

# **Solar Photovoltaic Cell/Module Manufacturing Activities 2007**

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## Preface

The Energy Information Administration (EIA) reports detailed historical data on photovoltaic module/cell manufacturing activities annually in its report, the *Renewable Energy Annual*. This report, *Solar Photovoltaic Cell/Module Manufacturing Activities*, provides an overview and tables with historical data spanning 1998-2007, as well as the revised methodology used to collect information from all manufacturers of renewable energy equipment for 2007, so that the methodology across EIA is uniform. Changes included adding “Energy Conversion Efficiency,” “Shipments by Origin,” “Shipments by Destination,” and collecting “Domestic Shipments by Sector, End Use, and Customer Type,” instead of “Total Shipments by Sector, End Use, and Customer Type.” All tables will correspond to similar tables to be presented in *Renewable Energy Annual 2007* and are numbered accordingly.

Data in this report is based upon manufacturing shipment information reported on Form EIA-63B, “Annual Photovoltaic Module/Cell Manufacturers Survey.” Shipments as reported by respondents are for terrestrial use only. Shipments intended for applications in space programs (satellites, military projects, etc.) are excluded.

Prior editions of this report may be found on the EIA website at <http://tonto.eia.doe.gov/reports/reportsD.asp?type=Renewable>.

Definitions for terms used in this report can be found in EIA’s Energy Glossary: <http://www.eia.doe.gov/glossary/index.html>.

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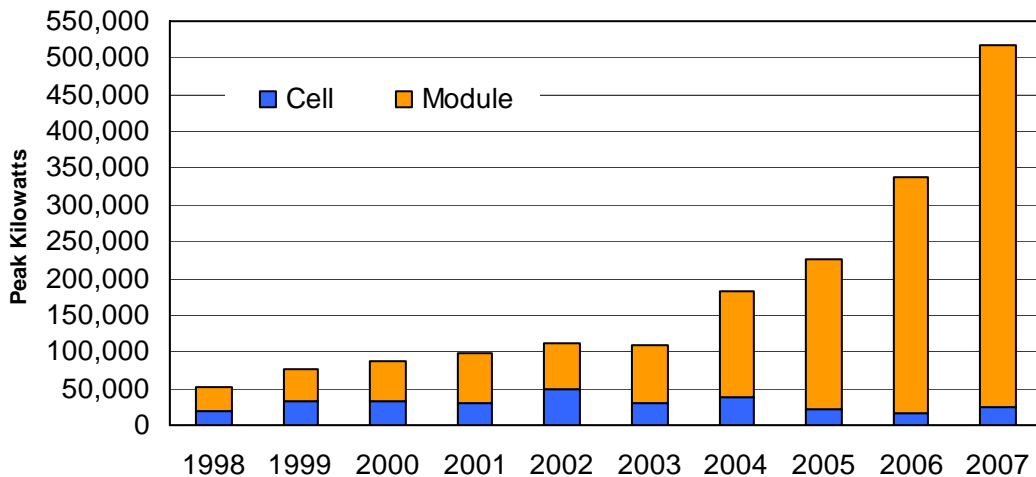
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# Solar Photovoltaic Cell/Module Manufacturing Activities 2007

## Overview

Government incentives, rising energy costs, and the growing concern over climate change have fueled rapid growth in the photovoltaic (PV) industry in the United States. Subsequent to the investment tax credit for solar installations that went into effect in January 2006 as part of the Energy Policy Act of 2005, the PV industry has experienced two consecutive years of enormous growth in total shipments of PV cells and modules. Shipments increased about 50 percent each year between 2005 and 2007. As a result, the industry is more than 10 times the size it was in 1998 (Figure 3.1, Table 3.1, and Table 3.3). Simultaneously, the significant growth of the PV market caused a silicon shortage within the PV industry. Nevertheless, supply shortages have led PV manufacturers to find ways to use silicon more effectively and efficiently. It has stimulated the development of thin-film technologies that do not rely on silicon and are less expensive to manufacture than the crystalline silicon technologies.

**Figure 3.1 Photovoltaic Cell and Module Shipments, 1998-2007**



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

## Industry Status

The number of active PV manufacturers and/or importers that ship PV cells and modules increased from 41 companies in 2006 to 46 companies in 2007. These new companies increased overall PV production to meet the expected increase in demand internationally. During 2007, PV cell and module shipments reached a record high of 517,684 peak

kilowatts, a 53 percent increase from 337,268 peak kilowatts in 2006 (Figure 3.1 and Table 3.1). Exports accounted for most of the increase.

