NREL/TP-411-6406 • UC Category: 270 • DE94006917

U.S. Manufacturers of Commercially Available Stand-Alone Photovoltaic Lighting Systems

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1617 Cole Boulevard
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A national laboratory of the U.S. Department of Energy
Operated by Midwest Research Institute
for the U.S. Department of Energy
under contract No. DE-AC02-83CH10093

Prepared under Task No. PV470101

May 1994

NOTICE

Printed in the United States of America
Available from:
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

Price: Microfiche A01
Printed Copy A03

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INTRODUCTION

The purpose of this document is to introduce the reader to photovoltaic (PV) lighting systems, to give some specifications for ordering these systems, and to provide a list of some of the manufacturers of these systems in the United States. These PV lighting systems are all commercially available. They are stand-alone systems since they are not tied to the electric utility power grid.

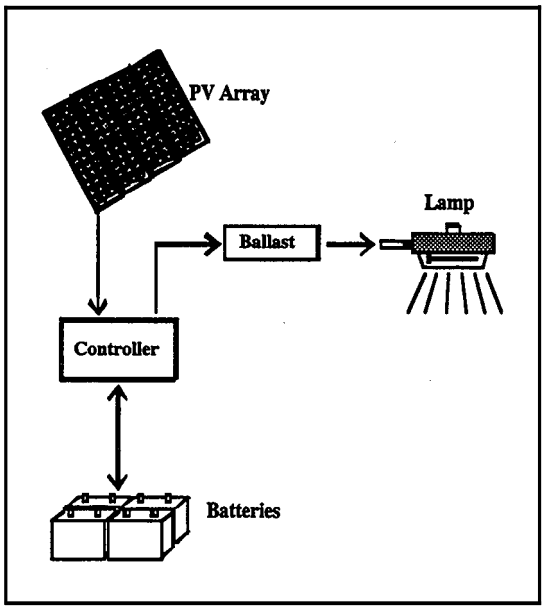

Figure 1. Simplified block diagram of a PV lighting system

PV Lighting Systems

PV lighting systems typically consist of a photovoltaic array, a charge/lighting controller, a bank of batteries, a ballast, and a lamp, as shown in Fig. 1. The PV array consists of photovoltaic modules which convert sunlight directly into electrical energy which is then stored in deep-cycle batteries. The controller turns the lamp on and off, and also increases the life of the batteries by protecting them from being overcharged during the day, and from being over-discharged at night. Most PV lighting systems use highly efficient fluorescent or low-pressure sodium lamps which operate at higher voltages than the batteries. Therefore, a ballast is required to convert the low voltage from the batteries (typically 12 or 24 volts) up to the high voltage for the lamp (several hundred volts).

System Specifications

When buying a PV lighting system it is important that the user convey certain specifications to the manufacturer. Some of these specifications include:

- Lamp run-time per night (the worst case occurs in mid-winter where available solar irradiance is the lowest and the nights are longest)
- Type of operation (24-hour or dusk-to-dawn)
- Days of autonomy (the number of days the system must continue to operate without full sunshine)
- Location & site (latitude and specific site - e.g., in a canyon or on a flat field)
- Type of lamp (e.g., fluorescent vs. low-pressure sodium)
- Minimum required light levels
- Reliability (e.g., an obstruction beacon on top of a high-voltage transmission tower near an airport must be more reliable than a billboard lighting system)

All of the above will effect the size of the PV array, the size of the battery bank, and the system cost. Some manufacturers leave it up to the purchaser to buy key components, especially the batteries or pole, as these

items may cost more to ship than customers would pay to obtain them locally. Therefore, it is important that the purchaser ask what is included or excluded with each particular lighting system.

TYPES OF PV LIGHTING SYSTEMS

Area/Street Lighting - used to illuminate streets, yards, parking lots, campgrounds, basketball courts, boat ramps, construction sites, fishing wharves, park trails, playgrounds, roadside rest areas, etc.

Billboard Lighting - used to illuminate billboards, bus shelter advertisements, city welcome monuments, corporate signs, etc.

Indoor Lighting - used to illuminate remote homes, remote classrooms, roadside restrooms, RVs, store displays, etc.

Marine Signal Lighting - used to illuminate beacon lights on buoys, lighthouses, breakwaters, and other obstructions. May also be used to mark navigational channels.

Obstruction Beacon Lighting - used to mark transmission towers and other tall obstacles.

Traffic Signal Lighting - used to illuminate flashing school zone signs, flashing traffic arrows, railroad crossing signals, traffic lights, programmable traffic message signs, etc.

