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# **Solar Photovoltaic Cell/Module Manufacturing Activities 2009**

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## Preface

The U.S. Energy Information Administration (EIA) reports detailed historical data on solar photovoltaic cell/module manufacturing activities annually in its report, the *Renewable Energy Annual*. This report, *Solar Photovoltaic Cell/Module Manufacturing Activities 2009*, provides an overview and tables with historical data spanning 2000-2009. These tables will correspond to identical tables to be presented in the *Renewable Energy Annual 2009* and are numbered accordingly.

Data in this report are based on 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.gov/reports/filterD.cfm?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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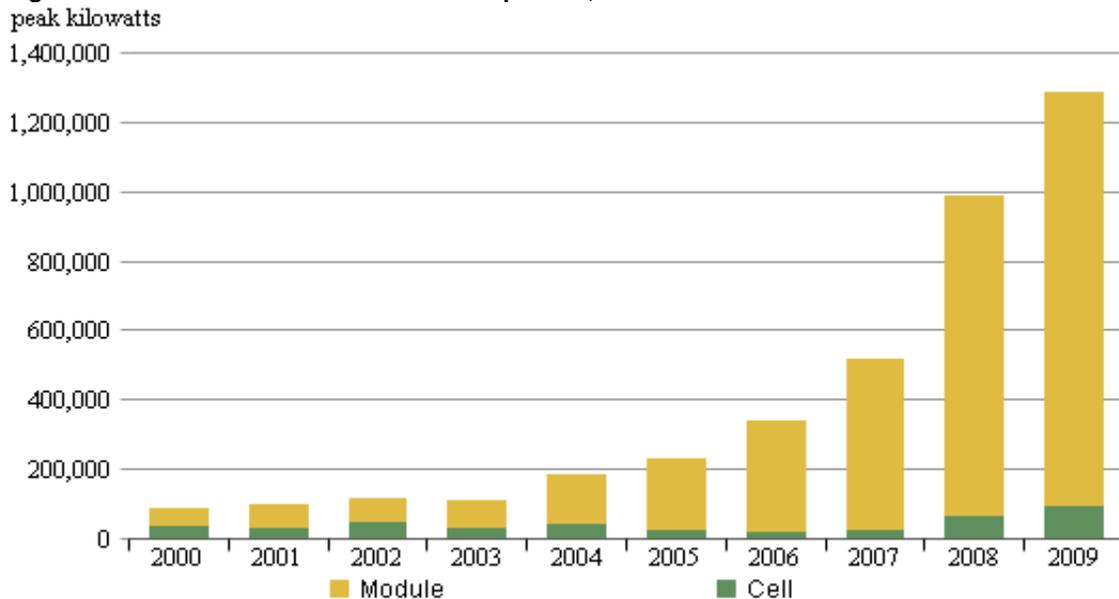
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# Solar Photovoltaic Cell/Module Manufacturing Activities 2009

## Overview

The U.S. photovoltaic (PV) industry hit a record high in 2009, shipping nearly 1.3 peak gigawatts of cells and modules (Figure 3.1 and Table 3.1). This represents a nearly 30-percent increase from 2008. Government stimulus funding and significant manufacturing cost reductions were believed to be major factors driving 2009 shipments. Although demand for solar cells/modules increased greatly, overall profit margins decreased significantly, compared with 2008.