The companies reporting PV shipments in 2007 also reported being involved in one or more of the following photovoltaic-related activities:

- A total of 24 companies were involved in module and/or cell manufacturing,
- 25 were designing modules or systems,
- 16 were developing prototype modules,
- 13 were developing prototype systems,
- 25 were involved in wholesale distribution,
- 14 were involved in retail distribution, and
- 13 were offering installation of their products (Table 3.18).

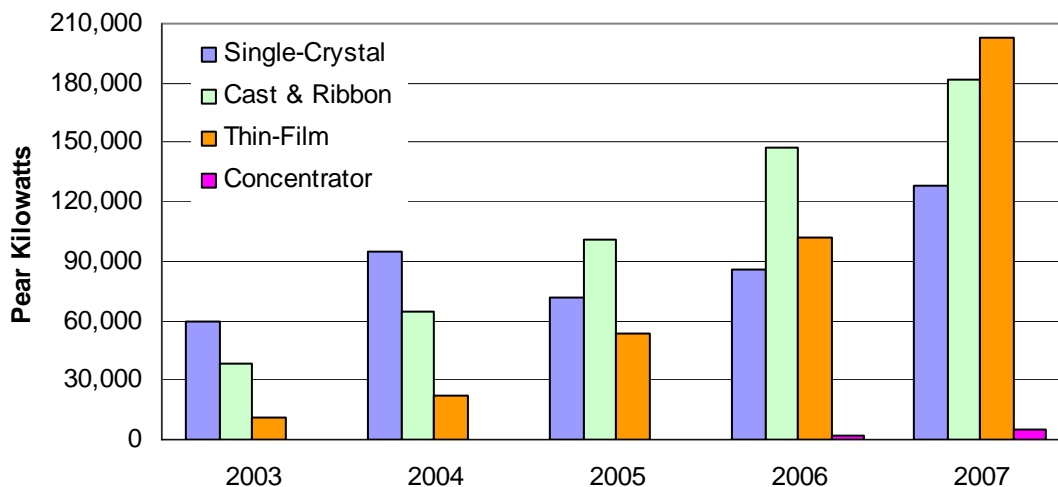
Of the 46 companies active in 2007, up to 19 are expecting to introduce crystalline silicon products, up to 6 companies are planning to introduce new thin-film products, and 2 companies are expecting to provide new concentrator photovoltaic (CPV) products in 2008 (Table 3.17). This indicates that the silicon shortage has opened the opportunity for the thin-film market and for companies to create new innovations to close the gap between thin-film PV and conventional crystalline silicon PV.

Corresponding to the strong growth of the PV shipments, employment in PV-related activities increased 53 percent, from 4,028 person-years in 2006 to 6,170 person-years in 2007 (Table 3.16). Of the 46 companies, 28 had 90 percent or more of their total company-wide revenues in PV-related activities, 7 had 50 to 89 percent, 7 had 10 to 49 percent, and 4 companies had less than 10 percent (Table 3.19).

PV cells and modules can be made from different semiconductor materials, varying in cost and performance. Shipments of PV cells and modules are divided into three main categories by product type (Figure 3.2): (1) crystalline silicon, a type of photovoltaic cell/module made from a wedge of single-crystal or polycrystalline silicon, based on crystal-producing processes such as single-crystal, cast, and ribbon; (2) thin-film, photovoltaic cell/module made from layers of semiconductor material, such as amorphous silicon (a-Si), cadmium telluride (CdTe), or copper indium gallium selenide (CIGS); and (3) concentrator, a type of photovoltaic cell/module including a reflective or refractive device (such as lenses that gather and concentrate sunlight onto the photovoltaic cell).



**Figure 3.2 Photovoltaic Cell and Module Shipments by Type, 2003-2007**



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

The performance of a photovoltaic cell/module can be described in terms of its energy conversion efficiency, the percentage of incident solar energy (input) that the cell converts to electricity (output) under standard rating conditions. In 2007, the average energy conversion efficiencies were as follows: crystalline silicon (single crystal) PV cell/module, 17 percent; crystalline silicon (cast) PV cell/module, 14 percent; crystalline silicon (ribbon) PV cell/module, 12 percent; thin-film (amorphous silicon) PV cell/module, 8 percent; thin-film other (special photovoltaic material such as CdTe, and CIGS) PV cell/module, 12 percent; and concentrator PV cell/module, 35 percent (Table 3.8).