Address Lighting - small systems with backlit letters or numbers for building addresses.

Walkway Lighting - small lights used to mark or accent sidewalks or garden paths.

U.S. MANUFACTURERS OF PV LIGHTING SYSTEMS

The manufacturers listed here may offer goods and services in addition to PV lighting systems. This list is representative of available information and should not be considered complete.

NREL cannot and does not endorse, nor recommend, one manufacturer over any other.

	Area/Street	Billboard	Indoor	Traffic Signal	Obstruction Beacon	Railroad Signal	Marine Signal
Atlantic Solar Products, Inc. 9351 J. Philadelphia Rd. Baltimore, MD 21237-4114 1-800-537-1566	●	●					
Currin Corp. P.O. Box 1191 Midland, MI 48640 517-835-7387			●				
Diversified Technologies Co. P.O. Box 27 Castle Rock, CO 80104 303-660-0534	●						
Electro Solar 502 Ives Place Pensacola, FL 32514 904-479-2191	●			●			
Hoxan America One Centennial Plaza Piscataway, NJ 08854 908-980-0777				●			
Integrated Power Corp. 7524 Standish Place Rockville, MD 20855 301-294-9133					●	●	
Jade Mountain P.O. Box 4616 Boulder, CO 80306 1-800-442-1972	●						
Magnaray International 2242 Whitfield Park Loop Sarasota, FL 34243 813-755-2111	●						

	Area/Street	Billboard	Indoor	Traffic Signal	Obstruction Beacon	Railroad Signal	Marine Signal
McCoy Industries, Inc. 7350 S. Tamiami Trail #7 Sarasota, FL 34231 813-371-0139	●	●					
Midwest Conservation Systems P.O. Box 397 Silver Lake, KS 66539 1-800-696-4509	●						
Northern Power Systems 1 N. Wind Rd. Moretown, VT 05660-0659 802-496-2955					●		
Photocomm, Inc. 7681 E. Gray Rd. Scottsdale, AZ 85260 602-948-8003	●	●					
Precision Solar Controls 2915 National Ct. Garland, TX 75041 214-278-0553	●	●		●			
RGA 454 Southlake Blvd. Richmond, VA 23236 804-794-1592				●			
Scientific Analysis, Inc. 6012 E. Shirley Lane Montgomery, AL 36117 205-271-0643	●						
Seanav Corp. P.O. Box 32038 Lafayette, LA 70593 318-235-1004							●

	Area/Street	Billboard	Indoor	Traffic Signal	Obstruction Beacon	Railroad Signal	Marine Signal
Simpler Solar Systems, Inc. 3120 W. Tharpe St. Tallahassee, FL 32303 1-800-248-9786	●	●					
Solar (or Energy) Depot 61 Paul Dr. San Rafael, CA 94903 415-499-1333	●		●				
Solar Electric Specialties Co. P.O. Box 537 Willits, CA 95490 707-459-9496	●		●	●			
Solar Electric Systems 13700 W. 108th St. Lenexa, KS 66215 913-338-1939	●	●	●				●
Solar Outdoor Lighting, Inc. 3131 S.E. Waaler St. Stuart, FL 34997 407-286-9461	●	●					●
Solec International, Inc. 12533 Chadron Ave. Hawthorne, CA 90250 213-970-0065	●						
Southwest Photovoltaic Systems 18802 Bluebird Tomball, TX 77375 713-351-0031	●			●			
SunAmp Power Co. 1902 N. Country Club Dr. #8 Mesa, AZ 85201 1-800-MR-SOLAR	●						

	Area/Street	Billboard	Indoor	Traffic Signal	Obstruction Beacon	Railroad Signal	Marine Signal
Sunelco, Inc. 100 Skeels St. Hamilton, MT 59840-1499 406-363-6924	●						
Suntrapper 12118 Radium St. San Antonio, TX 78216 210-341-2001						●	
Tideland Signal Corp. P.O. Box 52430 Houston, TX 77052 713-681-6101							●
Work Area Protection Corp. 2500 Production Dr. St. Charles, IL 60174-0087 708-377-9100				●			

This list should not be considered complete; addresses and phone numbers may change. If you would like to be added to this list, would like to update or correct the list information, or have any questions or comments, please contact:

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or

John Thornton 303-384-6469

Photovoltaic Analysis and Applications Development Project

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APPENDIX 1: PHOTOVOLTAIC LIGHTING SYSTEMS

Figure 2
Example of an area/street light at the NREL Solar Energy Research Facility (SERF), in Golden, Colorado