**Figure 3.1 Photovoltaic Cell and Module Shipments, 2000-2009**



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

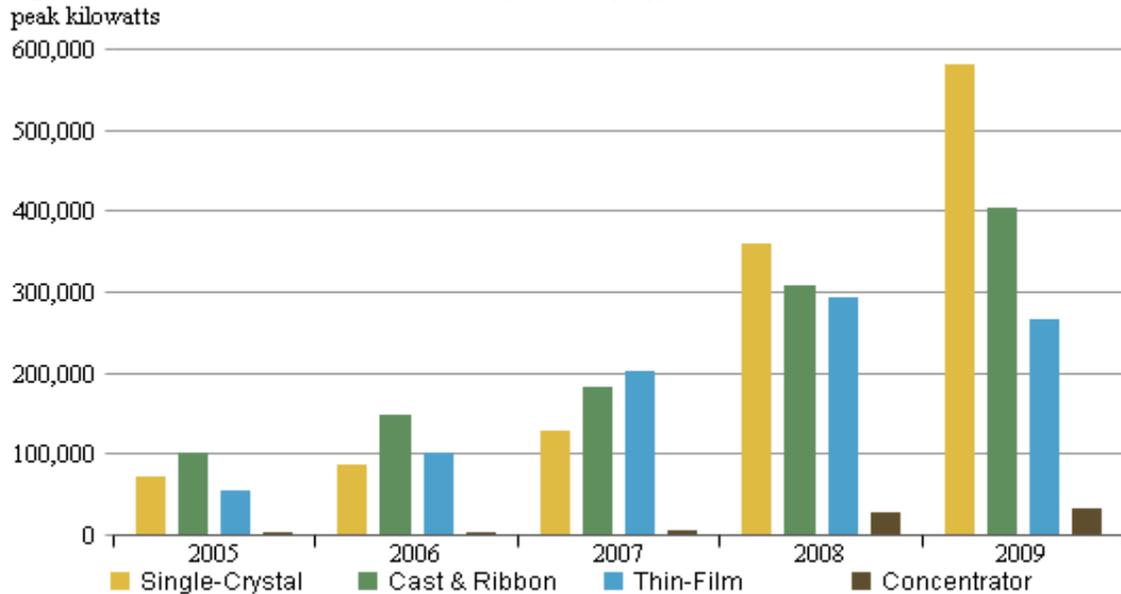
## Background

PV cells and modules can be made from different semiconductor materials, varying in cost and performance, and are divided into three main categories by product type (Figure 3.2):

- Crystalline silicon, which has two subtypes: (a) photovoltaic cell/module made from a wedge of a single-crystal; (b) polycrystalline silicon, based on crystal-producing processes such as cast and ribbon.
- 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).

- 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, 2005-2009**



Source: U.S. 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, i.e., the percentage of incident solar energy (input) that the cell converts to electricity (output) under standard rating conditions. In 2009, the average energy conversion efficiencies were as follows (Table 3.8):

- Crystalline silicon (single-crystal) PV cell/module was 20 percent.
- Crystalline silicon (cast) PV cell/module was 14 percent.
- Crystalline silicon (ribbon) PV cell/module was 13 percent.
- Thin-film (amorphous silicon) PV cell/module was 8 percent.
- Thin-film other (special photovoltaic material such as CdTe and CIGS) PV cell/module was 12 percent.
- Concentrator PV cell/module was 38 percent.

## Industry Status

With overall shipments of 1,282,560 peak kilowatts of cells and modules in 2009, the PV industry saw increases in shipments from existing companies as well as new companies entering the PV market. The number of active PV manufacturers and/or importers that ship PV cells and modules increased 53 percent, from 66 companies in 2008 to 101 companies in 2009 (Table 3.1).

Many of the companies reporting PV shipments in 2009 also reported being involved in one or more of the following photovoltaic-related activities (Table 3.18):

- 43 companies were involved in module and/or cell manufacturing.
- 49 designed modules or systems.
- 34 developed prototype modules.
- 26 developed prototype systems.
- 54 were involved in wholesale distribution.
- 23 were involved in retail distribution.
- 42 installed PV systems.

In addition, several manufacturers are planning to introduce new photovoltaic-related technical products in the next calendar year (Table 3.17).

- 22 plan to introduce new single-crystal silicon modules.
- 11 plan to introduce new cast silicon modules.
- 2 plan to introduce new ribbon silicon modules.
- 20 plan to introduce new thin-film modules.
- 3 plan to introduce new concentrator photovoltaic modules.

Corresponding to the strong growth in PV shipments, employment in PV-related activities increased more than 28 percent, from 11,245 person-years<sup>1</sup> in 2008 to 14,443 person-years in 2009 (Table 3.16). Of the 101 companies, 70 had 90 percent or more of their total company-wide revenues in PV-related activities, 10 had 50 to 89 percent, 8 had 10 to 49 percent, and 13 had less than 10 percent (Table 3.19).

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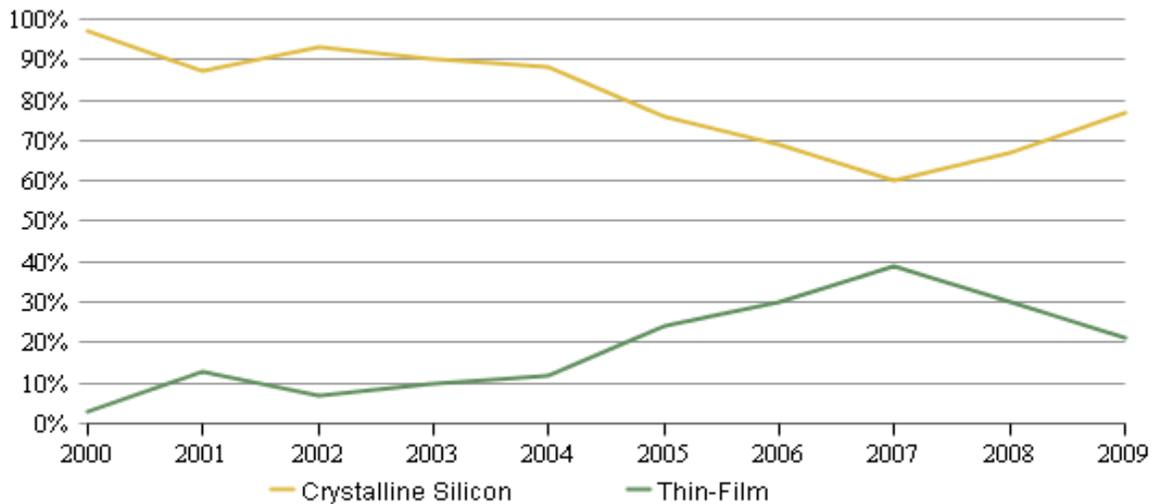
<sup>1</sup> Person-year: One whole year, or fraction thereof, worked by an employee, including contracted manpower.

