

# **Solar Thermal and Photovoltaic Collector Manufacturing Activities 2003**

## **With Preliminary Data For 2003**

**September 2004**

**Energy Information Administration**  
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## Preface

The Energy Information Administration (EIA) reports detailed historical data on solar manufacturing activities annually in its report, the *Renewable Energy Annual*. This report, *Solar Thermal and Photovoltaic Collector Manufacturing Activities With Preliminary Data For 2003*, provides an overview and tables with historical data spanning 1994-2002, including revisions, and preliminary data for 2003. These tables correspond to similar tables last presented in *Renewable Energy Annual 2002* and planned for *Renewable Energy Annual 2003*; and are numbered accordingly. The *Renewable Energy Annual 2003* will also present information on renewable energy trends and geothermal heat pump manufacturing activities. Definitions for terms used in this report can be found in EIA's Energy Glossary: [http://www.eia.doe.gov/glossary/glossary\\_main\\_page.htm](http://www.eia.doe.gov/glossary/glossary_main_page.htm).

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# Overview

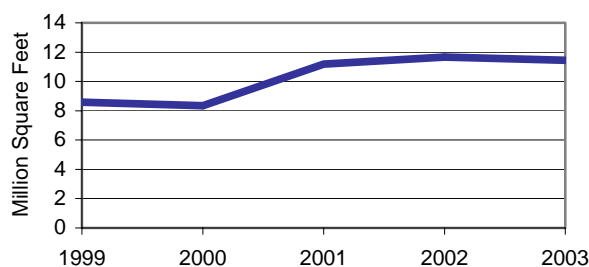
## Summary

While the U.S. solar collector market was ho-hum in 2003, the photovoltaic cell and module business was anything but dull. The second-largest manufacturer of photovoltaic (PV) cells and modules, AstroPower, went bankrupt. Other major manufacturers significantly changed their relative outputs of cells and modules, as well as entering and leaving major end-use markets. The result was the first decline in total peak kilowatt production of photovoltaic cells and modules since EIA resumed collecting such data in 1986.

## Solar Thermal Collectors

The solar collector market was lackluster in 2003. Total and domestic shipments of solar collectors remained close to 2002 and 2001 levels (Tables 10 and 11 and Figure 1). Total sales were 11.4 million square feet, down 2 percent from 2002. Domestic shipments of 10.9 million square feet declined a similar amount from 2002 levels. The number of companies shipping solar collectors has remained steady since 2000.

**Figure 1. Total Solar Thermal Collector Shipments, 1999-2003**



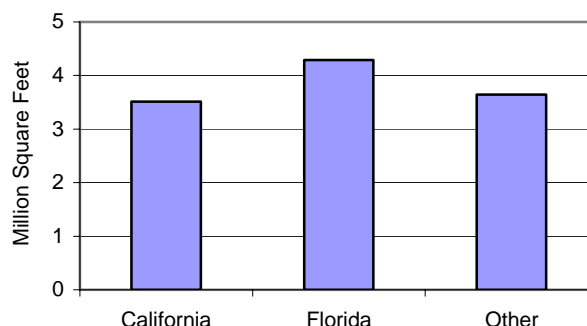
Source: Source: Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."

Low-temperature collectors continued to dominate the market in 2003, with a 95 percent share (Table 12). Nearly three-fourths of all collectors were produced in five domestic locales: California, New Jersey, Florida, Puerto Rico, and Tennessee (Table 13a), with two-thirds shipped from California and New Jersey alone. As in the past few years, around 80 to 85 percent of solar collectors were sent to the top 5 destinations (Table 13b). For 2003, these states were: Florida, California, New Jersey, Arizona, and Hawaii.

All but New Jersey have relatively high incidences of heated swimming pools. Over two-thirds were shipped to just Florida and California (Figure 2).

The small (0.5 million square feet) solar collector export market was dominated by sales to Canada, Mexico, and

**Figure 2. Solar Thermal Collector Shipments Top Destinations, 2003**

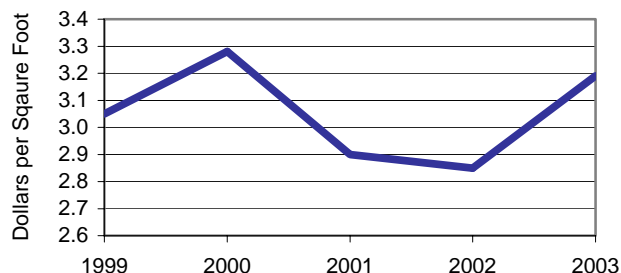


Source: Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."

Austria (Table 15). Collectors were shipped to various kinds of business in similar proportions for both 2002 and 2003 (Table 16).

Steady sales produced steady prices for the dominant low-temperature collector in 2003. The average price per square foot rose slightly to \$2.08 from \$1.97 in 2002 (Table 17). Medium- and high-temperature collectors went for a somewhat higher average price, resulting in the overall average price per square foot of all solar collectors rising to \$3.19 in 2003 from \$2.85 in 2002 (Figure 3).

**Figure 3. Solar Thermal Collector Average Prices, 1999-2003**



Source: Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."

Shipments by market sector, end use, and type were also similar in 2003 to 2002 (Table 18). The only shift of any size was between the residential and commercial sectors.