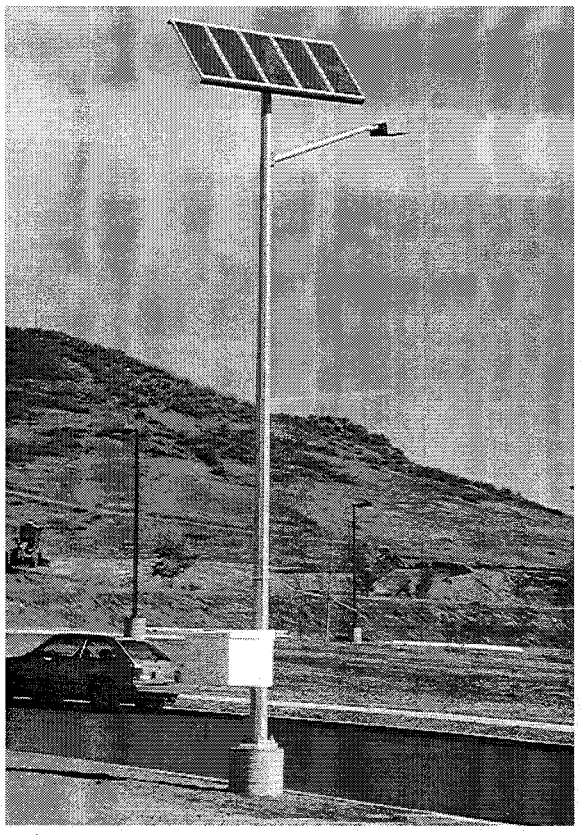


Figure 3
Photovoltaic area/street light in San Diego, California

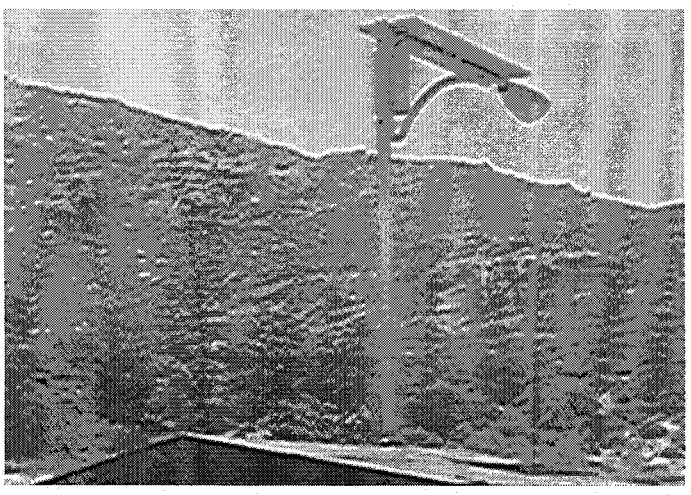


Figure 4
Photovoltaic billboard lighting system

Figure 5
Photovoltaic marine signal light

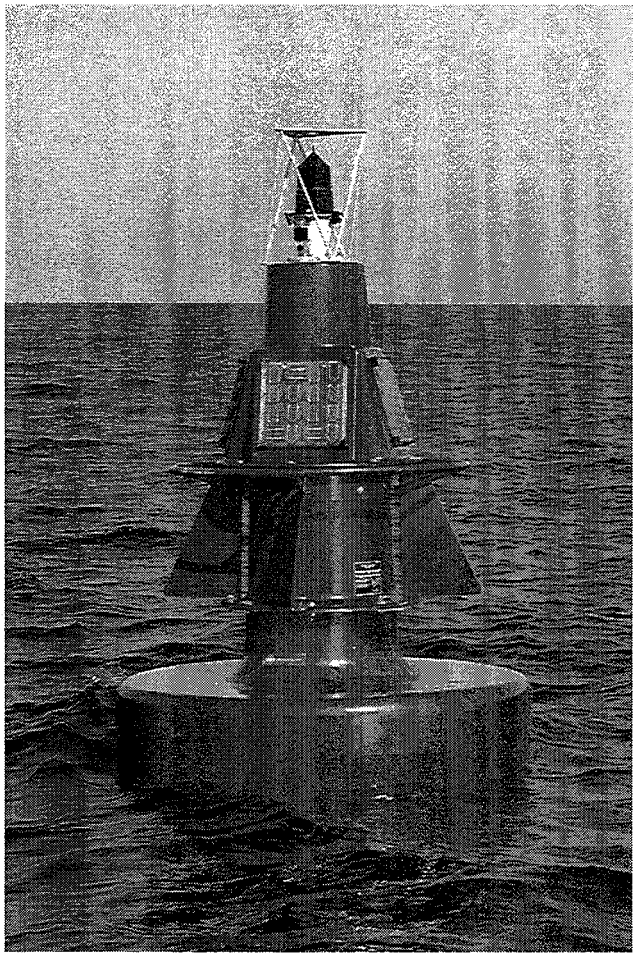
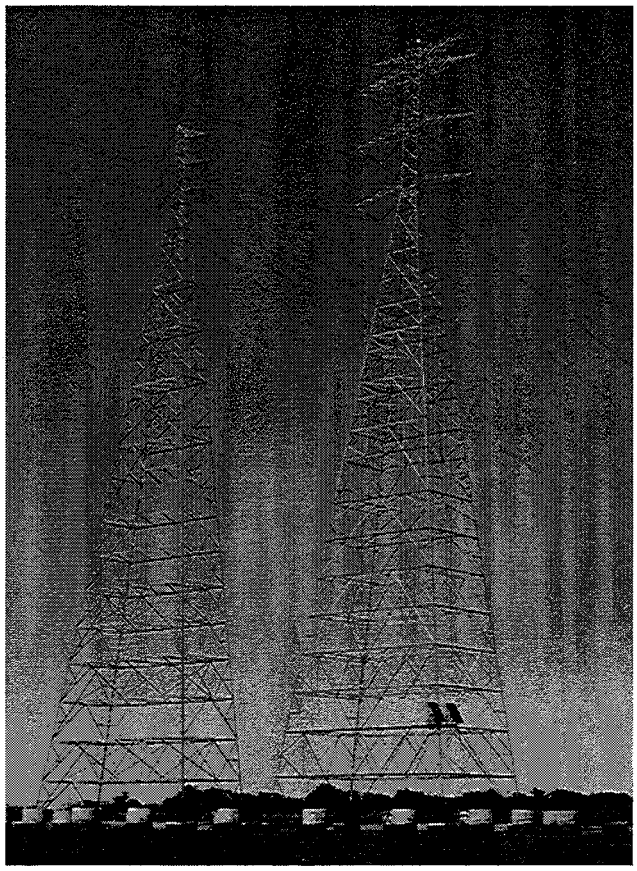