## Photovoltaic Cell and Module Shipments

Photovoltaic (PV) cell and module shipments increased for the sixth-consecutive year, reaching a record of 1,282,560 peak kilowatts in 2009. Cell shipments accounted for 93,681 peak kilowatts, while module shipments accounted for 1,188,879 peak kilowatts (Table 3.3).

Crystalline silicon cells and modules continued to dominate the PV industry in 2009, accounting for 77 percent of the total shipments (Figure 3.3 and Table 3.5). From 2000 to 2007, thin-film cells/modules (which do not rely on silicon and are less expensive to manufacture than the crystalline silicon cells/modules) took market share away from the established crystalline silicon cells/modules. Since 2007, crystalline silicon cells/modules have re-gained some of the lost market share from its chief rival, thin-film cells/modules.

**Figure 3.3 Crystalline Silicon Shipment and Thin-Film Shipment Market Shares, 2000-2009**  
market share



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

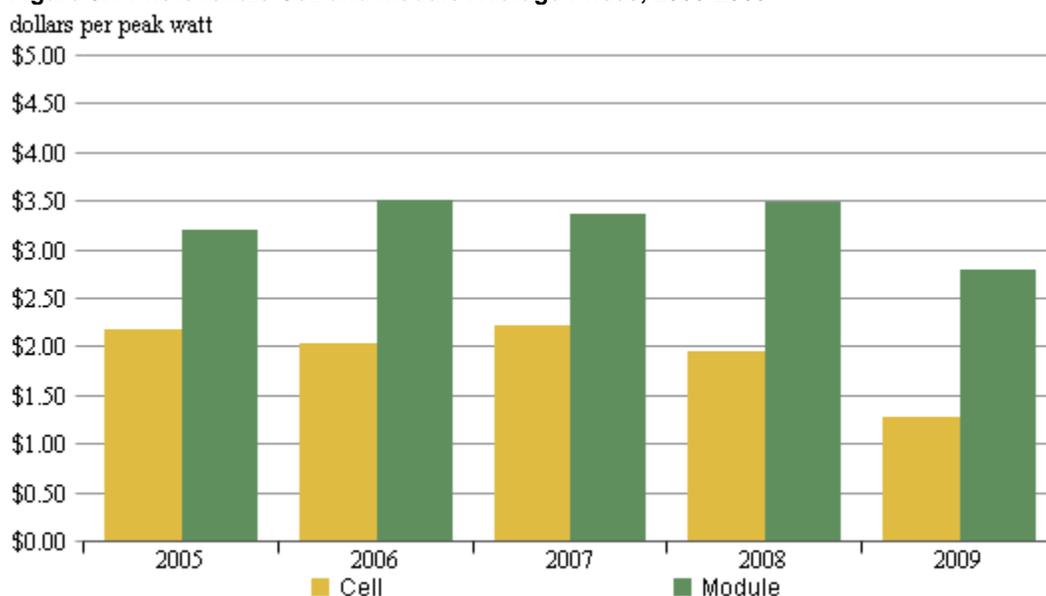
Shipments of single-crystal silicon totaled 580,629 peak kilowatts, an increase of nearly 62 percent compared with corresponding 2008 shipments. Cast and ribbon silicon shipments totaled 403,531 peak kilowatts in 2009, nearly a 32-percent increase from the corresponding 2008 shipments. Thin-film shipments decreased to 266,547 peak kilowatts in 2009, compared to 293,182 peak kilowatts in 2008. In 2009, thin-film shipments accounted for nearly 21 percent of the market, compared to slightly more than 39 percent in 2007. Shipments of concentrators accounted for less than 2 percent of the total in 2009 (Figure 3.3 and Table 3.5).

