 3 4 5 6 7
3	TIMER	24 hours	0.050	24.00	1 2 3 4 5 6 7

A

Nominal PV System Voltage: 12 Array mounting = Fixed tilt Array
Power system type: DC System with battery , NO maximum power tracker

Solar data and temperature location: PHOENIX, ARIZONA, U.S.A.
Latitude= N 33:25 Longitude= W112:00 Elevation= 339 N (M)
Azimuth = 0 Albedo = 20%

B

- - - - - - - - - PV ARRAY DESCRIPTION (ratings at 25˚C)- - - - - - - - - - - -
Modules: SIEMENS, SM55 Total Modules = 1
Series = 1 Parallel = 1 Power = 55 Peak Watts
Max. power voltage= 17.4 Max. power current = 3.2
Open circuit voltage= 21.7 Short circuit current = 3.5
Mismatch loss(%)= 3 Dirt loss(%)= 5 Wiring loss(%)= 2

C

- - - - - - - - - - - BATTERY SUBSYSTEM (ratings at 25˚C) - - - - - - - - - -
Battery: CONCORDE, PVX-1040 Amp-hr/ea = 117 Volts/ea = 12
Series = 1 Parallel = 1 Total= 1 Max. month daily DOD =
Total Amp-hrs.= 117 Battery Charge Efficiency = 95% Weight= 30 Kg
Equivalent to 6.29 days at highest monthly load to 80% DOD

D

- - - - - - - - - - - - - - - - ESTIMATED PERFORMANCE - - - - - - - - - - - - - - -

Month	Global kWh/M²	Tilt	@Tilt kWh/M²	Mean ˚C	Gross A-hr/d	Array Net A-hr/day	Load A-hr/day	Deficit A-hr/d	SOC	Array/Load Ratio
Jan	3.20	45	5.31	12.0	16.72	16.22	14.19		89-100	1.14
Feb	4.30	45	6.29	14.3	19.82	19.33	14.19		89-100	1.36
Mar	5.50	45	6.80	16.8	21.41	20.84	14.19		90-100	1.47
Apr	7.10	45	7.21	21.1	22.70	22.03	14.19		90-100	1.55
May	8.00	45	6.88	26.0	21.67	20.74	14.19		90-100	1.46
Jun	8.40	45	6.62	31.2	20.84	19.60	14.19		90-100	1.38
Jul	7.60	45	6.27	34.2	19.74	18.36	14.19		90-100	1.29
Aug	7.10	45	6.69	33.1	21.06	19.81	14.19		90-100	1.40
Sep	6.10	45	6.92	29.8	21.80	20.77	14.19		90-100	1.46
Oct	4.90	45	6.81	23.6	21.46	20.73	14.19		90-100	1.46
Nov	3.60	45	5.89	16.6	18.57	18.06	14.19		89-100	1.27
Dec	3.00	45	5.28	12.3	16.65	16.15	14.19		89-100	1.14

E

Lowest array to load Amp-hr/day ratio is 1.14

(Array Gross: 25˚C, no losses. Array Net: All losses and temperature effects.)
Saved as: X1206D2A.SSS Calculated by PVCAD

Case Study: Sensor-Activated Crosswalk Flasher
(See cover photo)
This issue's cover illustrates a sensor-activated crosswalk flasher installed for the County of Arlington in Virginia. The system is composed of three solar-powered points, two being sensor stations and the third a dual 12-inch, flashing beacon system. The sensor stations are located on either side of the crosswalk on the curbs. The flashers have been placed upstream from the crosswalk.

When the site was surveyed, it was noted power was available within 50 feet of the street lights. It appeared that the site could easily be connected to AC. However, county personnel indicated this was impossible as the electric utility owned the lighting system and would not share the power. Nor could we tap into a feed from a nearby building due to the extensive site remediation work required.

Each sensor station is equipped with a SmartwalkR 1400 microwave pedestrian sensor. Since power was an issue, each sensor required a separate solar power system for operation. Ultimately, the sensors were capable of running from either an AC or 12VDC source and pulled approximately .2A in standby. The dry contact output of the sensor was connected to the input of a radio transmitter unit with a digitally-coded signal. The radio transmitter also had a low standby draw and was 12VDC-compatible, making all the necessary hardware solar friendly.

Due to various site conditions, including shading by a large building, a 110W solar array was used to power each station, and an oversized battery included for extended back-up. All the hardware was installed on a 4.5 inch O.D. pole with a breakaway base. The sensor was installed at a height of 12 feet above the pavement as recommended by the manufacturer.

The flasher system was linked to both sensor stations using a digitally-coded receiver. Once the signal was received, the flasher began operation for the programmed run-time with a set of toggle switches in the system's enclosure. The unit uses two 12-inch, amber DC LED lamps from Precision Solar Controls which are configured for wig-wag operation.

Arlington County needed the system to enhance safety at this particular mid-block crossing as static signs had proven ineffective. The county is currently considering installing these systems in other locations within its jurisdiction. Proximity of the different sites will not be an issue since the digital coding of the radios allows multiple transmitter/receivers to operate without interfering with each other.

This is a handicap-friendly system because there's no contact needed for activation. Additional options are available for the system such as a "tattletale" light to make the unit more user friendly. The system sensors operate on a 24-hour basis. The flashing beacons only activate when alerted by the sensors. The total run-time is one hour of flashing per day.

The Arlington County solar-powered crosswalk flasher illustrates many of the benefits of solar technology: no trenching, no boring and reduced costs. Solar-powered traffic controls are the answer when power is too difficult to obtain; when it takes too long to run it to a site or where there's too many obstacles in the ground. If you can't bore under the road or across the road or dig up paving stones-solar is a viable solution.

When a traffic control project is defined correctly, i.e., all the equipment in the load and each component's duty cycle identified, solar clearly offers a cost-effective and feasible alternative-almost a set-it-and-forget-it type of product.