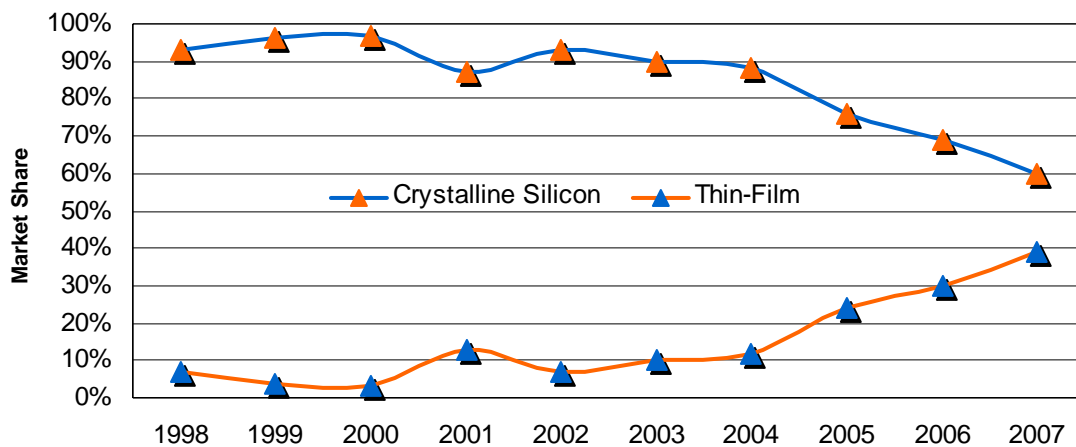
### Photovoltaic Cell and Module Shipments

Photovoltaic (PV) cell and module shipments reached 517,684 peak kilowatts in 2007, a 53 percent increase from the 2006 shipments of 337,268 peak kilowatts. Cell shipments accounted for 23,535 peak kilowatts, while module shipments accounted for 494,148 peak kilowatts (Figure 3.1 and Table 3.3). Shipments of cells have generally declined over the past decade, while module shipments have increased more than tenfold.

Despite the shift in focus to thin-film technologies, crystalline silicon cells and modules continued to dominate the PV industry in 2007, accounting for 60 percent of the total shipments (Table 3.5). However, this represents a considerable decline from its 76 percent market share in 2005. In particular, single-crystal silicon totaled 128,542 peak kilowatts, an increase of more than 50 percent compared with corresponding 2006 shipments. Cast and ribbon silicon shipments total 181,788 peak kilowatts in 2007, nearly a 23 percent increase from the corresponding 2006 shipments.

Shipments of thin-film PV doubled to 202,519 peak kilowatts in 2007, compared to 101,766 peak kilowatts in 2005. The market share for thin-film PV has grown rapidly over the past several years. In 2007, thin-film accounted for nearly 40 percent of the market, compared to approximately 10 percent in 2003 (Figure 3.3 and Table 3.5). If thin-film PV continues at its same growth rate (doubling in each of the past four years), its market share may surpass that of crystalline silicon PV by 2010.

**Figure 3.3 Crystalline Silicon Shipment and Thin-Film Shipment Market Shares, 1998-2007**



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

Over the last few years, there has been increasing interest in concentrator photovoltaic (CPV) technology. Although concentrator shipments only accounted for about 1 percent of the total in 2007, the shipments of 4,835 peak kilowatts are noteworthy, representing an increase of 144 percent when compared with corresponding 2006 shipments (Table 3.5).

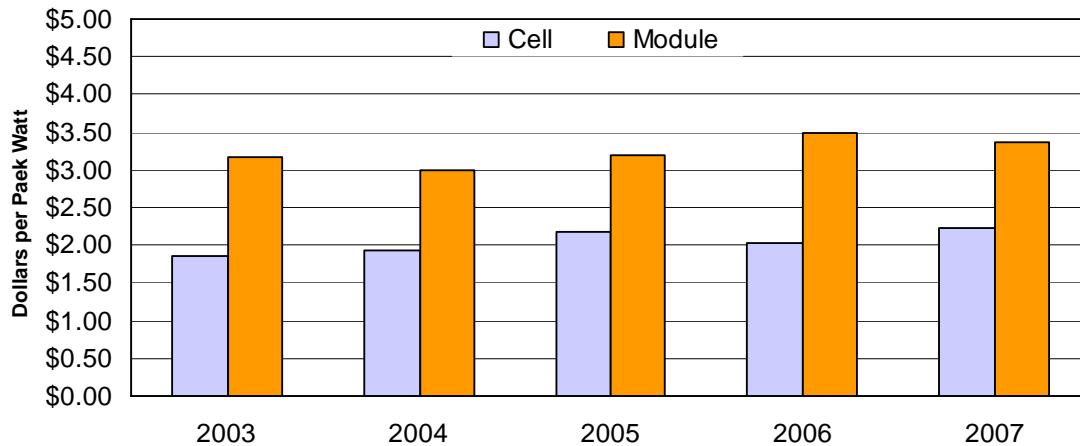
### Total Revenue and Average Price

Total revenue of photovoltaic cell and module shipments grew 49 percent from \$1.16 billion in 2006 to \$1.72 billion in 2007 (Table 3.6). Revenue includes charges for cooperative advertising and warranties, but does not include excise taxes and the cost of freight or transportation<sup>1</sup>.