One of the few notable differences between 2002 and 2003 solar collector shipments was in complete shipments. The number of complete systems rose 15 percent to 7,266 systems in 2003 (Table 19). Moreover the value of complete shipments increased even more— 31 percent. This difference is likely due to the average size of a complete collector decreasing from 143 square feet to 119 square

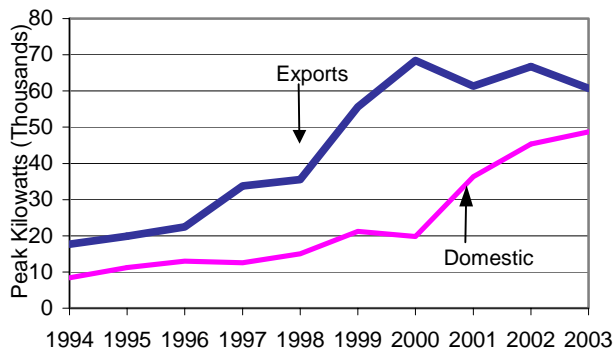
feet, requiring fixed per system costs to be spread over a smaller collector area.

Sales concentration remained constant during 2003, with 92 percent of sales made by the 5 largest firms (Table 21). This concentration has stayed between 90 and 96 percent over the past 5 years. New product introduction continues to be anticipated by only a few companies (Table 20); employment is near the 5-year industry average (Table 22); and except for non-collector system component manufacture, solar collector companies are remaining in the same lines of work (Table 23) as in recent years. Companies which produce solar products continue to do so as the predominant portion of their business (Table 24).

### Photovoltaic Cells and Modules

After uninterrupted increases for nearly two decades, shipments of photovoltaic (PV) cells and modules declined 2.5 percent in 2003 to 109,357 peak kilowatts (Table 26). Exports dropped sharply—9 percent—while domestic shipments rose 7 percent (Table 10 and Figure 4).

**Figure 4. Photovoltaic Exports and Domestic Shipments, 1994-2003**



Sources: Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey," and Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."

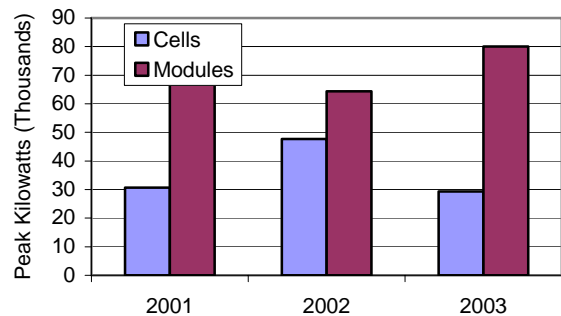
Module shipments increased 24 percent to 80,062 peak kilowatts, but cell shipments decreased to 29,295 peak kilowatts from 47,677 peak kilowatts in 2002 (Table 25 and Figure 5).

Two major events occurred in the PV industry during 2003 that affected cell and module shipments:

- The second-largest producer of PV cells and modules, AstroPower, went bankrupt. Its assets were purchased by General Electric's solar division. The bankruptcy had a major impact on the amount and distribution of cell and module shipments, as will be described later.
- Shell Solar repurchased substantial quantities of cells during 2003 for module manufacture.

Both of these events affected shipments to business categories. Shipments to module manufacturers decreased nearly two-thirds, owing largely to Shell Solar cell

**Figure 5. Photovoltaic Cell and Module Shipments, 2001-2003**



Source: Energy Information Administration, Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."

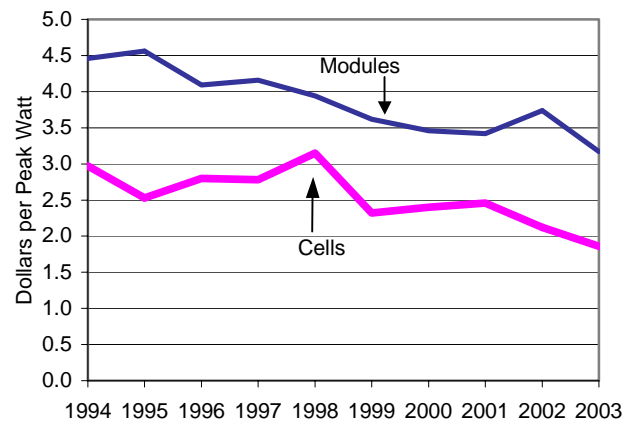
repurchases, which are treated as negative shipments (Table 27). In contrast, shipments to exporters and end-users rose substantially.

Single crystal cell and module shipments suffered the worst drop in 2003 of all PV technologies, falling 15,000 peak kilowatts (Table 28). This was due in large measure to the fact that AstroPower produced only single crystal cells. The sharp increase in cast and ribbon cell and module shipments was largely due to one company, RWE, expanding its module capacity substantially during 2003. Other companies also expanded module capacity.

Softer shipments also adversely affected prices in 2003. The average cell price per peak watt for the most prevalent technology, single-crystal silicon, dropped to \$1.88 from \$2.14 in 2002 (Table 29). Single-crystal module prices also dropped, despite increased shipments, from \$3.64 in 2002 to \$3.38 in 2003.

