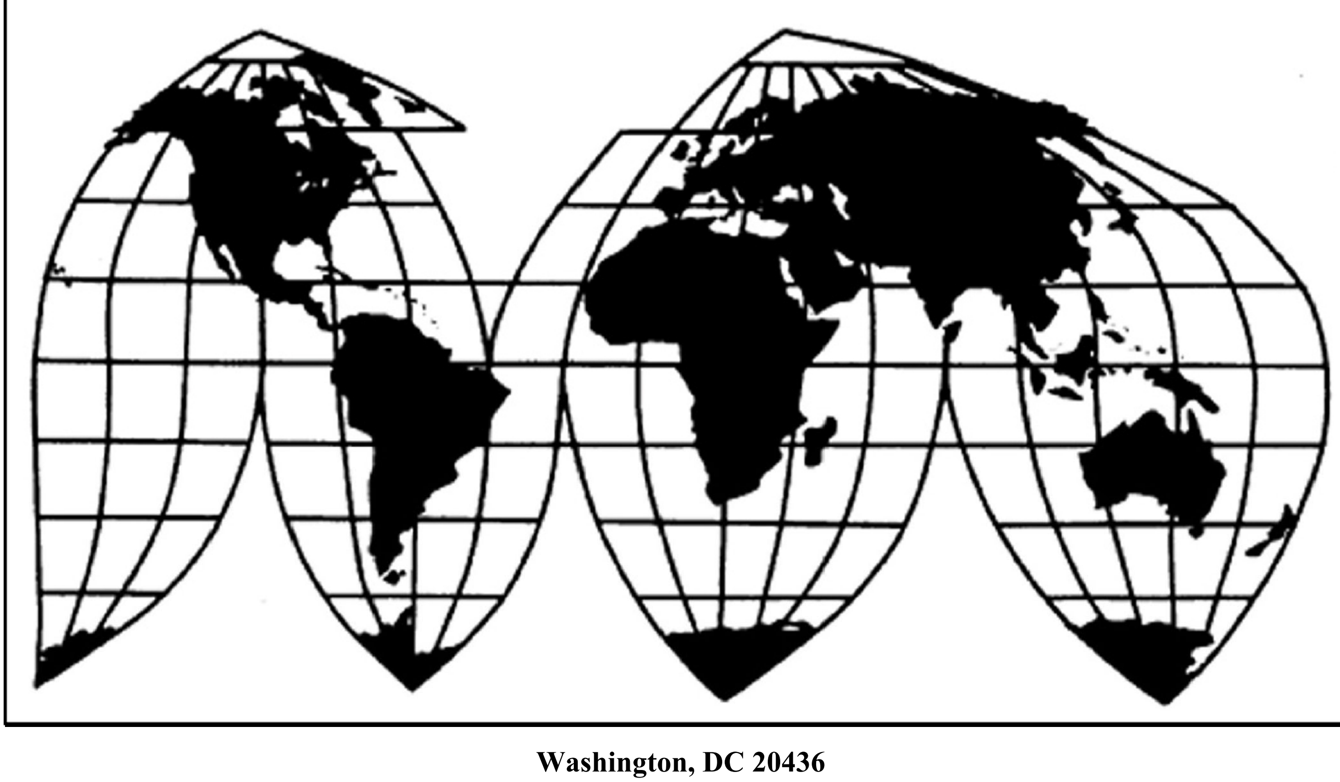
Crystalline Silicon Photovoltaic Cells, Whether or Not Partially or Fully Assembled Into Other Products: Advice on the Probable Economic Effect of Certain Modifications to the Safeguard Measure

Investigation No. TA-201-075 (Modification)

Publication 5032 **March 2020**

U.S. International Trade Commission



Washington, DC 20436

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Errata

For the United States International Trade Commission, *Crystalline Silicon Photovoltaic Cells, Whether or Not Partially or Fully Assembled Into Other Products: Advice on the Probable Economic Effect of Certain Modifications to the Safeguard Measure*, Investigation No. TA-201-075 (Modification), USITC Publication 5032, March 2020.

- Page II-12 was inadvertently excluded from the original public version of the report. It is now included.

April 10, 2024

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Note.—Information that would reveal confidential operations of individual concerns may not be published. Such information is identified by brackets in confidential reports and is deleted and replaced with asterisks (***) in public reports.

Abbreviations and Acronyms

Abbreviation or Acronym	**Definition**
AC	alternating current
a-Si	amorphous silicon
AUV	average unit value
BOS	balance of system
CBI	confidential business information
CdTe	cadmium telluride
CI(G)S	copper indium (gallium) (di)selenide
CIT	U.S. Court of International Trade
Commerce	U.S. Department of Commerce
Commission	U.S. International Trade Commission
CSPV	crystalline silicon photovoltaic
CSPV 1	*Crystalline Silicon Photovoltaic Cells and Modules from China*, Inv. Nos. 701-TA-481 and 731-TA-1190 (Final), 2012
CSPV 2	*Certain Crystalline Silicon Photovoltaic Products from China and Taiwan,* Inv. Nos. 701-TA-511 and 731-TA-1246-1247 (Final), 2015
CSPV Modification Advice	*Crystalline Silicon Photovoltaic Cells, Whether or Not Partially or Fully Assembled into Other Products: Advice on the Probable Economic Effect of Certain Modifications to the Safeguard Measure,* Inv. No. TA-201-075 (Modification), 2020
CSPV Monitoring	*Crystalline Silicon Photovoltaic Cells, Whether or Not Partially or Fully Assembled into Other Products: Monitoring Developments in the Domestic Industry,* Inv. No. TA-201-075 (Monitoring), 2020
CSPV Safeguard	*Crystalline Silicon Photovoltaic Cells, Whether or Not Partially or Fully Assembled into Other Products,* Inv. No. TA-201-075, 2017
Customs	U.S. Customs and Border Protection
DC	direct current
DOE	U.S. Department of Energy
EIA	U.S. Energy Information Agency
EVA	ethylene-vinyl acetate
GW	gigawatt
HIT	heterojunction with intrinsic thin layer
HTS	Harmonized Tariff Schedule of the United States
IRS	U.S. Internal Revenue Service
ITC	investment tax credit
ITRPV	International Technology Roadmap for Photovoltaic
kW	kilowatt
mono	monocrystalline
MW	megawatt
NREL	National Renewable Energy Laboratory
PERC	passivated emitter and rear contact
p-n	positive-negative junction

Abbreviation or Acronym	Definition
PRWs	production and related workers
PV	photovoltaic
R&D	research and development
SEIA	Solar Energy Industries Association
Trade Act	Trade Act of 1974
TRQ	tariff-rate quota
USITC	U.S. International Trade Commission
USTR	U.S. Trade Representative
W	watt
WoodMac	Wood Mackenzie
WTO	World Trade Organization

Executive Summary

This report contains the advice of the U.S. International Trade Commission (Commission or USITC) regarding the probable economic effect on the domestic crystalline silicon photovoltaic (CSPV) cell and module manufacturing industry of modifying the safeguard measure on CSPV products. Specifically, the Commission's advice pertains to the effect of increasing the level of the tariff-rate quota (TRQ) on CSPV cells (the integral component of CSPV modules) from the current 2.5 gigawatts (GW) to 4.0, 5.0, or 6.0 GW, without other changes to the remedy. This advice is provided in response to a request by the U.S. Trade Representative (USTR), pursuant to section 204(a)(4) of the Trade Act of 1974 (19 U.S.C. § 2254(a)(4)) (Trade Act), in a letter received by the Commission on December 6, 2019.