## Total Revenue and Average Price

Total revenue of photovoltaic cell and module shipments grew nearly 3 percent from \$3.34 billion in 2008 to \$3.43 billion in 2009 (Table 3.6). Revenue includes charges for cooperative advertising and warranties, but does not include excise taxes and the cost of freight or transportation.

The average price for modules (dollars per peak watt) decreased 20 percent, from \$3.49 in 2008 to \$2.79 in 2009. For cells, the average price decreased more than 34 percent, from \$1.94 in 2008 to \$1.27 in 2009 (Figure 3.4 and Table 3.6).

**Figure 3.4 Photovoltaic Cell and Module Average Prices, 2005-2009**



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

## Domestic Shipments

During 2009, shipments of solar cells and modules to domestic customers increased to 601,133 peak kilowatts, nearly 15 percent higher than the 524,252 peak kilowatts in 2008 (Table 3.2). The shipments went to all 50 States, the District of Columbia, Guam, Puerto Rico, and the Virgin Islands (Table 3.10). Nearly 75 percent of domestic PV cell and module shipments (449,438 peak kilowatts) went to five States (in order of decreasing volume): California, New Jersey, Florida, Arizona, and New York, with more than 55 percent (332,204 peak kilowatts) of domestic shipments going to California and New Jersey.

Domestic shipments to the commercial sector in 2009 accounted for 282,273 peak kilowatts, or nearly 47 percent of the domestic market. Of the domestic shipments to the commercial sector, nearly 86 percent were crystalline silicon, about 11 percent were thin-film PV, and more than 3 percent were concentrator PV (Table 3.7).

The residential sector was the second-largest domestic market in 2009, accounting for 221,245 peak kilowatts, or nearly 37 percent of the domestic market share. About 88 percent of its shipments were crystalline silicon shipments and about 12 percent were thin-film PV shipments.

Shipments to the electric power sector amounted to 53,636 peak kilowatts, or nearly 9 percent of the domestic market share. Crystalline silicon accounted for nearly 57 percent of the electric power shipments, thin-film PV accounted for nearly 43 percent, and concentrator PV accounted for 0.5 percent.

The industrial sector, with more than 7 percent of domestic shipments, was the smallest domestic sales market, totaling 43,445 peak kilowatts. Nearly 83 percent were crystalline silicon, and more than 17 percent were thin-film PV.

Electricity generation, which consists of both grid-connected (those connected to the electric power grid) and remote or dispersed applications (those not connected), continues to be the predominant end use for PV cells and modules. In 2009, PV cell and module shipments to the electricity generation market totaled 593,308 peak kilowatts, or nearly 99 percent of domestic shipments. Domestic shipments to original equipment manufacturers (OEM) and communication end uses were the second- and third-largest end uses, respectively, totaling nearly 0.9 percent. Domestic shipments to consumer goods, transportation, water pumping, and health end users held small market shares, totaling nearly 0.4 percent of domestic shipments (Table 3.7).

During 2009, PV shipments to installers, the largest customer type, totaled 214,799 peak kilowatts, nearly 36 percent of the domestic market share. Shipments to the second-largest customer type, wholesale distributors, amounted to 140,530 peak kilowatts, or more than 23 percent of the domestic market share (Table 3.4).

### **Export Shipments**

Exports of PV cells and modules totaled 681,427 peak kilowatts in 2009, a more than 47-percent increase from the 2008 exports of 462,252 peak kilowatts (Table 3.13). Exports exceeded domestic shipments in 2009, accounting for about 53 percent of total shipments. In contrast, 2008 exports were approximately 47 percent of total shipments (Table 3.10). The predominant type of export shipment was crystalline silicon cells and modules, accounting for nearly 71 percent (480,423 peak kilowatts) of total exports. The export market was dominated by sales to France, Germany, and Italy (Table 3.14).

## **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 typically produce the greatest amounts of power during the afternoon, when electricity demand is high.

During 2009, the number of shipments of complete PV systems decreased to 9,233 systems from the 20,025 systems in 2008. The total value of complete systems decreased 8 percent to \$1.15 billion in 2009. The total peak kilowatts of complete systems shipped increased from 202,632 in 2008 to 228,017 in 2009 (Table 3.15).

## **Origin of Shipments**

Imports of PV cells and modules shipments increased nearly 27 percent from 2008, to 743,414 peak kilowatts in 2009 (Table 3.11). Imports in 2009 accounted for over half of total shipments. The predominant type of import shipment was crystalline silicon cells and modules, accounting for more than 95 percent (708,246 peak kilowatts) of total imports. China, Mexico, and Philippines accounted for 78 percent of total imports (Table 3.12).