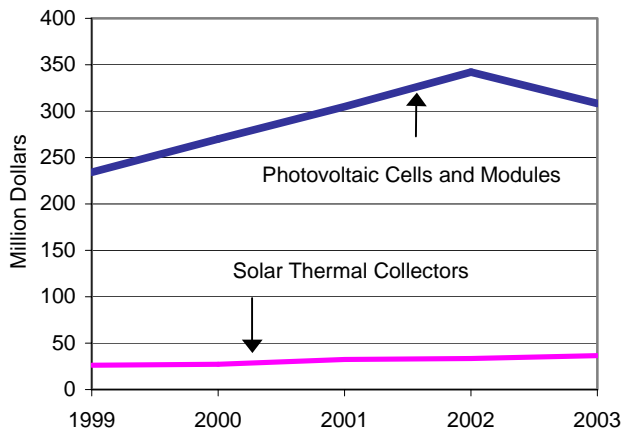
The average price per peak watt of all PV cells displayed a similar pattern (\$2.12 to \$1.86), while the average price of

**Figure 6. Photovoltaic Cell and Module Average Prices, 1994-2003**



Source: Energy Information Administration, Form EIA-63B, "Annual Photovoltaic Manufacturers Survey."

**Figure 7. Solar Equipment Manufacturers' Value of Shipments, 1999-2003**



Sources: Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey," and Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."

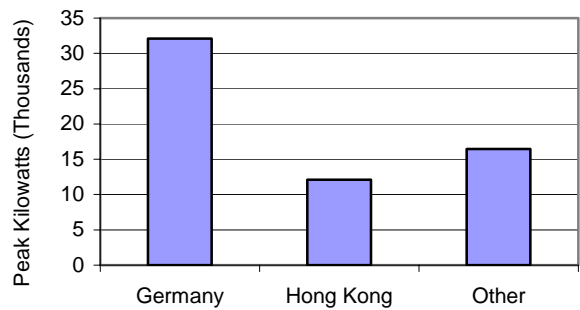
modules declined more (\$3.74 to \$3.17) than did the price of single-crystal modules (Figure 6).

The decline in average price combined with the drop in shipments to reduce the total value of PV shipments to \$308 million in 2003, a 9 percent decline from 2002 (Figure 7). The value of PV shipments still outweighs the value of solar thermal collectors by an 8:1 margin.

Market sector and end-use distributions of PV shipments in 2003 changed considerably from 2002. Shipments in 2003 to the industrial and residential markets declined sharply, 13 and 20 percent, respectively (Table 30). Commercial shipments, in contrast, rose nearly 60 percent from about 21,000 peak kilowatts in 2002 to nearly 33,000 peak kilowatts in 2003. Much of the commercial market increase was due to Shell Solar, which discontinued its recreational vehicle kits and began providing rooftop applications in 2003. This made the commercial market the largest market for PV shipments in 2003, supplanting the industrial market. The distribution of former Astropower markets also affected 2003 market sector shipments substantially.

Shell Solar's product switch also affected the distribution of shipments to end-use categories. Shipments to the transportation sector declined in 2003 by nearly 2,000 peak kilowatts, or 12 percent. Also, grid-interactive electricity generation shipments, which are how rooftop applications

**Figure 8. Photovoltaic Export Shipment Top Destinations, 2003**



Source: Energy Information Administration, Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."

are generally used, rose almost 9,000 peak kilowatts to over 42,000 peak kilowatts in 2003. With nearly a 40 percent share in 2003, the grid-interactive application increased its position as the predominant use of PV cell and module shipments, up from 30 percent in 2002.

PV exports were split nearly 50:50 between cells and modules during 2003 (Table 31). This was fairly similar to the 2002 pattern, when cells held a slight edge. Over half of 2003 PV exports were to Germany, which imported 2.5 times more U.S. cells and modules than the next-largest importer, Hong Kong (Table 32 and Figure 8).

Shipments of complete PV systems dropped 21 percent in 2003, yet the total peak kilowatts and value of shipped systems actually rose substantially (Table 33). These characteristics are heavily influenced by Shell Solar's change in product mix to larger rooftop installations. These developments affected prices. While the price per system increased more than 40 percent in 2003, the price per peak kilowatt dropped only slightly (\$5.28 in 2003 versus \$5.51 in 2002).

Employment in the PV manufacturing industry dropped slightly in 2003 but remained at approximately 2001-2002 levels (Table 34). Employment rose fairly steadily from 1994 through 1998, then remained stable through 2000. Despite only a 10 percent market share, 5 companies plan to introduce new thin-film products (Table 35). More companies (7) are planning for new products using crystalline silicon technology. No new flat plate or concentrator products are planned. The number and type of companies involved in PV-related businesses remained essentially unchanged in 2003 (Table 36).

**Table 10. Annual Photovoltaic and Solar Thermal Domestic Shipments, 1994-2003**

Year	Photovoltaic Cells and Modules <sup>a</sup> (Peak Kilowatts)	Solar Thermal Collectors <sup>a</sup>
		(Thousand Square Feet)
1994.....	8,363	7,222
1995.....	11,188	7,136
1996.....	13,016	7,162
1997.....	12,561	7,759
1998.....	15,069	7,396
1999.....	21,225	8,046
2000.....	19,839	7,857
2001.....	36,310	10,349
2002.....	45,313	11,004
2003 <sup>P</sup> .....	48,664	10,926
<b>Total.....</b>	<b>231,548</b>	<b>84,859</b>

<sup>a</sup> Total shipments minus export shipments.

P = Preliminary

Notes: Totals may not equal sum of components due to independent rounding. Total shipments include those made to U.S. Territories.

Sources: Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey," and Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."

**Table 11. Annual Shipments of Solar Thermal Collectors, 1994-2003**

Year	Number of Companies	Collector Shipments <sup>a</sup> (Thousand Square Feet)		
		Total <sup>b</sup>	Imports	Exports
1994	41	7,627	1,815	405
1995	36	7,666	2,037	530
1996	28	7,616	1,930	454
1997	29	8,138	2,102	379
1998	28	7,756	2,206	360
1999	29	8,583	2,352	537
2000	26	8,354	2,201	496
2001	26	11,189	3,502	840
2002	27	11,663	3,068	659
2003 <sup>P</sup>	26	11,444	2,986	518

<sup>a</sup> Includes imputation of shipment data to account for nonrespondents.

<sup>b</sup> Includes shipments of solar thermal collectors to the government, including some military, but excluding space applications.

P = Preliminary.

Note: Total shipments as reported by respondents include all domestic and export shipments and may include imported collectors that subsequently were shipped to domestic or foreign customers.

Source: Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."



**Table 12. Annual Shipments of Solar Thermal Collectors by Type, 1994-2003**  
(Thousand Square Feet)

Year	Low-Temperature		Medium-Temperature		High-Temperature Total Shipments <sup>a, c</sup>
	Total Shipments <sup>a, b</sup>	Average per Manufacturer	Total Shipments <sup>a</sup>	Average per Manufacturer	
1994.....	6,823	426	803	26	2
1995.....	6,813	487	840	32	13
1996.....	6,821	487	785	41	10
1997.....	7,524	579	606	29	7
1998.....	7,292	607	443	23	21
1999.....	8,152	627	427	21	4
2000.....	7,948	723	400	25	5
2001.....	10,919	1,092	268	16	2
2002.....	R11,126	R856	R535	R31	2
2003 <sup>P</sup> .....	10,877	906	560	33	7

<sup>a</sup> Includes imputation of shipment data to account for nonrespondents.

<sup>b</sup> Includes shipments of solar thermal collectors to the government, including some military, but excluding space applications.

<sup>c</sup> For high-temperature collectors, average annual shipments per manufacturer are not disclosed.

P = Preliminary.

R = Revised.

Source: Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."

**Table 13a. Domestic Shipments of Solar Collectors Ranked by Origin and Destination, 2003**

Origin/Destination	2003 Shipments <sup>P</sup>	
	Thousand Square Feet	Percent of U.S. Total
<b>Origin</b>		
Top Five States .....	8,351	73
California.....	3,990	35
New Jersey.....	3,536	31
Florida.....	623	5
Puerto Rico.....	113	1
Tennessee.....	89	1
Other.....	106	1
Imported.....	2,986	26
<b>U.S. Total .....</b>	<b>11,444</b>	<b>100.0</b>
<b>Destination</b>		
Top Five States.....	9,641	84
Florida.....	4,290	37
California.....	3,514	31
New Jersey.....	804	7
Arizona.....	731	6
Hawaii.....	302	3
Other.....	1,285	11
Exported .....	518	5
<b>U.S. Total .....</b>	<b>11,444</b>	<b>100.0</b>

W = Data withheld to avoid disclosure of proprietary company data.

P = Preliminary.

Notes: Totals may not equal sum of components due to independent rounding. U.S. total includes territories.

Source: Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."

**Table 13b. Domestic Shipments of Solar Collectors Ranked by Origin and Destination, 2002**

Origin/Destination	2002 Shipments	
	Thousand Square Feet	Percent of U.S. Total
<b>Origin</b>		
Top Five States.....	8,517	73
California.....	4,344	37
New Jersey.....	3,482	30
Florida.....	502	4
Puerto Rico.....	111	1
New York.....	80	1
Other.....	77	1
Imported.....	3,068	26
<b>U.S. Total .....</b>	<b>11,663</b>	<b>100</b>
<b>Destination</b>		
Top Five States.....	9,322	80
Florida.....	4,368	37
California.....	3,213	28
New Jersey.....	937	8
Arizona.....	530	5
Hawaii.....	274	2
Other.....	1,683	14
Exported.....	659	6
<b>U.S. Total .....</b>	<b>11,663</b>	<b>100</b>

W = Data withheld to avoid disclosure of proprietary company data.

Notes: Totals may not equal sum of components due to independent rounding. U.S. total includes territories.

Source: Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."

**Table 14. Shipments of Solar Thermal Collectors by Destination, 2003 (Square Feet)**

Destination	Shipments <sup>P</sup>
Alabama .....	458
Arizona .....	731,211
Arkansas .....	766
California .....	3,514,290
Colorado.....	17,859
Connecticut.....	131,521
Delaware.....	123
Florida .....	4,289,945
Georgia .....	45,726
Hawaii .....	302,072
Idaho .....	2,181
Illinois .....	211,794
Indiana .....	477
Iowa.....	238
Louisiana.....	34,138
Maine .....	1,860
Maryland .....	5,805
Massachusetts .....	35,826
Michigan.....	34,194
Minnesota.....	35,418
Mississippi.....	114
Missouri.....	279
Nebraska.....	1,525
Nevada.....	47,981
New Hampshire.....	258
New Jersey .....	803,579
New Mexico.....	50,140
New York.....	92,995
North Carolina.....	4,466
Ohio.....	34,364
Oklahoma.....	715
Oregon .....	118,269
Pennsylvania.....	37,011
Puerto Rico .....	114,700
South Carolina .....	295
Tennessee .....	477
Texas .....	86,796
Utah.....	12,960
Vermont.....	10,099
Virgin Islands.....	604
Virginia .....	73,978
Washington .....	477
Wisconsin.....	38,091
<b>Shipments to United States/Territories.....</b>	<b>10,926,073</b>
<b>Exports .....</b>	<b>517,664</b>
<b>Total Shipments .....</b>	<b>11,443,737</b>

P = Preliminary

Source: Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."