The average price for modules (dollars per peak watt) decreased about 4 percent, from \$3.50 in 2006 to \$3.37 in 2007. For cells, the average price increased more than 9 percent, from \$2.03 in 2006 to \$2.22 in 2007.

<sup>1</sup> See the EIA glossary.

**Figure 3.4 Photovoltaic Cell and Module Average Prices, 2003-2007**



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

### **Domestic Shipments**

Rising energy costs during the past few years and the public perception of potentially large energy savings combined with the availability of various incentives have increased the demand for PV. During 2007, domestic shipments continued to surge rapidly, totaling 280,475 peak kilowatts, nearly a 36 percent increase from 206,511 peak kilowatts in 2006 (Table 3.2).

In 2007, domestic shipments to the commercial sector accounted for 140,434 peak kilowatts or 50 percent of the domestic market. Of the domestic shipments to the commercial sector, 81 percent were crystalline silicon, and about 19 percent were thin-film PV. Less than 0.2 percent was concentrator PV (Table 3.7). The residential sector was the second-largest domestic market in the United States in 2007, accounting for 68,417 peak kilowatts or about 24 percent of the domestic market share. This market purchased 80 percent crystalline silicon and 20 percent thin-film PV. The electric power sector, with 13 percent of domestic shipments, was the third-largest domestic sales market, totaling 35,294 peak kilowatts. About 93 percent were crystalline silicon, 5 percent were thin-film PV, and 2 percent were concentrator PV. Shipments to the industrial sector amounted to 32,702 peak kilowatts, or about 12 percent of the domestic market share. Crystalline silicon accounted for 67 percent of the industrial shipments and thin-film PV accounted for 33 percent.

Electricity generation, which consists of both grid-interactive (those connected to the electric power grid)<sup>2</sup> and remote applications (those not connected), continues to be the predominant end use for PV cells and modules. In 2007, PV cell and module shipments to the electric generation market totaled 263,968 peak kilowatts or about 94 percent of domestic shipments. Domestic shipments to original equipment manufacturer (OEM) and transportation end uses were the second and third-largest end uses, respectively, totaling more than 3 percent. Domestic shipments to consumer goods and health end users hold small market shares, totaling less than 0.4 percent (Table 3.7).

During 2007, PV shipments to installers, the largest customer type, totaled 110,009 peak kilowatts, nearly 40 percent of the domestic market share. Shipments to the second-largest customer type, wholesale distributors, amounted to 109,015 peak kilowatts, or nearly 39 percent of the domestic market share (Table 3.4).

### **Complete Systems**

A complete PV system is defined as a power supply unit that satisfies all the power requirements of an application. Such a system is made up of different components, including one or more PV modules, a power conditioning unit to process the electricity into the form needed by the application, wires, and other electrical connectors. Batteries for back-up power supply are an option. Some large-scale PV systems use concentrators to focus incident insolation onto small PV cells and tracking systems to track the sun. These large-scale systems convert sunlight directly into electricity and produce the greatest amounts of power during the afternoon, when electricity demand is high.

During 2007, the number of shipments of complete PV systems decreased sharply to 10,600 systems from 67,172 systems in 2006. In contrast, the total value of complete systems increased 155 percent to \$491.7 million in 2007. The total peak kilowatts of complete system surged from 28,099 in 2006 to 80,560 in 2007 (Table 3.15). These statistics indicate companies are becoming more involved in developing larger PV systems with high demand and market growth potential.

### **Origin of Shipments**

Imports of PV cells and modules totaled 238,018 peak kilowatts or 46 percent of total shipments in 2007 (Table 3.11). The predominant type of import shipment was crystalline silicon cells and modules, accounting for 90 percent (214,457 peak kilowatts) of total imports. Japan, China, and Germany accounted for 85 percent of total imports (Table 3.12).

In 2007, a total of 279,666 peak kilowatts of PV cells and modules were manufactured in the United States; manufacturers in Ohio, Michigan, California, and Maryland produced 85 percent of total (Table 3.9).

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<sup>2</sup> See the EIA glossary.

## **Destination of Shipments**

Exports of PV cells and modules totaled 237,209 peak kilowatts in 2007, an 81 percent increase from the 2006 exports of 130,757 peak kilowatts (Table 3.13). The predominant type of export shipment was thin-film cells and modules, accounting for about 63 percent (149,977 peak kilowatts) of total exports. The export market accounted for 46 percent of total shipments and was dominated by sales to Germany (more than 64 percent of exports), Spain (about 13 percent), and Italy (about 4 percent) (Table 3.14).