The Commission advises that increasing the level of the TRQ from 2.5 GW to 4.0, 5.0, or 6.0 GW would likely result in a substantial increase in U.S. module producers' production, capacity utilization, and employment. This is because U.S. module producers would gain expanded access to imported cells at lower prices (due to application of safeguard duties on fewer cells) during the remaining two years of the safeguard measure. Increasing the TRQ, and thus allowing module producers expanded access to imported cells that are not subject to safeguard duties, would increase the price competitiveness of U.S. modules and reduce imports of foreign modules. Although these modifications are unlikely to affect the one producer currently producing cells in the United States, module producers' expanded access to imported cells that are not subject to safeguard duties would put downward pressure on prices for U.S. cells and reduce the operating income and return on investment of U.S. producer Suniva, Inc. (Suniva), if it were to restart production of cells.

The Safeguard Measure

Following receipt of a report from the Commission on imports of CSPV products (*CSPV Safeguard Investigation*), the President issued Proclamation 9693 on January 23, 2018, under section 203 of the Trade Act (19 U.S.C. § 2253), imposing a safeguard measure on certain CSPV products. In addition to imposing duties on imports of CSPV modules, the safeguard measure imposed a TRQ on imports of CSPV cells for a period of four years. The TRQ allows 2.5 GW of imported cells to enter the United States duty free each year, but imports that exceed that volume are subject to additional duties. While the TRQ's in-quota quantity of 2.5 GW does not change from year to year, the rates of duty applicable to goods entered in excess of those quantities decline in the second, third, and fourth years.

The Commission submitted a report to the President and Congress on February 7, 2020, pursuant to section 204(a)(2) of the Trade Act (19 U.S.C. § 2254(a)(2)), on the results of its monitoring of developments with respect to the domestic industry producing CSPV products since the imposition of the safeguard measure (*CSPV Monitoring*). The present investigation (*CSPV Modification Advice*) provides advice on certain alternative modifications of the safeguard measure on CSPV products. In addition to developing new information from parties' written submissions and industry research, this investigation draws substantially on the information presented in *CSPV Monitoring* as well as the investigative records developed in that investigation and in the original safeguard investigation.

U.S. CSPV Industry and Market Trends

In his request letter for *CSPV Modification Advice*, the USTR requested that the Commission conduct its analysis based on the most recent available data. Taking into account this request, as well as the changing composition of the domestic industry and fluctuations in demand that are likely to occur over the two years remaining in the safeguard measure, this report assesses trends in the CSPV industry and market using primarily 2019 data, along with projections for supply and demand for 2020 and 2021. The use of market and industry data from 2019 and future projections, rather than from a historical time period, is possible in this investigation because of three factors: the relative availability of projections for this market provided by outside sources; submissions by interested parties of projections for future industrial indicators, provided in both *CSPV Monitoring* and *CSPV Modification Advice*; and the Commission's institutional knowledge of this market and industry.

The U.S. CSPV cell manufacturing industry remains small, with only one producer, Panasonic Solar North America (Panasonic), currently producing cells and with no confirmed new investments in U.S. cell manufacturing. Panasonic produces *** and has confirmed that it is ending cell and module production by the end of May 2020. Suniva, the petitioner in the original safeguard investigation that had filed for bankruptcy protection and ceased production of cells and modules in April 2017, successfully exited bankruptcy in April 2019. Although it has not resumed production of cells, Suniva stated during *CSPV Monitoring* that it would require an investment of less than $10 million and would take 100 days upon obtaining that investment to restart production of CSPV cells, which it would plan to sell commercially in the United States.

By contrast, the U.S. CSPV module manufacturing industry experienced significant growth during 2018–19, with the addition of large new manufacturing plants by firms such as Hanwha, LG, and Jinko. U.S. CSPV module production grew from *** in 2018 to *** in 2019. While U.S. CSPV module production did not exceed the 2.5 GW TRQ on imported cells in 2019, the industry's production is expected to exceed the 2.5 GW TRQ in 2020 and 2021. According to the most recently available data, U.S. imports of CSPV cells within the scope of the safeguard measure nearly reached the 2.5 GW TRQ during the February 7, 2019 to February 6, 2020 safeguard remedy year. These data indicate that module producers will likely need to acquire imported cells at volumes that surpass the 2.5 GW TRQ to produce modules at the levels projected for 2020 and 2021.

Imported CSPV modules continue to account for the majority of supply to the U.S. market, and these imports have generally tracked trends in apparent U.S. consumption. Apparent U.S. consumption of CSPV modules declined from 2016 to 2018, but then increased in 2019. It is projected to increase in 2020 and then to remain relatively steady in 2021 and 2022. Bifacial modules, which absorb light and generate electricity on each side of the panel, are expected to account for a significantly larger share of apparent U.S. consumption in the near term, particularly if certain bifacial modules remain excluded from the safeguard measure.

Probable Economic Effect of Certain Modifications to the Safeguard Measure

In order to assess the probable economic effect of modifications to the safeguard measure, the Commission examined how certain conditions in the CSPV market would affect the domestic industry producing cells and modules if the TRQ on cells were expanded. Building on this information, the Commission used an industry-specific partial-equilibrium model to estimate the effects of the modifications on (1) U.S. module production, trade, pricing, employment, and capacity utilization and (2) U.S. cell production, trade, pricing, employment, and operating income, taking into account the vertical link between cell and module production.

The Commission's analysis took several factors into account in order to estimate the effects of the alternative TRQs over the remaining duration of the safeguard measure. These factors included (1) projections for new additions to U.S. module production capacity and projections of demand over the next two years; (2) the changing nature of the remedy over the course of any given year due to the way the TRQ "fills" from month to month; (3) the implications if Suniva re-enters cell production in the United States; and (4) the safeguard measure's product exclusion for imports of bifacial modules, which is likely to have significant effects on prices and trade in both modules and cells.