In 2009, about 42 percent of PV cells and modules were manufactured in the United States; manufacturers in California, Maryland, Massachusetts, Michigan, and Ohio produced nearly 87 percent of domestically produced cells and modules (Table 3.9).

**Table 3.1 Annual Shipments of Photovoltaic Cells and Modules by Source, 2000 - 2009**

Year	Number of Companies	Photovoltaic Cell and Module Shipments		
		(Peak Kilowatts)		
		Imports	Domestically Manufactured	Total
2000	21	8,821	79,400	88,221
2001	19	10,204	87,462	97,666
2002	19	7,297	104,793	112,090
2003	20	9,731	99,626	109,357
2004	19	47,703	133,413	181,116
2005	29	90,981	135,935	226,916
2006	41	173,977	163,291	337,268
2007	46	238,018	279,666	517,684
2008	66	586,558	399,947	986,504
2009	101	743,414	539,146	1,282,560

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

Domestically manufactured shipments include those made in U.S. Territories

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

**Table 3.2 Annual Shipments of Photovoltaic Cells and Modules by Disposition, 2000 - 2009**

Year	Number of Companies	Photovoltaic Cell and Module Shipments		
		(Peak Kilowatts)		
		Exports	Domestic Shipments	Total
2000	21	68,382	19,838	88,221
2001	19	61,356	36,310	97,666
2002	19	66,778	45,313	112,090
2003	20	60,693	48,664	109,357
2004	19	102,770	78,346	181,116
2005	29	92,451	134,465	226,916
2006	41	130,757	206,511	337,268
2007	46	237,209	280,475	517,684
2008	66	462,252	524,252	986,504
2009	101	681,427	601,133	1,282,560

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

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.

Domestic shipments include those shipped to U.S. Territories

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

**Table 3.3 Annual Photovoltaic Shipments by Cells and Modules, 2000 - 2009**

**(Peak Kilowatts)**

<b>Year</b>	<b>Cells</b>	<b>Modules</b>	<b>Total</b>
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
2008	65,811	920,693	986,504
2009	93,681	1,188,879	1,282,560

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

**Source:** U.S. 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, 2007 - 2009****(Peak Kilowatts)**

Customer Type	Shipments		
	2007	2008	2009
Wholesale Distributors	109,015	125,527	140,530
Retail Distributors	19,748	44,203	87,093
Exporters	1,513	888	950
Installers	110,009	231,235	214,799
End Users	38,686	109,879	132,293
Module Manufacturers	1,504	12,521	25,469
<b>U.S. Total</b>	<b>280,475</b>	<b>524,252</b>	<b>601,133</b>

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

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

**Table 3.5 Photovoltaic Cell and Module Shipments by Type, 2007 - 2009**

Type	Shipments (Peak Kilowatts)			Percent of Total		
	2007	2008	2009	2007	2008	2009
Crystalline Silicon						
Single-Crystal	128,542	359,259	580,629	25	36	45
Cast and Ribbon	181,788	306,537	403,531	35	31	31
Subtotal	310,330	665,795	984,161	60	67	77
Thin-Film	202,519	293,182	266,547	39	30	21
Concentrator	4,835	27,527	31,852	1	3	2
<b>U.S. Total</b>	<b>517,684</b>	<b>986,504</b>	<b>1,282,560</b>	<b>100</b>	<b>100</b>	<b>100</b>

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

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

**Table 3.6 Photovoltaic Cell and Module Shipment Revenue by Type, 2008 and 2009**

Type	2008			2009		
	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	1,398,140	3.97	2.94	1,735,298	3.06	1.71
Cast and Ribbon	1,091,526	3.60	2.44	1,036,045	2.63	1.73
Subtotal	2,489,666	3.80	2.80	2,771,343	2.89	1.72
Thin-Film	826,657	2.82	1.03	W	W	W
Concentrator	26,380	5.74	0.68	W	W	W
<b>U.S. Total</b>	<b>3,342,702</b>	<b>3.49</b>	<b>1.94</b>	<b>3,431,594</b>	<b>2.79</b>	<b>1.27</b>