Figure 6
Photovoltaic obstruction lighting in the Houston, Texas, ship channel



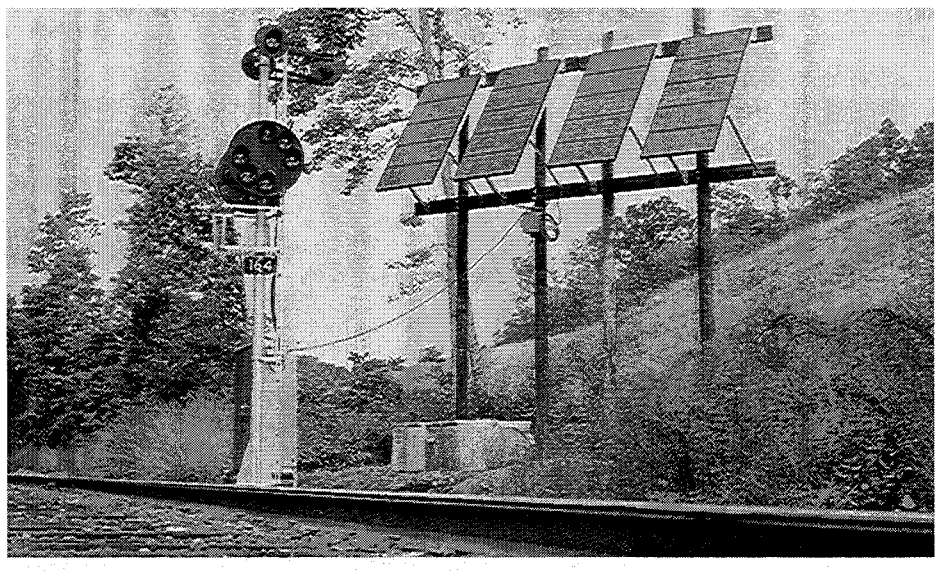


Figure 7
Photovoltaic railroad signal

Figure 8
Photovoltaic traffic signal

APPENDIX 2:
The Commercially Available Stand-Alone PV Lighting Systems (CASALS) Project