The degree of economic effects on U.S. imports, production, pricing, employment, and operating income depends on the extent to which imports of cells exceed the in-quota amount not subject to safeguard duties, or "fill the TRQ," every year. These imports are more likely to do so in 2020 and 2021, given projected expansions of demand for CSPV modules and of U.S. capacity to produce modules in those years relative to 2019. The model estimates that the TRQ would fill in both 2020 and 2021 under both the 2.5 GW TRQ "status quo" scenario and the 4.0 GW TRQ modification scenario (albeit later in the year). However, it would not fill in either the 5.0 GW or 6.0 GW TRQ modification scenarios. Because the TRQ does not fill in either the 5.0 GW or 6.0 GW TRQ modification scenarios (allowing in-quota access for cells throughout each remedy year), the economic effects of these modifications are identical.

An increase in the TRQ would likely significantly improve the cost competitiveness and profitability of U.S. module manufacturers, which currently rely predominantly on imported cells due in part to a lack of domestic CSPV cell supply. Although cell imports entered into the United States have not surpassed the 2.5 GW in-quota limit, they are likely to do so in remedy years 2020 and 2021, as noted, due to the projected substantial increase in U.S. module production and subsequent greater demand for cells as inputs to this new production. As above-quota safeguard duties begin to apply to imported cells in 2020 and 2021 under the status quo scenario, U.S. module producers' costs would likely increase, forcing module producers to choose between lower profitability or higher prices and risked market share losses to lower-priced module imports. In either case, U.S.-produced modules will likely become less competitive with imported modules.

Therefore, raising the TRQ would reduce the tariff cost burden on U.S. module manufacturers, which in turn would alleviate some of these competitive pressures as they seek to maximize capacity utilization in their projected substantial new investments. The model estimates that for each of the 4.0, 5.0, and 6.0 GW TRQ alternatives, U.S. module production, capacity utilization, and module employment would substantially increase relative to their projected levels under the current 2.5 GW TRQ.

Specifically, the model estimates that, during the remaining two years of the safeguard measure, U.S. module production would increase by *** percent above the level projected under the 2.5 GW baseline in both 2020 and 2021 if the TRQ is increased to 4.0 GW and by *** percent in 2020 and *** percent in 2021 if the TRQ is increased to either 5.0 or 6.0 GW. U.S. module producers' employment would increase by *** production workers in 2020 and *** production workers in 2021 if the TRQ is increased to 4.0 GW and by *** production workers in 2020 and *** production workers in 2021 if the TRQ is increased to either 5.0 or 6.0 GW. U.S. module capacity utilization would increase from *** percent in 2020 and *** percent in 2021 under the 2.5 GW TRQ to *** and *** percent if the TRQ were expanded to 4.0 GW, and would reach *** and *** percent if the TRQ were expanded to 5.0 or 6.0 GW. These estimates assume that Suniva restarts production and that there is no exclusion for bifacial modules. The model also estimates results under alternative scenarios where Suniva does not restart production and bifacial modules continue to be excluded from the safeguard measure. Under most of the scenarios examined, the increases in U.S. module production, capacity utilization, and employment would occur as U.S. module producers that source their cells abroad benefit from lower cell import prices, given that more cell imports would not be subject to safeguard duties in each remedy year. The volume of U.S. imports of foreign-produced modules (including both those covered by the safeguard measure and those that are non-covered) would be lower under the modified TRQs than they would be under the current 2.5 GW TRQ, as U.S. module producers' expanded access to lower-priced imported cells would allow them to be more price competitive with imported modules, resulting in U.S. purchasers of modules sourcing more products locally. However, the benefits of raising the TRQ for module producers would be limited by the continued exclusion of bifacial module imports from the safeguard measure. In addition to having a price advantage over module imports covered by the safeguard measure under the current exclusion, bifacial modules are projected to gain a large share of total demand over the next several years due to the power-generation advantages of bifacial technology and their relative cost competitiveness with monofacial modules.

The extent to which a domestic cell producer is harmed by an increase in cell imports under any expanded TRQ depends in part on the types of cells that a company produces. Panasonic, currently the only U.S. cell producer, produces HIT heterojunction cells that have a limited market in the United States and are produced ***. It is unlikely that a TRQ increase would significantly affect Panasonic's production, sales, or employment, particularly given the announcement that Panasonic will end production by the end of May 2020.

If it re-entered the U.S. market, Suniva would have an incentive to maximize capacity utilization in order to spread out fixed costs and benefit from lower variable costs, and would likely employ 200 workers if it operated at full capacity. Suniva would likely produce PERC cells, which are commonly used in U.S. module manufacturing. However, Suniva's sales of cells to U.S. module manufacturers may be hindered by the large share of U.S. module production that uses different technology or that uses imported cells from foreign affiliates. Suniva would be directly competing with imported cells for its sales of cells to U.S. module manufacturers. Any reduction in import prices associated with an increase in the TRQ would reduce prices for Suniva's cells and in turn reduce its operating income and return on investment.

The model estimates that if the TRQ is expanded to 4.0, 5.0, or 6.0 GW, imports of cells would increase in response to higher demand for foreign cells from module producers, and prices for cells would decline. The model also estimates that if Suniva were to re-enter the market, producing cells at full capacity, it could generate positive operating income; however, its revenues would be substantially reduced if the TRQ were expanded, due to lower U.S. prices for cells. Model estimates indicating that Suniva can re-enter and generate positive operating income are based on the demand projections. If future demand is below these projections, it will reduce Suniva's revenue, and if future demand is low enough, Suniva will no longer be able to generate positive operating income. Suniva's re-entry into the industry would not substantially affect module producers' economic outcomes under any of the TRQ expansion alternatives.

Part I: Introduction and Overview

Objectives of the Report

This report, *Crystalline Silicon Photovoltaic Cells, Whether or Not Partially or Fully Assembled into Other Products: Advice on the Probable Economic Effect of Certain Modifications to the Safeguard Measure* (*CSPV Modification Advice*), provides the advice of the U.S. International Trade Commission (USITC or Commission) regarding the probable economic effect on the domestic crystalline silicon photovoltaic (CSPV) cell and module manufacturing industry of certain modifications to the safeguard measure on CSPV products.[1] This advice is provided in response to a request by the U.S. Trade Representative (USTR) in a letter received by the Commission on December 6, 2019.[2] In his request letter, the USTR asked that the Commission analyze the effect of increasing the level of the tariff-rate quota (TRQ) covering CSPV cells from the current 2.5 gigawatts (GW) to 4.0, 5.0, or 6.0 GW, without other changes to the remedy.[3] The letter further asked that the analysis employ economic modeling, entailing both qualitative

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[1] CSPV cells use crystalline silicon to convert sunlight to electricity and are the basic elements of a CSPV module. They have a positive layer, a negative layer, and a positive-negative junction (p–n junction). Electricity is generated when sunlight strikes the CSPV cell, knocking electrons loose that flow onto thin metal "fingers" that run across the CSPV cell and conduct electricity to the busbars (which are interconnected during the module manufacturing process so that electricity is carried off the cell). Cells are the essential elements in CSPV modules (also commonly referred to as panels), which in turn are the main components of CSPV systems. CSPV systems convert sunlight into electricity for on-site use or for distribution through the electric grid.