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

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

**Source:** U.S. 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, 2008 and 2009  
(Peak Kilowatts)**

Sector and End Use	Crystalline Silicon <sup>1</sup>	Thin-Film Silicon	Concentrator Silicon	2009 Total	2008 Total
<b>Market Sector</b>					
Residential	195,391	25,854	-	221,245	173,989
Commercial	241,520	31,440	9,313	282,273	253,852
Industrial	35,886	7,560	-	43,445	51,493
Electric Power	30,407	22,951	278	53,636	35,819
Transportation	534	-	-	534	9,100
<b>U.S. Total</b>	<b>503,738</b>	<b>87,804</b>	<b>9,591</b>	<b>601,133</b>	<b>524,252</b>
<b>End Use</b>					
<b>Electricity Generation</b>					
Grid-Connected	489,554	86,043	9,591	585,189	500,854
Remote	7,550	569	-	8,119	15,527
Communication	1,678	139	-	1,817	2,622
Consumer Goods	120	170	-	290	312
Transportation	951	10	-	961	916
Water Pumping	903	20	-	923	1,145
Cells/Modules to OEM	2,610	845	-	3,455	2,659
Health	373	8	-	381	217
<b>U.S. Total</b>	<b>503,738</b>	<b>87,804</b>	<b>9,591</b>	<b>601,133</b>	<b>524,252</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:** U.S. 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, 2007 - 2009  
(Percent of Energy Converted)**

Year	Crystalline Silicon			Thin-Film Silicon		Concentrator Silicon
	Single-Crystal	Cast	Ribbon	Amorphous Silicon	Other	
2007	17	14	12	8	12	35
2008	19	14	13	8	12	34
2009	20	14	13	8	12	38

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

**Table 3.9 Shipments of Photovoltaic Cells and Modules by Origin, 2008 and 2009****(Peak Kilowatts)**

<b>Origin</b>	<b>2008</b>	<b>Percent of U.S. Shipments 2008</b>	<b>2009</b>	<b>Percent of U.S. Shipments 2009</b>
Arizona	13,583	1.38	13,091	1.02
California	44,059	4.47	132,499	10.33
Colorado	-	-	100	*
Delaware	15,000	1.52	-	-
Georgia	423	0.04	21,000	1.64
Iowa	1,143	0.12	874	0.07
Maryland	29,768	3.02	26,793	2.09
Massachusetts	38,811	3.93	115,277	8.99
Michigan	109,122	11.06	73,900	5.76
New Jersey	2,886	0.29	1,387	0.11
New Mexico	7,427	0.75	17,561	1.37
New York	144	0.01	1,114	0.09
Ohio	133,681	13.55	120,329	9.38
Pennsylvania	3,900	0.40	15,139	1.18
Texas	-	-	83	*
Shipments from United States/Territories	399,947	40.54	539,146	42.04
Imports	586,558	59.46	743,414	57.96
<b>Total Shipments</b>	<b>986,504</b>	<b>100.00</b>	<b>1,282,560</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:** U.S. Energy Information Administration, Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."

**Table 3.10 Shipments of Photovoltaic Cells and Modules by Destination, 2008 and 2009**

(Peak Kilowatts)

Destination	2008	Percent of U.S. Shipments 2008	2009	Percent of U.S. Shipments 2009
Alabama	92	*	77	*
Alaska	37	*	32	*
Arizona	17,908	1.82	38,536	3.00
Arkansas	100	0.01	193	0.02
California	327,788	33.23	266,629	20.79
Colorado	22,624	2.29	25,406	1.98
Connecticut	8,085	0.82	15,027	1.17
Delaware	1,008	0.10	1,001	0.08
District of Columbia	795	0.08	123	*
Florida	24,713	2.51	45,228	3.53
Georgia	473	0.05	1,009	0.08
Guam	-	-	110	*
Hawaii	7,879	0.80	6,625	0.52
Idaho	118	0.01	86	*
Illinois	1,443	0.15	6,500	0.51
Indiana	693	0.07	1,347	0.11
Iowa	74	*	111	*
Kansas	68	*	85	*
Kentucky	64	*	16	*
Louisiana	431	0.04	1,708	0.13
Maine	172	0.02	663	0.05
Maryland	9,451	0.96	7,859	0.61
Massachusetts	5,029	0.51	7,406	0.58
Michigan	365	0.04	935	0.07
Minnesota	234	0.02	599	0.05
Mississippi	15	*	28	*
Missouri	403	0.04	238	0.02
Montana	470	0.05	453	0.04
Nebraska	55	*	49	*
Nevada	14,330	1.45	5,783	0.45
New Hampshire	842	0.09	1,751	0.14
New Jersey	31,973	3.24	65,575	5.11
New Mexico	3,387	0.34	8,115	0.63
New York	11,813	1.20	33,470	2.61
North Carolina	2,674	0.27	11,226	0.88
North Dakota	13	*	18	*
Ohio	969	0.10	12,246	0.95
Oklahoma	364	0.04	185	0.01
Oregon	6,782	0.69	2,651	0.21
Pennsylvania	1,563	0.16	10,259	0.80
Puerto Rico	170	0.02	881	0.07
Rhode Island	87	*	645	0.05
South Carolina	106	0.01	262	0.02
South Dakota	31	*	10	*
Tennessee	155	0.02	734	0.06
Texas	8,778	0.89	8,999	0.70
Utah	314	0.03	215	0.02
Vermont	5,257	0.53	3,969	0.31
Virgin Islands of the U.S.	22	*	25	*
Virginia	379	0.04	1,208	0.09
Washington	1,988	0.20	1,482	0.12
West Virginia	72	*	1,529	0.12
Wisconsin	1,490	0.15	1,732	0.14
Wyoming	107	0.01	89	*
Shipments to United States/Territories	524,252	53.14	601,133	46.87
Exported	462,252	46.86	681,427	53.13
<b>Total Shipments</b>	<b>986,504</b>	<b>100.00</b>	<b>1,282,560</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:** U.S. Energy Information Administration, Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."