In 2007, a total of 280,475 peak kilowatts of domestic PV cell and module shipments went to all 50 States, the District of Columbia, the Virgin Islands, and Puerto Rico (Table 3.10). About 86 percent of domestic PV cell and module shipments (241,712 peak kilowatts) went to five States: California, Nevada, Colorado, New Jersey, and Arizona, with 75 percent (209,031 peak kilowatts) of the total shipments sent to California and Nevada.

**Table 3.1 Annual Shipments of Photovoltaic Cells and Modules, 1998 - 2007  
(Peak Kilowatts)**

Year	Number of Companies	Photovoltaic Cell and Modules Shipments		
		Total	Imports	Exports
1998	21	50,562	1,931	35,493
1999	19	76,787	4,784	55,585
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	20	109,357	9,731	60,693
2004	19	181,116	47,703	102,770
2005	29	226,916	90,981	92,451
2006	41	337,268	173,977	130,757
2007	46	517,684	238,018	237,209

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

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

**Table 3.2 Annual Photovoltaic Domestic Shipments, 1998 - 2007**

**(Peak Kilowatts)**

<b>Year</b>	<b>Photovoltaic Cells and Modules<sup>1</sup></b>
1998	15,069
1999	21,201
2000	19,838
2001	36,310
2002	45,313
2003	48,664
2004	78,346
2005	134,465
2006	206,511
2007	280,475
<b>U.S. Total</b>	<b>886,193</b>

<sup>1</sup>Total shipments minus export shipments.

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

Total shipments include those made in or shipped to U.S. Territories.

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

**Table 3.3 Annual Shipments of Photovoltaic Cells and Modules, 1998 - 2007**  
**(Peak Kilowatts)**

Year	Cells	Modules	Total
1998	18,249	32,313	50,562
1999	33,714	43,073	76,787
2000	33,213	55,007	88,221
2001	30,633	67,033	97,666
2002	47,677	64,413	112,090
2003	29,295	80,062	109,357
2004	37,842	143,274	181,116
2005	21,920	204,996	226,916
2006	17,060	320,208	337,268
2007	23,535	494,148	517,684

**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 3.4 Distribution of Domestic Photovoltaic Cells and Modules by Customer Type, 2005 - 2007****(Peak Kilowatts)**

Customer Type	Shipments		
	2005	2006	2007
Wholesale Distribution	-	-	109,015
Retail Distributers	-	-	19,748
Exporters	-	-	1,513
Installers	-	-	110,009
End Users	-	-	38,686
Module Module Manufacturers	-	-	1,504
<b>U.S. Total</b>	-	-	<b>280,475</b>

- = No data reported.

**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 3.5 Photovoltaic Cell and Module Shipments by Type, 2005 - 2007**

Type	Shipments (Peak Kilowatts)			Percent of Total		
	2005	2006	2007	2005	2006	2007
Crystalline Silicon						
Single-Crystal	71,901	85,627	128,542	32	25	25
Cast and Ribbon	101,065	147,892	181,788	45	44	35
Subtotal	172,965	233,518	310,330	76	69	60
Thin-Film	53,826	101,766	202,519	24	30	39
Concentrator	125	1,984	4,835	*	1	1
Other <sup>1</sup>	-	-	-	-	-	-
<b>U.S. Total</b>	<b>226,916</b>	<b>337,268</b>	<b>517,684</b>	<b>100</b>	<b>100</b>	<b>100</b>

<sup>1</sup>Other includes categories not identified by reporting companies.

\* = Less than 0.5 percent.

- = No data reported.

**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 3.6 Photovoltaic Cell and Module Shipment Revenue by Type, 2006 and 2007**

Type	2006			2007		
	Revenue (Thousand Dollars)	Average Price (Dollars per Peak Watt)		Revenue (Thousand Dollars)	Average Price (Dollars per Peak Watt)	
		Modules	Cells		Modules	Cells
Crystalline Silicon						
Single-Crystal	339,859	4.09	2.09	478,355	3.74	3.06
Cast and Ribbon	529,176	3.66	2.39	645,964	3.62	2.65
Subtotal	869,035	3.82	2.28	1,124,319	3.67	2.74
Thin-Film	W	W	W	W	W	W
Concentrator	W	W	W	W	W	W
Other <sup>1</sup>	-	-	-	-	-	-
<b>U.S. Total</b>	<b>1,155,002</b>	<b>3.50</b>	<b>2.03</b>	<b>1,716,096</b>	<b>3.37</b>	<b>2.22</b>

<sup>1</sup>Other includes categories not identified by reporting companies.

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

- = No data reported.