CSPV modules typically consist of a laminate that is framed in aluminum and then attached to a junction box. A CSPV laminate is composed of CSPV cells that are connected, encapsulated in an ethyl vinyl acetate (EVA) film, and covered with a glass front layer and a back sheet. The back sheet is most commonly a plastic film composite, though glass is also used in some applications, such as certain bifacial CSPV modules. USITC, *CSPV Monitoring,* 2020, I-54, I-56.

[2] See appendix A. USTR's request for probable economic effect advice was made pursuant to section 204(a)(4) of the Trade Act of 1974 (19 U.S.C. § 2254(a)(4)) (Trade Act). Section 204(a)(4) of the Trade Act requires the Commission, upon request of the President, to advise the President of its judgment as to the probable economic effect on the industry concerned of any reduction, modification, or termination of the action taken under section 203 of the Trade Act (a safeguard measure) that is under consideration. The President has delegated certain authority to the USTR for this purpose.

[3] A tariff-rate quota combines a quantity limit and a tariff on specified products. Imports entering during a specific time period at levels below a specified quantity are subject to a lower, or sometimes a free, duty rate. Imports above the quantitative threshold face a higher duty but are allowed entry, unlike absolute quotas.

This report discusses data in terms of watts (W); kilowatts (kW, equal to 1,000 watts); megawatts (MW, or 1,000 kW); and gigawatts (GW, or 1,000 MW).

and quantitative analysis, and that it be based on the most recent available data. This report addresses those requests.

As described in greater detail below, the Commission recently prepared a report under section 204(a)(2) of the Trade Act of 1974 (19 U.S.C. § 2254(a)(2)) (Trade Act), entitled *Crystalline Silicon Photovoltaic Cells, Whether or Not Partially or Fully Assembled into Other Products: Monitoring Developments in the Domestic Industry* (*CSPV Monitoring*).[4] As part of that investigation, the Commission obtained significant recent information about the domestic industry, imports, and developments relating to the covered products through questionnaire responses, submissions by interested parties, a public hearing, and additional industry research. *CSPV Modification Advice* derives much of its background information from *CSPV Monitoring* and its investigative record, and is meant to be read in conjunction with *CSPV Monitoring* for purposes of understanding the product, industry, and market. *CSPV Modification Advice* also includes information gathered from additional industry research and review of written submissions, and responses to those submissions, from interested parties provided in response to a notice of investigation the Commission published announcing initiation of this investigation on the probable economic effects of certain modifications to the safeguard measure.[5]

Organization of the Report

Part I of this report presents the purpose of *CSPV Modification Advice*, summarizes other Commission investigations involving CSPV products, explains the scope of the safeguard measure, and describes the CSPV safeguard measure in its current form, including product exclusions. Part II presents industry and market information that was used to establish the baseline for the economic model, including demand forecasts and an overview of the U.S. cell and module industries. Part III provides quantitative and qualitative analysis of the probable economic effects of the three alternative safeguard measure modifications identified in the request letter from USTR.

The Safeguard Investigation

The investigation relating to imports of CSPV products originated with the filing of a petition on May 17, 2017, under section 202(a) of the Trade Act (19 U.S.C. § 2552(a)) by counsel for Suniva, Inc. (Suniva). The petition alleged that certain CSPV products were being imported into the United States in such increased quantities as to be a substantial cause of serious injury,

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[4] USITC, *CSPV Monitoring,* 2020.

[5] Appendix B contains information regarding the Commission's Notice of Investigation and appendix C a summary of the views provided by interested parties to this investigation.

or threat thereof, to the domestic industry producing an article like or directly competitive with the imported article.

The Commission conducted an investigation under section 202(b)(1)(A) of the Trade Act (19 U.S.C. § 2552(b)(1)(A)). The President received the resulting report from the Commission in November 2017 under section 202 of the Trade Act (19 U.S.C. § 2252). Given that the report contained an affirmative serious injury determination and remedy recommendations, the President, on January 23, 2018, pursuant to section 203 of the Trade Act (19 U.S.C. § 2253), issued Proclamation 9693 imposing a safeguard measure in the form of (a) a tariff-rate quota on imports of CSPV (or "solar") cells not partially or fully assembled into other products and (b) an increase in duties on imports of CSPV modules for a period of four years, effective February 7, 2018.[6]

Scope of the Safeguard Measure

According to Presidential Proclamation 9693, the safeguard measure covers the CSPV products effective with respect to goods entered, or withdrawn from warehouse for consumption, on or after February 7, 2018, and through February 6, 2022.[7] Such products include:

> *(a) solar cells, whether or not assembled into modules or made up into panels{…};*
> *(b) parts or subassemblies of solar cells{…};*
> *(c) inverters or batteries with CSPV cells attached{…}; and*
> *(d) DC generators with CSPV cells attached{…}.*

In further defining the merchandise covered by the safeguard measure, Presidential Proclamation 9693 defines CSPV cells and CSPV modules:

> *{…} the term "crystalline silicon photovoltaic cells" ("CSPV cells") means crystalline silicon photovoltaic cells of a thickness equal to or greater than 20 micrometers, having a p/n junction (or variant thereof) formed by any means, whether or not the cell (or subassemblies thereof. . .) has undergone other processing, including, but not limited to, cleaning, etching, coating, and/or addition of materials (including, but not limited to, metallization and conductor patterns) to collect and forward the electricity that is generated by the cell. Such cells include photovoltaic*

[6] USITC, *CSPV Safeguard Investigation*, 2017. For a summary of data collected on CSPV products from the original safeguard investigation, see USITC, *CSPV Monitoring*, 2020, appendixes C and D. 83 Fed. Reg. 3541 (January 25, 2018). The duties on modules do not apply to modules comprised of cells made in the United States.

[7] 83 Fed. Reg. 3541 (January 25, 2018).

cells that contain crystalline silicon in addition to other photovoltaic materials. This includes, but is not limited to, passivated emitter rear contact cells, heterojunction with intrinsic thin-layer cells, and other so-called hybrid cells. . . .{Included are} goods presented in cell form and which at the time of importation are not presented assembled into circuits, laminates or modules or made up into panels.

{…} a module is a joined group of CSPV cells {…} regardless of the number of cells or the shape of the joined group, that are capable of generating electricity. Also included as a "module" are goods each known as a "panel" comprising a CSPV cell that has undergone any processing, assembly, or interconnection (including, but not limited to, assembly into a laminate). Such CSPV cells assembled into modules or made up into panels include {…} (i) CSPV cells which are presented attached to inverters or batteries {…}; and (ii) CSPV cells classifiable as DC generators{…}.

CSPV cells, whether or not partially or fully assembled into other products, are not covered by the safeguard measure if such CSPV cells were manufactured in the United States.

Presidential Proclamation 9693 explicitly states that the safeguard measure does not cover a variety of specific CSPV and other solar products. Pursuant to authority provided by the President, the USTR on two separate occasions (September 2018 and June 2019) determined that additional CSPV products should be excluded from the safeguard measure, including bifacial modules ("bifacial module exclusion") and rear contact modules.[8]

The bifacial module exclusion is of particular importance in the forward-looking analysis of this report. As described in Part III, the bifacial module exclusion will likely result in substantial increases in imports of bifacial modules if it remains in effect, and such modules will

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[8] Bifacial CSPV cells convert light that hits both the front and the back of the CSPV cell into electricity. While monofacial CSPV cells have a metalized back layer, bifacial cells allow light through to the back side of the CSPV cell. When bifacial cells are assembled into CSPV modules, the modules' transparent back sheet or rear glass layer allows sunlight to reflect onto the rear of the CSPV cells. This results in additional electricity generation. Monofacial modules typically have a nontransparent back sheet, and only absorb light on one side of the modules. For additional information describing bifacial product technology, see USITC, *CSPV Monitoring*, 2020, I-74 to I-76.

Some manufacturers place metal contacts onto the rear side of the CSPV cell, creating back (or rear contact) cells. This provides several advantages such as reduced shading, improved cell interconnection, and better aesthetics. Rear contact cells and modules were excluded from the safeguard with respect to goods entered into the United States, or withdrawn from a U.S. warehouse for consumption, on or after September 19, 2018. For more on these products, see USITC, *CSPV Monitoring,* 2020, I-12, I-73.

See USITC, *CSPV Monitoring*, 2020, I-9 to I-13, for additional information about specific safeguard measure product exclusions.

likely compete with domestically produced CSPV products in the U.S. market. Going forward, the status of the bifacial module exclusion is uncertain.[9]

The safeguard measure is applicable to imports from all countries, except for imports from certain developing countries that are members of the WTO, as long as such a country's share of total imports of the product, based on imports during a recent representative period, does not exceed 3 percent, provided that imports that are the product of all such countries with less than 3 percent import share collectively account for not more than 9 percent of total imports of the product.[10]

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[9] In October 2019, the USTR subsequently withdrew the exclusion for bifacial solar panels. After evaluating newly available information demonstrating that global production of bifacial solar panels is increasing, that the exclusion will likely result in significant increases in imports of bifacial solar panels, and that such panels likely will compete with domestically produced monofacial and bifacial CSPV products in the U.S. market, the USTR determined, after consultation with the Secretaries of Commerce and Energy, that maintaining the exclusion will undermine the objectives of the safeguard measure. 84 Fed. Reg. 54244 (October 9, 2019).

On October 25, 2019, after a complaint was filed challenging the withdrawal of this exclusion, the U.S. Court of International Trade (CIT) issued an order extending the effective date of the withdrawal of the exclusion to November 8, 2019. Court Order, *Invenergy Renewables LLC v. United States*, Ct. No. 19-00192 (Oct. 25, 2019) (ECF No. 29). On November 7, 2019, the CIT granted a temporary restraining order barring the USTR and U.S. Customs and Border Protection (Customs) from withdrawing the bifacial exclusion until November 21, 2019, or until the CIT ruled on the motion for a preliminary injunction. Court Order, *Invenergy Renewables LLC v. United States*, Ct. No. 19-00192 (Nov. 7, 2019) (ECF No. 68). On December 5, 2019, the CIT issued an order preliminarily enjoining USTR and Customs from withdrawing the exclusion until entry of final judgment in the case. Court Order, *Invenergy Renewables LLC v. United States*, Ct. No. 19-00192 (Dec. 5, 2019) (ECF No. 114).

On January 27, 2020, the USTR published a notice and request for comments, establishing procedures for interested persons to submit comments, and respond to comments, on whether the USTR should maintain the exclusion of bifacial solar panels from the safeguard measure, withdraw the exclusion, or take some other action within his authority with respect to this exclusion. 85 Fed. Reg. 4756 (January 27, 2020); *see also Invenergy Renewables LLC v. United States*, Ct. No. 19-00192 (Feb. 14, 2020) (ECF No. 150) (rejecting the plaintiff's motion challenging USTR's notice).

[10] The countries listed in Presidential Proclamation 9693 as developing countries that are World Trade Organization (WTO) members are: Afghanistan, Albania, Algeria, Angola, Armenia, Azerbaijan, Belize, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Burkina Faso, Burma, Burundi, Cambodia, Cameroon, Cabo Verde, Central African Republic, Chad, Comoros, Republic of the Congo (Brazzaville), Democratic Republic of the Congo (Kinshasa), Côte d'Ivoire, Djibouti, Dominica, Ecuador, Egypt, Eritrea, Ethiopia, Eswatini, Fiji, Gabon, The Gambia, Georgia, Ghana, Grenada, Guinea, Guinea-Bissau, Guyana, Haiti, India, Indonesia, Iraq, Jamaica, Jordan, Kazakhstan, Kenya, Kiribati, Kosovo, Kyrgyzstan, Lebanon, Lesotho, Liberia, Macedonia, Madagascar, Malawi, Maldives, Mali, Mauritania, Mauritius, Moldova, Mongolia, Montenegro, Mozambique, Namibia, Nepal, Niger, Nigeria, Pakistan, Papua New Guinea, Paraguay, Rwanda, Saint Lucia, Saint Vincent and the Grenadines, Samoa, São Tomé and Principe, Senegal, Serbia, Sierra Leone, Solomon Island, Somalia, South Africa, South Sudan, Sri

Tariff-rate Quota under the Safeguard Measure

The safeguard measure imposed a TRQ on imports of CSPV cells for a period of four years, with unchanging in-quota quantities and annual reductions in the rates of duty applicable to goods entered in excess of those quantities in the second, third, and fourth years. The annual aggregate in-quota quantity of CSPV cell imports not exceeding 2.5 GW in each year under the TRQ are allocated among all countries, except those that are specifically excluded. Table I-1 presents the safeguard TRQ measure on CSPV cells.