Six commercially available, stand-alone photovoltaic (PV) area lighting systems were installed at NREL in 1993 for long-term independent evaluation and testing under real-world conditions. The results of this project will include a description of the different types of systems, the testing that was conducted, the experiences gained during installation, system safety issues, and the data gathered to evaluate the systems' performance. This data includes battery and PV array voltages and currents; temperatures from the back of the PV array, the controller, the batteries, the ballast and the lamp; solar insolation; relative lamp illuminance; ambient temperature; and other weather parameters. Table 1 shows the area and street lighting systems being tested at NREL along with relevant system specifications. Table 2 presents typical parameters of various lamps. The results of this study are being used to evaluate nightly system operation, long-term reliability under various solar and weather conditions, an intercomparison of different types of lighting systems, as well as cost versus performance. This ongoing study is helping to evaluate the performance of these commercially available stand-alone PV lighting systems, information which will, in turn, help both the manufacturers and users in the PV community.

TABLE 1. AREA AND STREETLIGHTS UNDER TEST AT NREL

based upon information supplied by the manufacturers

Manufacturer	System Type	# of PV Modules	PV Array Output (W)	# of Batteries	Battery Capacity (Ah)	Hours of Autonomy	Lamp Power (Watts)	Lamp Type (1)	PV Material (2)	Battery Type	Controller Type	Pole Height (ft)	Array Tilt (Degrees)	System Cost	$/Lamp Watt-Hrs Autonomy (3)
Diversified Technologies	Area	2	106	2	172	36	18	HIF	x-Si	Sealed Lead-Acid Gel-Cell	Shunt	15	50	$1,575	$2.43
Midwest Conservation Systems	Area	2	106	3	270	67	18	LPS	x-Si	Sealed Lead-Acid Gel-Cell	Series	15	47	$2,438	$2.02
Photocomm	Area Street	5	250	4	440	78	36	HIF	m-Si	Flooded Lead-Acid with Hydrocaps	Constant Voltage	26	52	$6,790	$2.42
Solar Outdoor Lighting	Area Street	3	144	3	135	60	39	HIF	x-Si	Sealed Lead-Acid Gel-Cell	Series	15	0	$2,695	$1.15
Solec	Area	2	140	2	230	60	39	HIF	x-Si	Sealed Flooded Lead-Acid	Shunt	16	44	$2,078	$0.89
SunAmp	Area	3	180	3	300	52	35	LPS	m-Si	Sealed Captive-Electrolyte Lead-Acid	Shunt	22	55	$2,871	$1.59

Notes:
(1) LPS = low-pressure sodium
HIF = high-intensity fluorescent
(2) m-Si = multicrystalline silicon
x-Si = single-crystalline silicon
(3) The figure in the last column is calculated as follows: (System Cost)/(Lamp Watts * Hours of Autonomy)

TABLE 2. SUMMARY OF TYPICAL LAMP CHARACTERISTICS

based upon information supplied by the manufacturers

	Lumens per Watt	Color Rendering Index %	Service Life (Hours)	Warm-Up Time	Effects of Cold Temperatures
Fluorescent	Good 80	Good 80	Good 10,000	Immediate	Reduced Light Output
Low-Pressure Sodium	Very Good 200	Very Poor <20	Good 18,000	Several Minutes	Minimal
High-Pressure Sodium	Very Good 140	Fair 20	Very Good >24,000	Several Minutes	Minimal
Neo-Lux	Excellent 600	Very Good*	Excellent >66,000	Immediate	Minimal
Halogen	Poor 25	Excellent 100	Poor 2,000	Immediate	Minimal
Incandescent	Poor 20	Excellent 100	Poor 1,000	Immediate	Minimal

Note: * Actual value not available

REPORT DOCUMENTATION PAGE

Form Approved
OMB NO. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	May 1994	Technical Report

4. TITLE AND SUBTITLE

U.S. Manufacturers of Commercially Available Stand-Alone Photovoltaic Lighting Systems

5. FUNDING NUMBERS

C:

TA: PV470101

6. AUTHOR(S)

P. McNutt

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

National Renewable Energy Laboratory
1617 Cole Blvd.
Golden, CO 80401-3393

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

TP-411-6406

DE94006917

11. SUPPLEMENTARY NOTES

NREL Technical Monitor:

12a. DISTRIBUTION/AVAILABILITY STATEMENT

12b. DISTRIBUTION CODE

UC-270

13. ABSTRACT *(Maximum 200 words)*

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14. SUBJECT TERMS

photovoltaics ; solar cells

15. NUMBER OF PAGES

17

16. PRICE CODE

A03

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL