

U.S. SOLAR PHOTOVOLTAIC (PV) CELL AND MODULE TRADE OVERVIEW

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Recent growth in the U.S. and global solar photovoltaic (PV) markets, expanding U.S. PV production capacity, and growing PV production in China, Mexico, and other countries contributed to a \$3.2 billion increase in total U.S. PV cell and module trade¹ from 2006–10 (box 1). U.S. imports are rising due to increasing crystalline silicon (c-Si) module production in low-cost production locations and a growing U.S. market, while exports are rising due to increasing U.S. production capacity and expanding markets in Canada and Europe.

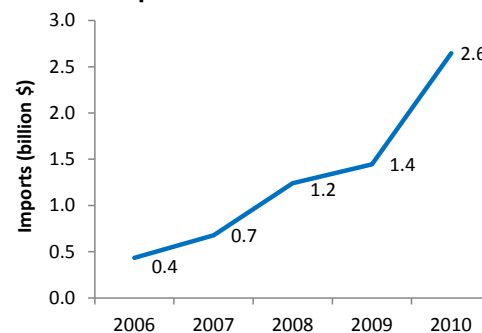
GROWING U.S. PV IMPORTS FROM ASIA AND MEXICO

U.S. PV imports increased from \$433.6 million in 2006 to \$2.6 billion in 2010 (more than 500%), reflecting U.S. solar market growth and rising production in Asia and Mexico.² Crystalline silicon modules accounted for 94% of 2009 module imports.³

- **China the largest source of imports:** China surpassed Japan in 2009 to become the largest source of U.S. PV imports. This shift reflects the growth of c-Si cell and module production by China-based companies. China accounted for 48% of global cell production in 2010.⁴
- **Declining share from Japan:** Imports from Japan rose in value, but Japan’s share of imports declined from 48% to 11%. This reflects the increasing presence in the U.S. market of Chinese and other foreign producers and the expansion of module production in Mexico and the United States by Japan-based firms. Sanyo assembles modules in Mexico, Sharp produces modules in the United States, and Kyocera assembles modules in both countries.
- **Share from Mexico constant:** Imports from Mexico rose significantly in value while remaining constant as a share of the market. Several companies established or expanded module assembly plants in Mexico during 2006–10, while others contracted with Jabil Circuit to assemble modules in Mexico. Several plants in Mexico use U.S. inputs. For example, U.S.-based United Solar has a plant in Mexico that assembles modules from U.S. made cells. Sanyo produces cells in Japan using U.S. inputs. These cells are assembled into modules in Mexico for the U.S. market.

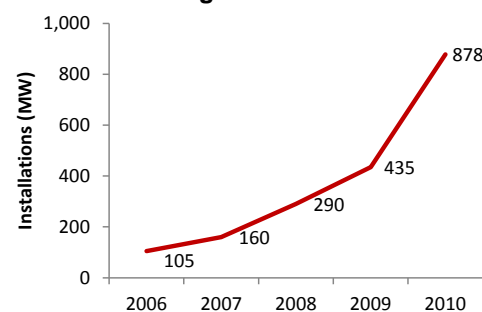
The United States was the second largest global PV importer in 2010. The European Union has the largest market and was the leading importer, with \$17 billion in imports from China alone in 2010.⁵ China was the third largest PV importer, with \$2.2 billion in imports.

U.S. PV imports increased to \$2.6 billion



Source: USITC DataWeb/USDOC.

U.S. PV market grew more than 700%



Sources: Solar Energy Industries Association and GTM Research.

U.S. PV imports, 2006–10

	2006	2007	2008	2009	2010	2006	2010
	million dollars					percent	
China	70.4	188.5	229.3	418.7	1,192.4	16.2	45.1
Mexico	79.3	54.3	213.2	349.3	481.1	18.3	18.2
Japan	208.1	229.8	250.9	237.4	301.3	48.0	11.4
Taiwan	28.8	59.4	175.6	109.0	264.0	6.6	10.0
Malaysia	0.1	0.1	0.0	54.9	139.1	0.0	5.3
Other	47.0	144.9	371.7	276.4	267.1	10.8	10.1
Total	433.6	676.9	1,240.8	1,445.7	2,645.0	100	100

Source: USITC DataWeb/USDOC.

Note: Numbers may not add due to rounding.

Box 1: PV technology

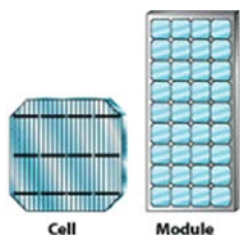


Image source: EERE Web site, <http://www.eere.energy.gov> (accessed February 19, 2010).

PV cells convert sunlight into electricity and are the basic element of a module.

PV modules are made up of interconnected cells encapsulated between a backing material and a clear plastic or glass front. A PV panel is a group of connected modules, though the term is commonly used interchangeably with module.

Crystalline silicon (c-Si) modules use c-Si as the photosensitive material. They were the first modules commercialized and account for most global production.

Thin-film modules use a thin layer of a raw material such as cadmium telluride as the photosensitive material and are a newer (2nd generation) PV technology. They are usually less efficient than c-Si modules, but can be less expensive to produce.

Disclaimer: The views expressed are those of the author and not those of the USITC or any of its Commissioners.