Table I-1
CSPV cells: Safeguard TRQ measure on cells

Period	Safeguard duty on first 2.5 GW of imported cells	Safeguard duty on imported cells exceeding 2.5 GW (percent)
February 7, 2018–February 6, 2019	--	30
February 7, 2019–February 6, 2020	--	25
February 7, 2020–February 6, 2021	--	20
February 7, 2021–February 6, 2022	--	15

Source: 83 Fed. Reg. 3541 (January 25, 2018).

Import Duties under the Safeguard Measure

The safeguard measure imposed additional duties on imports of CSPV modules for a period of four years, with annual reductions in the rates of duty in the second, third, and fourth years. The additional duty is imposed on the declared value of CSPV modules, including the cost or value of the non-cell portions of the modules (such as aluminum frames). Table I-2 presents the import duties under the safeguard measure on CSPV modules.

Lanka, Suriname, Tanzania, Timor-Leste, Togo, Tonga, Tunisia, Turkey, Tuvalu, Uganda, Ukraine, Uzbekistan, Vanuatu, Yemen, Zambia, and Zimbabwe. If the President determines that a surge in imports of CSPV products from a developing country that is a WTO member results in imports of that product from that developing country exceeding either of the thresholds described, the safeguard measure shall be modified to apply to such product from such country.

Turkey was removed from the list as of May 17, 2019. India was removed from the list as of June 5, 2019. Proclamation to Modify the List of Beneficiary Developing Countries Under the Trade Act of 1974, May 16, 2019, https://www.whitehouse.gov/presidential-actions/proclamation-modify-list-beneficiary-developing-countries-trade-act-1974/; Proclamation to Modify the List of Beneficiary Developing Countries Under the Trade Act of 1974, May 31, 2019, https://www.whitehouse.gov/presidential-actions/proclamation-modify-list-beneficiary-developing-countries-trade-act-1974-2/.

Table I-2
CSPV modules: Safeguard measure on modules

Period	Safeguard duty on imported modules (percent)
February 7, 2018–February 6, 2019	30
February 7, 2019–February 6, 2020	25
February 7, 2020–February 6, 2021	20
February 7, 2021–February 6, 2022	15

Source: 83 Fed. Reg. 3541 (January 25, 2018).

CSPV Monitoring Summary

Following imposition of the safeguard measure, the Commission proceeded to monitor developments with respect to the domestic industry, as required by section 204(a)(1) of the Trade Act. Because the safeguard measure was imposed for a period that exceeded three years, the Commission instituted an investigation on July 25, 2019, for the purpose of preparing a report to the President and Congress, required by section 204(a)(2) of the Trade Act, on the results of its monitoring of developments with respect to the domestic industry.[11] The Commission submitted *CSPV Monitoring* to the President and Congress on February 7, 2020, the midpoint of the relief period.

As previously mentioned, *CSPV Modification Advice* draws on the information presented in *CSPV Monitoring* and refers to *CSPV Monitoring* for supporting information throughout. The earlier report, *CSPV Monitoring,* summarized several major trends in the U.S. CSPV market and industry, stating:

> *Following the imposition of the safeguard measure effective February 7, 2018, there have been a number of significant developments with respect to the domestic industry for CSPV products, including U.S. producer entries and exits from the industry, changes in import volumes, and generally decreased prices. The price declines for CSPV cells and modules were directionally consistent with the historical downward trend in prices for CSPV products, though parties agreed that the prices were higher than they would have been without the safeguard measure.*

[11] 84 Fed. Reg. 37674 (August 1, 2019). Section 204(a)(1) of the Trade Act (19 U.S.C. § 2254(a)(1)) requires the Commission, so long as any action under section 203 of the Trade Act remains in effect, to monitor developments with respect to the domestic industry, including the progress and specific efforts made by workers and firms in the domestic industry to make a positive adjustment to import competition. Section 204(a)(2) of the Trade Act requires that whenever the initial period of an action under section 203 exceeds three years, the Commission shall submit a report on the results of the monitoring under section 204(a)(1) to the President and the Congress not later than the midpoint of the initial period of relief during which the action is in effect.

With respect to CSPV cells, following the imposition of the safeguard measure, imports increased from 2017 to 2018 and were higher in the first half of 2019 compared with the first half of 2018. Some of the major U.S. CSPV cell producers ceased production, leading to declines in domestic cell production capacity and production from 2017 to 2018 and from the first half of 2018 to the first half of 2019, and only one cell producer remained in operation in the first half of 2019. Employment at U.S. CSPV cell production facilities initially declined from 2017 to 2018 but was higher in the first half of 2019 compared with the first half of 2018. The financial performance of the cell producers generally declined. Additionally, there were changes to the character of certain U.S. CSPV cell operations (i.e., Suniva bankruptcy and SunPower acquisition of SolarWorld) that affected the implementation of adjustment plans.

With respect to CSPV modules, imports initially declined from 2017 to 2018 but were higher in the first half of 2019 compared with the first half of 2018. Multiple large CSPV module producers opened production facilities in the United States particularly in the first half of 2019, leading to increases in domestic module production capacity, production, and market share from 2017 to 2018 and from the first half of 2018 to the first half of 2019. Employment at U.S. CSPV module production facilities initially declined from 2017 to 2018 but was higher in the first half of 2019 compared with the first half of 2018. The U.S. module producers' financial performance showed mixed results.[12]

Antidumping and Countervailing Duty Investigations and Tariff Treatment[13]

In addition to the safeguard measure, imports of CSPV products have been the subject of antidumping and countervailing duty investigations, resulting in the imposition of antidumping and countervailing duty orders on imports of CSPV cells and modules from China and Taiwan.[14] CSPV products from China are also subject to additional tariffs under section 301

[12] USITC, *CSPV Monitoring,* 2020, 1.

[13] For more detailed information on these investigations, see USITC, *CSPV Monitoring,* 2020, I-3 to I-9.

[14] The first set of antidumping and countervailing duty investigations (*CSPV 1*) covered CSPV cells and modules from China (Inv. Nos. 701-TA-481 and 731-TA-1190), and was completed in December 2012. The scope of this investigation included modules assembled outside of China using Chinese CSPV cells, but not the reverse: the scope of the *CSPV 1* orders did not include U.S. imports of CSPV modules assembled in China from CSPV cells made in a country other than China. See 77 Fed. Reg. 73017 and

of the Trade Act.[15] Imports of CSPV products subject to the safeguard measure are primarily provided for in subheading 8541.40.60 of the *Harmonized Tariff Schedule of the United States* (HTS) and are free of duty under the general duty column.[16]

73018 (December 7, 2012); USITC, *CSPV 2 Original Publication*, 2015, 3–4. The second set of antidumping and countervailing duty investigations (*CSPV 2*) covered CSPV cells and modules from China and Taiwan (Inv. Nos. 701-TA-511 and 731-TA-1246-1247), and was completed in February 2015. In these investigations, the module assembly location determined the country of origin for U.S. imports of modules from China, and the cell manufacture location determined the country of origin for U.S. imports of cells and modules from Taiwan. See 80 Fed. Reg. 8592 and 8596 (February 18, 2015); USITC, *CSPV 2 Original Publication*, 2015, 3–4, 6.