**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 3.7 Domestic Shipments of Photovoltaic Cells and Modules by Market Sector, End Use, and Type, 2006 and 2007  
(Peak Kilowatts)**

Sector and End Use	Crystalline Silicon <sup>1</sup>	Thin-Film Silicon	Concentrator Silicon	Other	2007 Total	2006 Total
Market Sector						
Residential	54,793	13,624	-	-	68,417	-
Commercial	113,780	26,404	250	-	140,434	-
Industrial	22,064	10,638	-	-	32,702	-
Electric Power	32,682	1,876	737	-	35,294	-
Transportation	3,627	-	-	-	3,627	-
<b>U.S. Total</b>	<b>226,946</b>	<b>52,542</b>	<b>987</b>	<b>-</b>	<b>280,475</b>	<b>-</b>
End Use						
Electricity Generation						
Grid Interactive	201,588	50,613	900	-	253,101	-
Remote	10,726	54	87	-	10,867	-
Communication	2,336	500	-	-	2,836	-
Consumer Goods	29	560	-	-	589	-
Transportation	4,018	-	-	-	4,018	-
Water Pumping	3,818	34	-	-	3,852	-
Cells/Modules to OEM	4,022	780	-	-	4,802	-
Health	410	-	-	-	410	-
<b>U.S. Total</b>	<b>226,946</b>	<b>52,542</b>	<b>987</b>	<b>-</b>	<b>280,475</b>	<b>-</b>

<sup>1</sup>Includes single-crystal and cast and ribbon types.

- = No data reported.

**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 3.8 Average Energy Conversion Efficiency of Photovoltaic Cells and Modules Shipped in 2007**

**(Percent of Energy Converted)**

Year	Crystalline Silicon			Thin-Film Silicon		Concentrator Silicon	Other
	Single Crystal	Cast	Ribbon	Amorphous Silicon	Other		
2007	17	14	12	8	12	35	-

- = No data reported.

**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 3.9 Shipments of Photovoltaic Cells and Modules by Origin, 2006 and 2007  
(Peak Kilowatts)**

Origin	2006	2007
Arizona	-	6,000
California	-	45,236
Delaware	-	18,412
Iowa	-	1,147
Maryland	-	28,323
Massachusetts	-	8,264
Michigan	-	47,647
New Jersey	-	1,578
New Mexico	-	2,752
New York	-	107
Ohio	-	116,500
Pennsylvania	-	3,700
Shipments from United States/Territories	-	279,666
Imports	-	238,018
<b>Total Shipments</b>	-	<b>517,684</b>

- = No data reported.

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

**Table 3.10 Shipments of Photovoltaic Cells and Modules by Destination, 2006 and 2007  
(Peak Kilowatts)**

Destination	2006	2007
Alabama	-	25
Alaska	-	40
Arizona	-	8,198
Arkansas	-	14
California	-	180,272
Colorado	-	14,178
Connecticut	-	813
Delaware	-	754
District of Columbia	-	6
Florida	-	6,342
Georgia	-	138
Hawaii	-	3,085
Idaho	-	56
Illinois	-	396
Indiana	-	277
Iowa	-	50
Kansas	-	52
Kentucky	-	12
Louisiana	-	132
Maine	-	116
Maryland	-	1,068
Massachusetts	-	2,904
Michigan	-	140
Minnesota	-	381
Mississippi	-	2
Missouri	-	221
Montana	-	439
Nebraska	-	41
Nevada	-	28,759
New Hampshire	-	517
New Jersey	-	10,305
New Mexico	-	1,529
New York	-	4,536
North Carolina	-	985
North Dakota	-	23
Ohio	-	229
Oklahoma	-	264
Oregon	-	1,640
Pennsylvania	-	953
Puerto Rico	-	10
Rhode Island	-	765
South Carolina	-	250
South Dakota	-	34
Tennessee	-	53
Texas	-	6,048
Utah	-	113
Vermont	-	1,443
Virgin Islands of the U.S.	-	1
Virginia	-	174
Washington	-	668
West Virginia	-	52
Wisconsin	-	828
Wyoming	-	147
Shipments to United States/Territories	-	280,475
Exported	-	237,209
<b>Total Shipments</b>	-	<b>517,684</b>

- = No data reported.

**Table 3.10 Shipments of Photovoltaic Cells and Modules by Destination, 2006 and 2007  
(Peak Kilowatts) (Continued)**

Destination	2006	2007
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Source: Energy Information Administration, Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."