**Table 15. Distribution of U.S. Solar Thermal Collector Exports by Country, 2003**

Country	Percent of U.S. Exports <sup>P</sup>
<b>Asia and the Middle East</b>	
China .....	2.03
Guam .....	0.41
India .....	0.13
Japan .....	2.70
Taiwan .....	0.53
<b>Total .....</b>	<b>5.8</b>
<b>Europe</b>	
Austria .....	11.41
Belgium & Luxembourg .....	4.59
Czech Republic .....	2.85
France .....	5.01
Spain .....	1.15
Sweden .....	4.50
Switzerland .....	0.95
<b>Total .....</b>	<b>30.5</b>
<b>North America</b>	
Bahamas .....	0.47
Barbados .....	0.06
Bermuda .....	*
Canada .....	35.09
Costa Rica .....	3.81
French West Indies .....	0.17
Guatemala .....	1.94
Mexico .....	19.75
Panama .....	*
<b>Total .....</b>	<b>61.3</b>
<b>South America</b>	
Bolivia .....	1.43
Ecuador .....	0.09
Peru .....	0.40
<b>Total .....</b>	<b>1.9</b>
<b>Other, nonspecified .....</b>	<b>0.5</b>
<b>Total .....</b>	<b>100.0</b>

P = Preliminary.

Notes: Totals may not equal sum of components due to independent rounding.

Source: EIA Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."

**Table 16. Distribution of Solar Thermal Collector Shipments, 2002 and 2003**

Recipient	Shipments (Thousand Square Feet)	
	2002	2003 <sup>P</sup>
Wholesale Distribution .....	6,411	6,316
Retail Distributors .....	4,509	4,283
Exporters .....	177	262
Installers .....	403	413
End Users and Other <sup>a</sup> .....	162	170
<b>Total .....</b>	<b>11,663</b>	<b>11,444</b>

<sup>a</sup>Other includes minimal shipments not explained on form EIA-63A.

P = Preliminary.

Note: Totals may not equal sum of components due to independent rounding.

Source: Energy Information Administration. Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."

**Table 17. Solar Thermal Collector Shipments by Type, Quantity, Value, and Average Price 2002 and 2003**

Type	2002			2003 <sup>P</sup>		
	Quantity (Thousand Square Feet)	Value (Thousand Dollars)	Average Price (Dollars per Square Foot)	Quantity (Thousand Square Feet)	Value (Thousand Dollars)	Average Price (Dollars per Square Foot)
<b>Low-Temperature</b>						
Liquid and Air	R 11,126	R 21,942	1.97	10,877	22,674	2.08
<b>Medium/High Temperature</b>	537	11,344	21.11	567	13,784	24.31
Medium:						
Air	R4	W	W	6	W	W
Liquid						
ICS/Themosiphon	110	5,229	47.74	111	5,803	52.09
Flat Plate	419	5,771	13.77	440	7,378	16.78
Evacuated Tube	2	W	W	2	W	W
Concentrator	*	W	W	*	W	W
<b>High:</b>						
Parabolic Dish and Trough	2	W	W	7	W	W
<b>Total</b>	<b>11,663</b>	<b>33,286<sup>a</sup></b>	<b>2.85</b>	<b>11,444</b>	<b>36,458</b>	<b>3.19</b>

<sup>a</sup>Total includes institutional research project.

ICS = Integral collector storage.

W = Data withheld to avoid disclosure of proprietary company data

R = Revised.

P = Preliminary

Notes: Totals may not equal sum of components due to independent rounding.

Source: Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."

**Table 18. Shipments of Solar Collectors by Market Sector, End Use, and Type, 2002 and 2003 (Thousand Square Feet)**

Type	Low-Temperature	Medium-Temperature					High-Temperature	2003 <sup>P</sup> Total	2002 Total
	Liquid/Air	Air	Liquid				Parabolic Dish/Trough		
	Metallic and Nonmetallic		ICS/Ther- mosiphon	Flat-Plate (Pumped)	Evacuated Tube	Concen- trator			
<b>Market Sector</b>									
Residential .....	9,993	6	106	400	1	*	0	10,506	11,000
Commercial .....	813	0	3	40	1	0	7	864	595
Industrial .....	71	0	0	0	0	0	0	71	62
Utility .....	0	0	0	0	0	0	0	0	4
Other <sup>a</sup> .....	0	0	2	0	0	0	0	2	1
<b>Total .....</b>	<b>10,877</b>	<b>6</b>	<b>111</b>	<b>440</b>	<b>2</b>	<b>*</b>	<b>7</b>	<b>11,444</b>	<b>11,663</b>
<b>End use</b>									
Pool Heating .....	10,778	0	0	22	0	0	0	10,800	11,073
Hot Water .....	0	0	111	397	2	*	0	511	423
Space Heating .....	65	6	0	4	*	0	0	76	146
Space Cooling .....	0	0	0	0	*	0	0	*	*
Combined Space and Water Heating .....	0	0	0	16	0	0	7	23	17
Process Heating .....	34	0	0	0	0	0	0	34	4
Electricity .....									
Generation .....	0	0	0	0	0	0	0	0	0
Other <sup>b</sup> .....	0	0	0	0	0	0	0	0	0
<b>Total .....</b>	<b>10,877</b>	<b>6</b>	<b>111</b>	<b>440</b>	<b>2</b>	<b>*</b>	<b>7</b>	<b>11,444</b>	<b>11,663</b>

<sup>a</sup>Other market sector include shipments of solar thermal collectors to sectors such as government, including the Military but excluding space applications.

<sup>b</sup>Other end use includes shipments of solar thermal collectors for other uses such as cooking, water pumping, water purification, desalinization, distillation, etc.

\*=Less than 500 square feet.

ICS= Integral Collector Storage.

P = Preliminary.

Note: Totals may not equal sum of components due to independent rounding.

Source: Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."

**Table 19. Shipments of Complete Solar Thermal Collector Systems, 2002 and 2003**

Shipment Information	2002	2003 <sup>P</sup>
Complete Collector Systems		
Shipped.....	6,333	7266
Thousand Square Feet.....	904	864
Percent of Total Shipments.....	8	8
Number of Companies.....	27	26
Value of Systems (Thousand Dollars).....	10,363	13,586

P = Preliminary.

Source: Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."

**Table 20. Number of Companies Expecting To Introduce New Solar Thermal Collector Products in 2004**

New Product Type	Number of Companies
Low-Temperature Collectors .....	4
Medium-Temperature Collectors .....	7
High-Temperature Collectors.....	1
Noncollector Components .....	3

Source: Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."

**Table 21. Percent of Solar Collector Shipments by 10 Largest Companies, 1994-2003**

Year	Company Rank	Shipments (Thousand Square Feet)	Percent of Total Shipments
1994.....	1-5	6,401	84
	6-10	861	11
1995.....	1-5	6,525	85
	6-10	806	11
1996.....	1-5	6,452	85
	6-10	910	12
1997.....	1-5	7,183	88
	6-10	731	9
1998.....	1-5	6,938	89
	6-10	613	8
1999.....	1-5	7,813	91
	6-10	563	7
2000.....	1-5	7,521	90
	6-10	567	7
2001.....	1-5	10,732	96
	6-10	325	3
2002.....	1-5	10,755	92
	6-10	670	6
2003 <sup>P</sup> .....	1-5	10,485	92
	6-10	700	6

P = Preliminary.

Note: Totals may not equal sum of components due to independent rounding.

Source: Energy Information Administration: Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."

**Table 22. Employment in the Solar Thermal Collector Industry, 1994-2003**

Year	Person Years
1994.....	402
1995.....	386
1996.....	239
1997.....	184
1998.....	207
1999.....	289
2000.....	284
2001.....	256
2002.....	356
2003 <sup>P</sup> .....	287

P = Preliminary.

Source: Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."

**Table 23. Companies Involved in Solar Thermal Activities by Type, 2002 and 2003**

Type of Activity	2002	2003 <sup>P</sup>
Collector or System Design.....	20	20
Prototype Collector Development.....	13	12
Prototype System Development.....	9	11
Wholesale Distribution .....	21	21
Retail Distribution .....	13	12
Installation .....	10	10
Noncollector System Component Manufacture .....	12	9

P = Preliminary.  
Source: Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."

**Table 24. Solar-Related Sales as a Percentage of Total Company Sales, 2002 and 2003**

Percent of Total Sales	Number of Companies	
	2002	2003 <sup>P</sup>
90-100 .....	19	18
50-89 .....	4	5
10-49 .....	1	1
Less than 10.....	3	2
<b>Total.....</b>	<b>27</b>	<b>26</b>

P = Preliminary.  
Source: Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."

**Table 25. Annual Shipments of Photovoltaic Cells and Modules, 2001-2003 (Peak Kilowatts)**

Item	2001	2002	2003 <sup>P</sup>
Cells.....	30,633	47,677	29,295
Modules .....	67,033	64,413	80,062
<b>Total .....</b>	<b>97,666</b>	<b>112,090</b>	<b>109,357</b>

P = Preliminary.  
Source: Energy Information Administration, Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."

**Table 26. Annual Shipments of Photovoltaic Cells and Modules, 1994-2003**

Year	Number of Companies	Photovoltaic Cell and Module Shipments <sup>a</sup> (Peak Kilowatts)		
		Total	Imports	Exports
1994.....	22	26,077	1,960	17,714
1995.....	24	31,059	1,337	19,871
1996.....	25	35,464	1,864	22,448
1997.....	21	46,354	1,853	33,793
1998.....	21	50,562	1,931	35,493
1999.....	19	76,787	4,784	55,562
2000.....	21	88,221	8,821	68,382
2001.....	19	97,666	10,204	61,356
2002.....	19	112,090	7,297	66,778
2003 <sup>P</sup> .....	20	109,357	9,731	60,693

<sup>a</sup> Does not include shipments of cells and modules for space/satellite applications.

P = Preliminary.

Note: Total shipments as reported by respondents include all domestic and export shipments and may include imported collectors that subsequently were shipped to domestic or foreign customers.

Source: Energy Information Administration, Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."

**Table 27. Distribution of Photovoltaic Cells and Modules, 2001-2003**

Recipient	Shipments (Peak Kilowatts)		
	2001	2002	2003 <sup>P</sup>
Wholesale Distributors.....	59,799	62,651	65,477
Retail Distributors .....	5,302	8,270	6,624
Exporters .....	4,441	449	7,600
Installers .....	10,810	11,538	11,733
End-Users.....	1,482	4,012	8,286
Module manufacturers .....	14,045	23,784	8,738
Other <sup>a</sup> .....	1,787	1,386	899
<b>Total .....</b>	<b>97,666</b>	<b>112,090</b>	<b>109,357</b>

<sup>a</sup> Other includes categories not identified by reporting companies.

P = Preliminary.