[15] CSPV modules and cells, which are primarily classified in HTS subheading 8541.40.60, were included in the list of articles subject to additional 25 percent ad valorem duties effective August 23, 2018. 83 Fed. Reg. 40823, August 16, 2018.

[16] USITC, *CSPV Monitoring,* 2020, I-15.

Part II: Overview of U.S. CSPV Industry and Market

The U.S. industry producing crystalline silicon photovoltaic (CSPV) cells remains small, with only one current U.S. cell producer (Panasonic); one other, Suniva, seeking to restart production; and no confirmed new investments in U.S. cell manufacturing. U.S. CSPV module manufacturing capacity, on the other hand, substantially increased in 2019, and is expected to grow further in 2020, due to investments by major international suppliers and expansions by current U.S. module producers.[1]

At the same time, the quantity of U.S. cell and module imports reached record levels in 2019. The increase in cell imports was driven by higher domestic CSPV module production. The rise in module imports was due to an increase in CSPV project construction and increased purchases of modules in 2019 for future installation projects in order to qualify projects for the 30 percent investment tax credit, as discussed in *CSPV Monitoring*.[2] U.S. imports of bifacial modules (a subset of overall module imports) also substantially increased in the second half of 2019 in response to increasing demand for these products and their exclusion from the safeguard measure. In January 2020, bifacial modules *** the announcement of the exclusion. Reflecting increased domestic production and imports, apparent U.S. consumption of CSPV modules totaled *** in 2019, and is forecast to exceed *** annually during 2020–22.

The analysis in this section will provide an overview of the U.S. CSPV industry and market, focusing on full-year 2019 data and projections through 2022.[3] The first section gives a detailed overview of the CSPV cell industry, specifically focusing on Panasonic (the only cell producer that was active in 2019) and Suniva, which has emerged from bankruptcy and is seeking to restart production.[4] The remaining sections will cover the U.S. CSPV module industry, U.S. imports of CSPV cells and modules, and apparent U.S. consumption of CSPV modules. Cost,

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[1] USITC, *CSPV Monitoring,* 2020, I-39 to I-41; USITC, *CSPV Monitoring* hearing transcript, December 5, 2019, 70 (Rashid) and 72 (Mutchler).

[2] USITC, *CSPV Monitoring*, 2020, II-13, II-17 to II-18, II-26; WoodMac and SEIA, *U.S. Solar Market Insight Q4 2019*, Executive Summary, December 2019, 9, 17; Groom, "Expiring U.S. Solar Subsidy Spurs Rush for Panels," July 19, 2019; Roselund, "PV Module Shipments Spiked in September," November 15, 2019; Bloomberg, "US Solar Companies Are Stockpiling a Massive Amount," November 13, 2019.

[3] This chapter will primarily discuss trends on a calendar year basis, though some of these are included in the model on a monthly basis as described in appendix D.

[4] Panasonic accounted for *** U.S. CSPV cell production in the first half of 2019. U.S. CSPV cell production in 2016, the last year that Suniva and SunPower were active cell producers for the full year, totaled ***. U.S. CSPV cell production declined to *** in 2017, *** in 2018, and *** during January to June 2019. USITC, *CSPV Monitoring,* 2020, III-11.

employment, and price data are discussed in part III, and the methodology for calculating data used in the model is described in appendix D. For additional historical information on the industry and market, see *CSPV Monitoring*.[5]

U.S. CSPV Cell Industry

Panasonic[6]

Panasonic is the only active cell producer in the United States, with production in Buffalo, New York. The cell technology that Panasonic produces is known as "heterojunction with intrinsic thin layer" (HIT).[7] Panasonic produced *** of these cells during January to June 2019 and had an annualized production capacity of ***. The firm projects cell production of *** in 2020.[8] Panasonic ***, as it ***.[9] In the first half of 2019, Panasonic *** of cells and *** as of the end of June 2019.[10] These cells are ***.[11] Exports accounted for *** of Panasonic's cell shipments in the first half of 2019. Panasonic employed an average of *** production and related workers (PRWs) in cell production in the first half of 2019. On January 26, 2020, Panasonic announced that it would stop production of cells and modules in Buffalo by the end of May 2020.[12]

[5] USITC, *CSPV Monitoring,* 2020.

[6] This section is based on USITC, *CSPV Monitoring,* 2020, III-6 to III-7, and Panasonic's *CSPV Monitoring* U.S. producer questionnaire, unless otherwise noted.

[7] Heterojunction CSPV cells add thin layers of photosensitive semiconductor materials (typically amorphous silicon) on top of a monocrystalline wafer. These additional layers increase the absorption of sunlight and the overall efficiencies of the CSPV cells. They also perform better in hot climates than typical monocrystalline cells. The share of CSPV cell production accounted for by heterojunction cells is expected to increase substantially over the next decade. USITC, *CSPV Monitoring,* 2020, I-78; Panasonic website, https://www.panasonic.com/global/corporate/technology-design/technology/hit.html and https://eu-solar.panasonic.net/en/panasonic-hit-sanyo-history.htm (accessed January 23, 2020).

[8] ***.

[9] Panasonic also produced *** of CSPV modules during January–June 2019, and has an annualized production capacity of ***.

[10] As will be discussed in part III, the ***.

[11] ***.

[12] There are no changes in Tesla production and employment at the plant. This announcement was made after most of this report was prepared, but does not have a significant impact on the analysis and conclusions, as will be discussed in part III. Panasonic, "Panasonic to Wind Down," February 26, 2020; Yamazaki and Groom, "Panasonic to Exit Solar Production," February 25, 2020.

Suniva[13]

Suniva stopped producing CSPV cells in April 2017, when the firm filed for bankruptcy protection. Before this, it produced monocrystalline (mono), including passivated emitter rear contact (PERC), cells and modules.[14] ***. In April 2019, Suniva successfully completed a reorganization and exited bankruptcy with a court-approved restructuring plan. The company is now under new U.S. ownership (Granite Holdings I, LLC c/o Lion Point Capital) ***.

Suniva stated that it would take 100 days and less than $10 million to restart production after receiving the necessary capital investment. Suniva said that its annual production capacity, upon restarting production, would be 450 MW of mono PERC cells (monofacial) or up to 540 MW of bifacial mono PERC cells. It plans to sell its cells to other firms, and does not plan to restart module assembly operations or contract with other firms to produce Suniva-branded

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[13] This section is based on USITC, *CSPV Monitoring,* 2020, III-3 to III-4, and Suniva's U.S. producer *CSPV Monitoring* questionnaire, unless otherwise noted.