**Table 3.11 Import Shipments of Photovoltaic Cells and Modules by Type, 1999 - 2007**

**(Peak Kilowatts)**

Item/Year	Crystalline Silicon	Thin-Film Silicon	Concentrator Silicon	Other	Total
<b>Cells</b>					
1999	150	4	-	-	154
2000	3,779	3	24	-	3,805
2001	3,169	6	-	-	3,175
2002	915	4	-	-	919
2003	439	3	-	-	442
2004	33,607	-	-	-	33,607
2005	46,538	-	-	-	46,538
2006	74,290	-	-	-	74,290
2007	64,757	-	95	-	64,852
<b>Modules</b>					
1999	3,530	1,100	-	-	4,630
2000	4,383	633	-	-	5,016
2001	6,681	348	-	-	7,029
2002	6,119	259	-	-	6,378
2003	9,027	262	-	-	9,289
2004	14,096	-	-	-	14,096
2005	33,081	11,337	25	-	44,443
2006	84,308	14,170	1,209	-	99,687
2007	149,699	23,466	-	-	173,165
<b>Totals</b>					
1999	3,680	1,104	-	-	4,784
2000	8,161	636	24	-	8,821
2001	9,850	354	-	-	10,204
2002	7,034	263	-	-	7,297
2003	9,466	265	-	-	9,731
2004	47,703	-	-	-	47,703
2005	79,619	11,337	25	-	90,981
2006	158,598	14,170	1,209	-	173,977
2007	214,457	23,466	95	-	238,018

- = No data reported.

**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 3.12 Origin of U.S. Photovoltaic Cell and Module Import Shipments by Country, 2006 and 2007  
(Peak Kilowatts)**

Region/Country	2006	2007	Percent of U.S. Imports 2007
Asia			
China	33,363	59,405	24.96
Hong Kong	3,759	3,429	1.44
India	4,850	4,976	2.09
Japan	102,465	102,791	43.19
Philippines	606	364	0.15
Taiwan	12,766	583	0.24
Total	157,810	171,547	72.07
Europe			
France	2,000	-	-
Germany	7,295	41,265	17.34
Spain	215	-	-
Sweden	3,645	-	-
United Kingdom	18	4	*
Total	13,173	41,268	17.34
North & Central America			
Canada	-	1,241	0.52
Mexico	2,338	23,961	10.07
Total	2,338	25,202	10.59
Oceania & Australia			
Australia	657	-	-
Total	657	-	-
<b>U.S. Total</b>	<b>173,977</b>	<b>238,018</b>	<b>100.00</b>

\* = Less than 0.01 percent.

- = No data reported.

**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 3.13 Export Shipments of Photovoltaic Cells and Modules by Type, 1999 - 2007**

**(Peak Kilowatts)**

Item/Year	Crystalline Silicon	Thin-Film Silicon	Concentrator Silicon	Other	Total
<b>Cells</b>					
1999	31,031	-	9	-	31,040
2000	32,019	-	86	-	32,105
2001	26,899	-	174	-	27,073
2002	33,952	-	267	-	34,219
2003	30,337	-	127	-	30,464
2004	36,492	-	-	-	36,492
2005	20,434	-	-	-	20,434
2006	12,960	838	400	-	14,198
2007	16,592	1,500	3,753	-	21,845
<b>Modules</b>					
1999	23,587	958	-	-	24,545
2000	35,440	837	-	-	36,277
2001	29,660	4,622	-	-	34,282
2002	29,987	2,572	-	-	32,559
2003	25,190	5,039	-	-	30,229
2004	52,938	13,341	-	-	66,278
2005	39,992	32,000	25	-	72,017
2006	47,681	68,880	-	-	116,561
2007	66,791	148,477	95	-	215,364
<b>Totals</b>					
1999	54,618	958	9	-	55,585
2000	67,460	837	86	-	68,382
2001	56,559	4,622	174	-	61,356
2002	63,939	2,572	267	-	66,778
2003	55,527	5,039	127	-	60,693
2004	89,430	13,341	-	-	102,770
2005	60,426	32,000	25	-	92,451
2006	60,640	69,718	400	-	130,757
2007	83,383	149,977	3,848	-	237,209

- = No data reported.

**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 3.14 Destination of U.S. Photovoltaic Cell and Module Export Shipments by Country, 2006 and 2007  
(Peak Kilowatts)**