**Table 3.11 Import Shipments of Photovoltaic Cells and Modules by Type, 2000 - 2009**

**(Peak Kilowatts)**

Item/Year	Crystalline Silicon	Thin-Film Silicon	Concentrator Silicon	Total
<b>Cells</b>				
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
2008	136,740	5	-	136,745
2009	118,167	65	-	118,231
<b>Modules</b>				
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
2008	418,252	30,661	900	449,813
2009	590,079	35,103	-	625,182
<b>Totals</b>				
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
2008	554,992	30,666	900	586,558
2009	708,246	35,168	-	743,414

- = No data reported.

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

**Source:** U.S. 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, 2008 and 2009  
(Peak Kilowatts)**

Region/Country	2008	Percent of U.S. Imports 2008	2009	Percent of U.S. Imports 2009
Asia				
China	133,038	22.68	234,717	31.57
Hong Kong	6,200	1.06	3,100	0.42
India	1,096	0.19	1,847	0.25
Japan	145,745	24.85	84,134	11.32
Philippines	150,092	25.59	213,200	28.68
Taiwan	44,889	7.65	61,792	8.31
Total	481,060	82.01	598,790	80.55
Central America				
Mexico	43,440	7.41	132,564	17.83
Total	43,440	7.41	132,564	17.83
Europe				
Germany	58,517	9.98	11,731	1.58
Norway	-	-	86	0.01
Spain	3,540	0.60	243	0.03
Total	62,057	10.58	12,060	1.62
<b>U.S. Total</b>	<b>586,558</b>	<b>100.00</b>	<b>743,414</b>	<b>100.00</b>

- = No data reported.

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

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

**Table 3.13 Export Shipments of Photovoltaic Cells and Modules by Type, 2000 - 2009****(Peak Kilowatts)**

Item/Year	Crystalline Silicon	Thin-Film Silicon	Concentrator Silicon	Total
<b>Cells</b>				
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
2008	36,419	605	15,967	52,991
2009	42,299	2,291	21,743	66,333
<b>Modules</b>				
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
2008	204,471	203,391	1,400	409,261
2009	438,124	176,452	518	615,094
<b>Totals</b>				
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
2008	240,890	203,996	17,367	462,252
2009	480,423	178,743	22,261	681,427

- = No data reported.

**Note:** Totals may not equal sum of components due to independent rounding.**Source:** U.S. 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, 2008 and 2009**