Note: Totals may not equal sum of components due to independent rounding.

Source: Energy Information Administration, Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."

**Table 28. Photovoltaic Cell and Module Shipments by Type, 2001-2003**

Type	Shipments (Peak Kilowatts)			Percent of Total		
	2001	2002	2003 <sup>P</sup>	2001	2002	2003 <sup>P</sup>
Crystalline Silicon						
Single Crystal.....	54,736	74,717	59,379	56	67	54
Cast and Ribbon .....	29,915	29,406	38,561	31	26	35
Subtotal.....	84,651	104,123	97,939	87	93	90
Thin-Film Silicon .....	12,541	7,396	10,966	13	7	10
Concentrator Silicon .....	474	571	452	*	*	*
Other <sup>a</sup> .....	0	0	0	0	0	0
<b>Total .....</b>	<b>97,666</b>	<b>112,090</b>	<b>109,357</b>	<b>100</b>	<b>100</b>	<b>100</b>

<sup>a</sup> Includes categories not identified by reporting companies.

\* = Less than 0.5 percent.

P = Preliminary.

Notes: Data do not include shipments of cells and modules for space/satellite applications. Totals may not equal sum of components due to independent rounding.

Source: Energy Information Administration, Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."

**Table 29. Photovoltaic Cell and Module Shipment Values by Type, 2002 and 2003**

Type	2002			2003 <sup>P</sup>		
	Value (Thousand Dollars)	Average Price (Dollars per Peak Watt)		Value (Thousand Dollars)	Average Price (Dollars per Peak Watt)	
		Modules	Cells		Modules	Cells
Crystalline Silicon						
Single-Crystal .....	201,488	3.64	2.14	158,480	3.38	1.88
Cast and Ribbon .....	115,625	3.98	1.38	113,511	2.97	1.23
Subtotal.....	317,113	3.81	2.13	271,991	3.16	1.87
Thin-Film Silicon .....	<b>W</b>	<b>W</b>	<b>W</b>	<b>W</b>	<b>W</b>	<b>W</b>
Concentrator Silicon .....	<b>W</b>	<b>W</b>	<b>W</b>	<b>W</b>	<b>W</b>	<b>W</b>
Other <sup>a</sup> .....	0	---	---	0	---	---
<b>Total .....</b>	<b>341,975</b>	<b>3.74</b>	<b>2.12</b>	<b>308,192</b>	<b>3.17</b>	<b>1.86</b>

<sup>a</sup> Includes categories not identified by reporting companies.

W = Data withheld to avoid disclosure of proprietary company data.

-- = Does not apply.

P = Preliminary.

Notes: Data do not include shipments of cells and modules for space/satellite applications. Totals may not equal sum of components due to independent rounding.

Source: Energy Information Administration, Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."



**Table 30. Shipments of Photovoltaic Cells and Modules by Market Sector, End Use, and Type, 2002 and 2003 (Peak Kilowatts)**

Sector and End Use	Crystalline Silicon <sup>a</sup>	Thin-Film Silicon	Concentrator Silicon	Other	2003 <sup>P</sup> Total	2002 Total
<b>Market</b>						
Industrial .....	26,793	1,158	0	0	27,951	32,218
Residential .....	22,493	896	0	0	23,389	29,315
Commercial.....	24,649	7,955	0	0	32,604	20,578
Transportation.....	10,928	162	0	0	11,089	12,932
Utility .....	7,446	737	291	0	8,474	7,640
Government <sup>b</sup> .....	5,318	59	161	0	5,538	8,565
Other <sup>c</sup> .....	313	0	0	0	313	841
<b>Total .....</b>	<b>97,939</b>	<b>10,966</b>	<b>452</b>	<b>0</b>	<b>109,357</b>	<b>112,090</b>
<b>End Use</b>						
Electricity Generation						
Grid Interactive .....	34,902	7,583	0	0	42,485	33,983
Remote .....	13,974	792	260	0	15,025	21,693
Communications.....	13,920	265	0	0	14,185	17,290
Consumer Goods.....	2,926	69	0	0	2,995	3,400
Transportation.....	13,807	336	0	0	14,143	16,028
Water Pumping.....	5,864	209	0	0	6,073	7,532
Cells/Modules To OEM <sup>d</sup> .....	9,658	1,675	0	0	11,334	7,869
Health .....	2,887	37	0	0	2,924	4,202
Other <sup>e</sup> .....	2	0	192	0	194	93
<b>Total .....</b>	<b>97,939</b>	<b>10,966</b>	<b>452</b>	<b>0</b>	<b>109,357</b>	<b>112,090</b>

<sup>a</sup> Includes single-crystal and cast and ribbon types.

<sup>b</sup> Includes Federal, State, local governments, excluding military.

<sup>c</sup> Other includes shipments that are manufactured for private contractors for research.

<sup>d</sup> Original equipment manufacturer.

<sup>e</sup> Other uses include shipments of photovoltaic and modules for other uses, such as cooking food, desalinization, distillation, etc.

P = Preliminary.

Note: Totals may not equal sum of components due to independent rounding.

Source: Energy Information Administration, Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."

**Table 31. Export Shipments of Photovoltaic Cells and Modules by Type, 2002 and 2003 (Peak Kilowatts)**

Item	Type							
	Crystalline		Thin-Film Silicon		Concentrator Silicon		Total	
	2002	2003 <sup>P</sup>	2002	2003 <sup>P</sup>	2002	2003 <sup>P</sup>	2002	2003 <sup>P</sup>
Cells.....	33,952	30,337	0	0	267	127	34,219	30,464
Modules .....	29,987	25,190	2,572	5,039	0	0	32,559	30,229
<b>Total .....</b>	<b>63,939</b>	<b>55,527</b>	<b>2,572</b>	<b>5,039</b>	<b>267</b>	<b>127</b>	<b>66,778</b>	<b>60,693</b>

P = Preliminary.