Region/Country	2006	2007	Percent of U.S. Exports 2007
<b>Africa</b>			
Angola	1	s	*
Egypt	307	-	-
Gambia	-	1	*
Kenya	172	17	*
Namibia	-	38	0.02
Nigeria	6	174	0.07
South Africa	385	619	0.26
Tanzania	6	42	0.02
Uganda	-	27	0.01
Total	876	918	0.39
<b>Asia</b>			
Afghanistan	83	147	0.06
Cambodia	-	156	0.07
China	4,403	7,238	3.05
Hong Kong	2,116	5,427	2.29
India	1,946	2,795	1.18
Indonesia	13	-	-
Israel	55	174	0.07
Japan	-	1,032	0.44
Malaysia	3	4	*
North Korea	42	-	-
Oman	-	14	*
Saudi Arabia	1	11	*
Singapore	2,349	698	0.29
South Korea	4,021	3,444	1.45
Taiwan	5	1,111	0.47
Thailand	45	-	-
United Arab Emirates	12	18	*
Total	15,093	22,269	9.39
<b>Europe</b>			
Austria	328	118	0.05
Belgium	1	147	0.06
Bulgaria	-	15	*
Denmark	3	-	-
Finland	6	10	*
France	1,447	10,228	4.31
Germany	80,583	152,654	64.35
Iceland	-	1	*
Ireland	28	-	-
Italy	1,475	10,364	4.37
Luxembourg	324	-	-
Netherlands	138	451	0.19
Norway	256	292	0.12
Portugal	6,605	647	0.27
Slovakia	-	5	*
Spain	15,242	31,384	13.23
Sweden	2,501	1,333	0.56
Switzerland	23	109	0.05
United Kingdom	186	11	*
Total	109,144	207,768	87.59
<b>North &amp; Central America</b>			
Bahamas	1	-	-
Bermuda	1	1	*
British Virgin Islands	-	6	*
Canada	1,536	1,246	0.53
Costa Rica	347	-	-

**Table 3.14 Destination of U.S. Photovoltaic Cell and Module Export Shipments by Country, 2006 and 2007 (Peak Kilowatts) (Continued)**

Region/Country	2006	2007	Percent of U.S. Exports 2007
Dominican Republic	1	33	0.01
El Salvador	1	-	-
Grenada	32	-	-
Guadeloupe	31	-	-
Guatemala	101	3	*
Haiti	24	20	*
Honduras	111	26	0.01
Jamaica	-	43	0.02
Martinique	-	1	*
Mexico	723	116	0.05
Nicaragua	50	30	0.01
Panama	85	4	*
Trinidad and Tobago	8	4	*
Total	3,051	1,533	0.65
Oceania & Australia			
Australia	1,562	2,757	1.16
French Polynesia	93	15	*
New Zealand	70	9	*
Total	1,725	2,781	1.17
South America			
Argentina	43	90	0.04
Bolivia	89	89	0.04
Brazil	79	1,359	0.57
Chile	85	140	0.06
Colombia	226	52	0.02
Ecuador	1	58	0.02
Guyana	60	-	-
Peru	240	141	0.06
Uruguay	45	-	-
Venezuela	1	9	*
Total	869	1,939	0.82
<b>U.S. Total</b>	<b>130,757</b>	<b>237,209</b>	<b>100.00</b>

\* = Less than 0.01 percent.

s = Value is less than 0.5 of the table metric, but value is included in any associated total.

- = No data reported.

**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 3.15 Shipments of Complete Photovoltaic Module Systems, 2005 - 2007**

<b>Shipment Information</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
Complete Photovoltaic Module System Shipped	37,115	67,172	10,600
Peak Kilowatts	6,583	28,099	80,560
Percentage of Total Module Shipments	3	9	16
Revenue of Systems (Thousand Dollars)	43,029	192,928	491,740

**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 3.16 Employment in the Photovoltaic Manufacturing Industry, 1998 - 2007**

<b>Year</b>	<b>Number of Companies</b>	<b>Number of Person-Years</b>
1998	21	1,988
1999	19	2,013
2000	21	1,913
2001	19	2,666
2002	19	2,696
2003	20	2,590
2004	19	2,916
2005	29	3,198
2006	41	4,028
2007	46	6,170

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

**Table 3.17 Number of Companies Expecting to Introduce New Photovoltaic Products in 2008**

New Product Type	Number of Companies
Crystalline Silicon	
Single-Crystal Silicon Modules	11
Cast Silicon Modules	6
Ribbon Silicon Modules	2
Thin-Film	
Amorphous Silicon Modules	3
Other (Thin Film)	3
Other (Flat Plate)	1
Concentrators	2
Nonmodule System Components	1

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



**Table 3.18 Number of Companies Involved in Photovoltaic-Related Activities, 2006 and 2007**

Type of Activity	Number of Companies	
	2006	2007
Module or Cell Manufacturing	16	24
Module or Systems Design	26	25
Prototype Module Development	18	16
Prototype Systems Development	10	13
Wholesale Distribution	29	25
Retail Distribution	12	14
Installation	4	13
Noncollector System Component Manufacture	5	6

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

**Table 3.19 Photovoltaic-Related Sales as a Percentage of Total Company Sales Revenue, 2006 and 2007**

Percent of Total Sales Revenue	Number of Companies	
	2006	2007
90-100	-	28
50-89	-	7
10-49	-	7
Less than 10	-	4
<b>U.S. Total</b>	-	<b>46</b>

- = No data reported.

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