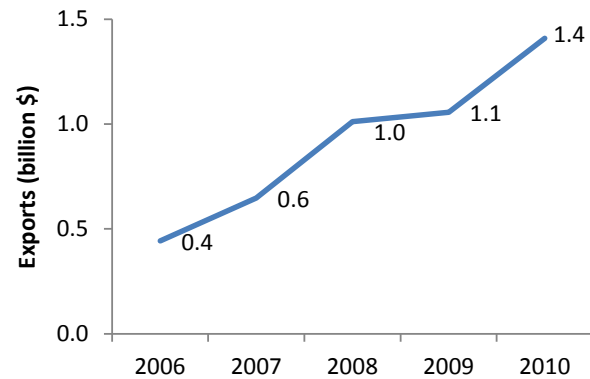
RISING U.S. EXPORTS TO CANADA AND EU

U.S. PV exports rose from \$442.7 million in 2006 to \$1.4 billion in 2010 (more than 200%), reflecting the growth of U.S. production, expanding markets in Canada and Europe, and higher module prices in Europe. Shipments of cells and modules by U.S. producers increased from \$653 million in 2006 to \$2.4 billion in 2009.⁶ Thin-film modules account for a significant share of U.S. shipments and were 29% of 2009 exports.⁷

- **Rising exports to EU:** The largest destination for U.S. exports is the EU-27, which is the largest global market and generally has higher prices for solar modules than the United States. The two largest U.S. export destinations in Europe, Germany and Italy, were the two largest PV markets in 2010.⁸
- **Increasing exports to Canada:** U.S. exports to Canada rose significantly due to the growth in U.S. production capacity and the increase in the size of the Canadian market. Annual PV installations in Canada increased from 4 megawatts (MW) in 2006 to 62 MW in 2009 and grew further in 2010.⁹
- **Growing cell exports to China:** Cells accounted for 81% of 2010 exports to China.

Despite growing U.S. PV production and rising exports, the United States exports significantly less than the leading Asian producers. PV cell production in China and Taiwan rose at a faster pace than in the United States from 2006–10 and these two sources accounted for a combined 61% of 2010 global solar cell production. The United States accounted for 5% of global cell production in 2010.¹⁰

U.S. PV exports increased more than 200%



Source: USITC DataWeb/USDOC.

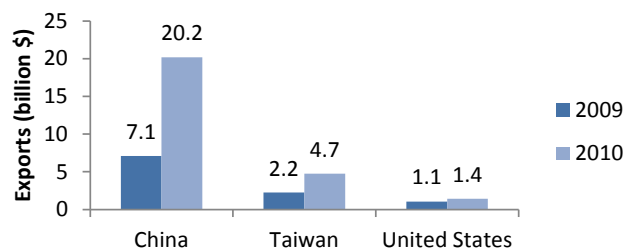
U.S. PV exports, 2006–10, million dollars

	2006	2007	2008	2009	2010
All EU-27	307.7	464.3	750.0	769.6	988.5
Germany	211.0	298.9	415.3	540.7	606.6
Italy	5.7	26.9	51.6	72.8	120.4
Canada	13.0	12.3	21.7	107.0	178.5
China	10.4	30.9	23.2	26.8	79.6
Other	111.6	139.5	216.4	153.3	162.5
Total	442.7	646.9	1,011.3	1,056.7	1,409.0

Source: USITC DataWeb/USDOC.

Note: Numbers may not add due to rounding.

U.S. trails leading Asian producers in exports



Sources: USITC DataWeb/USDOC; GTIS, Global Trade Atlas database.

Notes: China was the leading global exporter in 2010, followed by Taiwan. PV specific data for Japan and many other major producers are not available. Data from the EIA and the Japan Photovoltaic Energy Association on MW exported in 2009 indicate that Japanese exports also exceed U.S. exports.

¹ Total trade is imports plus exports.

² There is not a specific Harmonized Commodity Description and Coding System (HS) subheading for PV cells and modules. PV cells and modules are generally included in HS 8541.40, which includes PV, other photosensitive semiconductor devices, and light-emitting diodes. Some countries have more specific provisions for PV cells and modules, including Australia, China, India, Japan (imports), Norway, Taiwan, and the United States. PV modules are generally included in 8541.40.6020, solar cells assembled into modules or panels, in the Harmonized Tariff Schedule (HTS) of the United States and cells in HTS 8541.40.6030, solar cells not assembled into modules or panels. (The term “modules” is used here to refer to production and trade of both panels and modules.) All U.S. trade data in this paper are from U.S. International Trade Commission (USITC) DataWeb/U.S. Department of Commerce (USDOC) and all global trade data are from GTIS, Global Trade Atlas database.

³ Energy Information Administration (EIA), *Solar Photovoltaic Cell/Module Manufacturing Activities 2009*, January 2011, 18.

⁴ Garrett Hering, “Year of the Tiger,” *Photon International*, March 2011, 206.

⁵ EU imports from China are based on Chinese export data.

⁶ Shipment data are from the U.S. Census Bureau’s *Current Industrial Report* and may not be directly comparable to export data.

⁷ EIA, *Solar Photovoltaic Cell/Module Manufacturing Activities 2009*, January 2011, 20.

⁸ Solarbuzz, “Solarbuzz Reports World Solar Photovoltaic Market Grew to 18.2 Gigawatts in 2010,” March 15, 2011.

⁹ Department of Natural Resources Canada, “National Survey Report of PV Power Applications in Canada,” June 2010, 8;

Garrett Hering and William P. Hirshman, “Conquering the World,” *Photon International*, February 2011, 56.

¹⁰ Hering, “Year of the Tiger,” 188, 206; European Photovoltaic Industry Association, *Solar Generation IV—2007*, 26.

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