**(Peak Kilowatts)**

Region/Country	2008	Percent of U.S. Exports 2008	2009	Percent of U.S. Exports 2009
<b>Africa</b>				
Egypt	-	-	1	*
Ethiopia	-	-	2	*
Kenya	416	0.09	400	0.06
Nigeria	400	0.09	450	0.07
South Africa	1,162	0.25	902	0.13
Total	1,978	0.43	1,754	0.26
<b>Asia</b>				
Afghanistan	76	0.02	-	-
Bahrain	1	*	s	*
Cambodia	624	0.13	-	-
China	4,418	0.96	18,297	2.69
Hong Kong	4,120	0.89	3,609	0.53
India	1,137	0.25	14,806	2.17
Indonesia	176	0.04	-	-
Israel	149	0.03	3,800	0.56
Japan	440	0.10	5,472	0.80
Korea, South	10,763	2.33	12,581	1.85
Malaysia	19	*	25	*
Oman	24	*	-	-
Singapore	12,297	2.66	3	*
Sri Lanka	-	-	1	*
Taiwan	700	0.15	1,244	0.18
Thailand	14	*	-	-
United Arab Emirates	234	0.05	195	0.03
Total	35,192	7.61	60,034	8.81
<b>Australia and Oceania</b>				
Australia	8,108	1.75	8,368	1.23
New Zealand	48	0.01	2	*
Vanuatu	-	-	s	*
Total	8,156	1.76	8,370	1.23
<b>Central America</b>				
Bahamas	100	0.02	-	-
Belize	7	*	-	-
British Virgin Islands	-	-	31	*
Cayman Islands	3	*	-	-
Costa Rica	16	*	6	*
Dominica	5	*	-	-
Dominican Republic	159	0.03	1,062	0.16
El Salvador	2	*	17	*
Guatemala	16	*	9	*
Haiti	225	0.05	111	0.02
Honduras	61	0.01	47	*
Jamaica	50	0.01	50	*
Mexico	564	0.12	638	0.09
Nicaragua	139	0.03	166	0.02
Panama	134	0.03	104	0.02
Trinidad and Tobago	4	*	-	-
Total	1,484	0.32	2,239	0.33
<b>Europe</b>				
Albania	481	0.10	4,700	0.69
Austria	4,155	0.90	3,000	0.44
Belgium	2,148	0.46	27,247	4.00
Bulgaria	541	0.12	4,700	0.69
Czech Republic	592	0.13	6,902	1.01
Denmark	101	0.02	7	*
Finland	1	*	4	*
France	31,196	6.75	47,271	6.94
Germany	198,230	42.88	309,147	45.37
Greece	487	0.11	1,600	0.23
Hungary	512	0.11	4,701	0.69
Ireland	17	*	29	*
Italy	49,830	10.78	108,187	15.88
Kazakhstan	1	*	-	-
Netherlands	20	*	2,994	0.44
Norway	-	-	2	*
Poland	482	0.10	4,700	0.69
Portugal	10	*	1,007	0.15
Romania	482	0.10	4,700	0.69
Russian Federation	2	*	-	-
Spain	105,555	22.84	23,460	3.44
Sweden	1,131	0.24	1,868	0.27
Switzerland	383	0.08	8,182	1.20

**Table 3.14 Destination of U.S. Photovoltaic Cell and Module Export Shipments by Country, 2008 and 2009 (Peak Kilowatts) (Continued)**

Region/Country	2008	Percent of U.S. Exports 2008	2009	Percent of U.S. Exports 2009
Turkey	3	*	41	*
United Kingdom	50	0.01	18	*
Total	396,410	85.76	564,466	82.84
North America				
Canada	17,819	3.85	43,458	6.38
Total	17,819	3.85	43,458	6.38
South America				
Argentina	5	*	-	-
Bolivia	135	0.03	139	0.02
Brazil	652	0.14	503	0.07
Chile	145	0.03	190	0.03
Colombia	97	0.02	53	*
Ecuador	21	*	16	*
Guyana	-	-	7	*
Peru	152	0.03	148	0.02
Uruguay	8	*	2	*
Venezuela	-	-	50	*
Total	1,214	0.26	1,107	0.16
<b>U.S. Total</b>	<b>462,252</b>	<b>100.00</b>	<b>681,427</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:** U.S. Energy Information Administration, Form EIA-63B, "Annual Photovoltaic Module/Cell Manufacturers Survey."

**Table 3.15 Shipments of Complete Photovoltaic Module Systems, 2007 - 2009**

<b>Shipment Information</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>
Complete Photovoltaic Module Systems Shipped	10,600	20,025	9,233
Peak Kilowatts	80,560	202,632	228,017
Percentage of Total Module Shipments	16	22	19
Revenue of Systems (Thousand Dollars)	491,740	1,246,126	1,145,366

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

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

**Table 3.16 Employment in the Photovoltaic Manufacturing Industry, 2000 - 2009**

<b>Year</b>	<b>Number of Companies</b>	<b>Number of Person-Years</b>
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
2008	66	11,245
2009	101	14,443

**Source:** U.S. 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 2010**

<b>New Product Type</b>	<b>Number of Companies</b>
Crystalline Silicon	
Single-Crystal Silicon Modules	22
Cast Silicon Modules	11
Ribbon Silicon Modules	2
Thin-Film	
Amorphous Silicon Modules	11
Other (Thin Film)	9
Concentrators	3
Nonmodule System Components	8

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

**Table 3.18 Number of Companies Involved in Photovoltaic-Related Activities, 2008 and 2009**

Type of Activity	Number of Companies	
	2008	2009
Module or Cell Manufacturing	29	43
Module or Systems Design	39	49
Prototype Module Development	28	34
Prototype Systems Development	20	26
Wholesale Distribution	37	54
Retail Distribution	16	23
Installation	28	42
Noncollector System Component Manufacture	9	15

**Source:** U.S. 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, 2008 and 2009**

Percent of Total Sales Revenue	Number of Companies	
	2008	2009
90-100	50	70
50-89	7	10
10-49	4	8
Less than 10	5	13
<b>U.S. Total</b>	<b>66</b>	<b>101</b>

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