Notes: Totals may not equal sum of components due to independent rounding.

Source: Energy Information Administration, Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."

**Table 32. Destination of U.S. Photovoltaic Cell and Module Export Shipments by Country, 2003**

Country	Peak Kilowatts <sup>P</sup>	Percent of U.S. Exports <sup>P</sup>
<b>Africa</b>		
Egypt.....	63.2	0.1
Kenya.....	157.8	0.3
Nigeria .....	0.2	*
Other Africa.....	1,013.9	1.7
South Africa, Rep of.....	1,144.8	1.9
Zambia.....	18.1	*
<b>Total .....</b>	<b>2,398.1</b>	<b>4.0</b>
<b>Asia and the Middle East</b>		
Bangladesh.....	250.2	0.4
China .....	63.3	0.1
Hong Kong.....	12,127.4	20.0
Japan .....	2,557.9	4.2
Malaysia.....	0.1	*
Nepal .....	223.5	0.4
North Korea .....	94.9	0.2
Singapore .....	948.7	1.6
South Korea.....	205.4	0.3
Taiwan .....	257.1	0.4
Thailand.....	158.1	0.3
<b>Total .....</b>	<b>16,886.5</b>	<b>27.8</b>
<b>Australia</b>		
Australia.....	1,455.2	2.4
French Pacific Island .....	0.6	*
<b>Total .....</b>	<b>1,455.8</b>	<b>2.4</b>
<b>Europe</b>		
Belgium & Luxembourg .....	369.3	0.6
France.....	0.2	*
Germany .....	32,088.4	52.9
Greece .....	75.0	0.1
Italy .....	65.8	0.1
Spain.....	3,537.3	5.8
United Kingdom .....	291.1	0.5
<b>Total .....</b>	<b>36,427.1</b>	<b>60.0</b>
<b>North America</b>		
Canada .....	2,034.9	3.4
Mexico .....	791.5	1.3
Netherlands Antilles.....	0.2	*
<b>Total .....</b>	<b>2,826.6</b>	<b>4.7</b>
<b>South America</b>		
Argentina .....	126.5	0.2
Brazil.....	316.7	0.5
Chile.....	3.4	*
Colombia.....	63.2	0.1
Ecuador .....	1.3	*
Guyana .....	4.6	*
Other Latin America.....	21.7	*
Peru .....	94.9	0.2
Puerto Rico.....	3.1	*
Uruguay .....	63.2	0.1
<b>Total .....</b>	<b>698.6</b>	<b>1.3</b>
<b>Other .....</b>	<b>0.1</b>	<b>*</b>
<b>Total U.S. Exports.....</b>	<b>60,692.8</b>	<b>100.0</b>

P = Preliminary.

Note: "Other" represents shipments to countries not disaggregated by companies on Form EIA63B. Totals may not equal sum of components due to independent rounding.

\* = Value Less Than 0.05 Percent

Source: Energy Information Administration, Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."

**Table 33. Shipments of Complete Photovoltaic Module Systems, 2001-2003**

Shipment Information	2001	2002	2003 <sup>P</sup>
Complete Photovoltaic Module Systems Shipped .....	6,759	R7,008	5,525
Peak Kilowatts .....	10,075	R8,160	9,545
Percent of Total Module Shipments .....	15	13	12
Value of Systems (Thousand Dollars) .....	50,467	R44,984	50,412

P = Preliminary.

R = Revised

Source: Energy Information Administration, Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."

**Table 34. Employment in the Photovoltaic Manufacturing Industry, 1994-2003**

Year	Number of Companies	Number of Person-Years
1994.....	22	1,312
1995.....	24	1,578
1996.....	25	1,280
1997.....	21	1,736
1998.....	21	1,988
1999.....	19	2,013
2000.....	21	1,913
2001.....	19	2,666
2002.....	19	2,696
2003 <sup>P</sup> .....	20	2,590

P = Preliminary.

Source: Energy Information Administration, Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."

**Table 35. Companies Expecting to Introduce New Photovoltaic Products in 2004**

New Product Type	Number of Companies
<b>Crystalline Silicon</b>	
Single-Crystal Silicon Modules.....	4
Cast Silicon Modules.....	2
Ribbon Silicon Modules.....	1
<b>Thin-Film</b>	
Amorphous Silicon Modules.....	2
Other (Thin-Film).....	3
<b>Other (Flat Plate).....</b>	<b>0</b>
<b>Concentrators.....</b>	<b>0</b>
<b>Nonmodule System Components.....</b>	<b>0</b>

Source: Energy Information Administration, Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."

**Table 36. Number of Companies Involved in Photovoltaic-Related Activities, 2002 and 2003**

Type of Activity	Number of Companies	
	2002	2003 <sup>P</sup>
Cell Manufacturing .....	11	12
Module or System Design.....	16	17
Prototype Module Development.....	12	13
Prototype Systems Development.....	11	11
Wholesale Distribution .....	12	13
Retail Distribution.....	8	7
Installation.....	8	8
<b>Noncollector System</b>		
Component Manufacturing.....	3	5

P = Preliminary.

Source: Energy Information Administration, Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."