Suniva manufactures p-type cells, which is the type of cell most commonly used in global CSPV production. In the production of p-type monocrystalline (mono) CSPV wafers, the silicon is doped with boron to create a positive electrical orientation. Some firms also produce n-type cells. In the production of n-type mono wafers, the silicon is doped with phosphorous to create a negative electrical orientation. In the CSPV cell production process, a positive layer is added to create the positive–negative (p–n) junction. CSPV n-type cells can be more expensive to produce, but have a number of benefits such as higher conversion efficiencies, no light-induced degradation, and the potential use of less-pure wafers. See USITC, *CSPV Monitoring*, 2020, I-78 to I-79.

[14] Monocrystalline cells are made from a single grown crystal and tend to convert sunlight into electricity more efficiently than multicrystalline cells. Multicrystalline (also known as polycrystalline) cells have a random crystal structure and tend to have a lower conversion efficiency (the percent of sunlight that is converted to electricity). However, there are a range of conversion efficiencies for both monocrystalline and multicrystalline CSPV modules, and there are various products within these two categories.

PERC CSPV cells incorporate an additional rear dielectric layer that reflects light that did not generate electricity as it initially passed through the CSPV cell back into the CSPV cell. There is, therefore, another opportunity for the CSPV cell to absorb this light. PERC cells have higher efficiency, as well as better performance in certain conditions, such as low-light and high-heat environments. USITC*, CSPV Monitoring,* 2020, I-80.

modules.[15] Suniva stated that it expects to employ over 200 people after restarting operations.[16]

Other U.S. Cell Manufacturing

There are no other firms that transform wafers into CSPV cells in the United States.[17] Solaria Corp. (Solaria) ***.[18] Equipment manufacturer Meyer Burger Technology Ltd. (Meyer Burger) reportedly has signed a $101 million contract for cell production equipment with a North American startup, subject to the startup raising the necessary funding.[19] In November 2019, Meyer Burger indicated that the startup was still seeking to raise the necessary capital.[20] No other information is available on the firm that signed the contract or whether manufacturing would take place in the United States. Additionally, in September 2018, Sunpreme, Inc. (Sunpreme)—which produces cells in China for assembly into modules in the Philippines—announced plans to open the first phase of a U.S. cell and module plant in early 2019 and a second phase in late 2019, depending on funding. But there is no evidence that such facilities have come online or that the firm is still pursuing such an investment.[21]

U.S. CSPV Module Industry

The U.S. CSPV module industry experienced significant growth during 2018–19 with the addition of new, large manufacturing plants by firms such as Hanwha Q Cells USA Corp. (Hanwha), LG Electronics U.S.A., Inc. (LG), and Jinko Solar U.S. Industries, Inc. (Jinko), as detailed in *CSPV Monitoring*.[22] U.S. CSPV module production capacity increased from *** in 2018

[15] USITC, *CSPV Monitoring* hearing transcript, December 5, 2019, 91.
[16] Suniva *CSPV Monitoring* prehearing brief, November 26, 2019, attachment 12.
[17] Crystalline silicon wafers are transformed into cells as part of the CSPV manufacturing process. For the steps in the CSPV cell manufacturing process, see USITC, *CSPV Monitoring,* 2020, I-65 to I-67.
[18] *** Solaria U.S. producer *CSPV Safeguard* questionnaire at II-9; USITC, *CSPV Monitoring,* 2020, I-38.
[19] Hutchins, "Someone Is Building a Heterojunction Cell Factory," July 22, 2019.
[20] Meyer Burger, "Meyer Burger Gives Update," November 4, 2019.
[21] Merchant, "Sunpreme Plans Texas Cell and Module," September 27, 2019; Pickerel, "Sunpreme Hybrid Solar Cells," June 18, 2019.
[22] USITC, *CSPV Monitoring,* 2020, I-39 to I-41.

to *** in full year 2019, and is projected to reach *** in 2020 and *** in 2021 (figure II-1). Module production capacity exceeded the level of the tariff-rate quota (TRQ) for CSPV cells by *** in 2019 and is estimated to exceed the level of the TRQ for CSPV cells by *** in 2020 and *** in 2021.[23]

Figure II-1
Estimated U.S. CSPV module production capacity, 2018–21

*   *   *   *   *   *   *

[23] For the purposes of this report, it is assumed that all cells are consumed in module production, though a small share may go into off-grid products, and ***. Further, it is assumed that the combined output of cells that go into a module is equal to the power output of the module. On a global basis, the cell-to-module power ratio for mono modules with full cells was greater than 98 percent in 2019, and the ratio for modules with half-cut cells was more than 100 percent. (Half-cut cells result in lower cell currents and, therefore, reduce power losses and increase cell efficiency and module output.) International Technology Roadmap for Photovoltaic (ITRPV), *Results 2018 Including Maturity Report*, October 2018, 38; USITC, *CSPV Monitoring,* field notes, Hanwha Q Cells USA Corp., Dalton, Georgia, October 30, 2019; data submitted in response to *CSPV Monitoring* questionnaires; *CSPV Modification Advice* written submissions; *CSPV Modification* briefs; and USITC, *CSPV Monitoring,* 2020, I-39 to I-41, I-46, I-78.

U.S. CSPV module production increased from *** in 2018 to *** in 2019 (figure II-2). U.S. producers project that their module production will increase to about *** in 2020 and *** in 2021. Based on projections provided by these producers, U.S. module production will exceed the TRQ by *** in 2020 and *** in 2021.[24]

Figure II-2
U.S. CSPV module production, 2018–21, based on firm information and projections

*　　*　　*　　*　　*　　*　　*

Almost all U.S. module production was shipped to customers in the United States. U.S. exports of CSPV modules declined from *** in 2016 to *** in 2018, and there were *** exports in the first half of 2019.[25] Exports are *** during 2019–22. Of the firms that provided written submissions for this investigation, ***

[24] This estimate is based primarily on forecasts provided by firms and is not a Commission projection based on quantitative modeling analysis, which will be provided in part III.

[25] Compiled from data submitted in response to *CSPV Monitoring* questionnaires.

exported modules in 2019, with exports totaling ***. *** indicated that it plans to export during 2020–21, with expected exports of *** in 2020 and *** in 2021.[26]

U.S. Imports

U.S. CSPV Cell Imports

U.S. imports of CSPV cells increased from 0.8 GW in 2018 to 2.5 GW in 2019, while the value of imports increased from $261 million in 2018 to $437 million in 2019. The unit value of imports declined from $0.312 per watt in 2018 to $0.173 per watt in 2019. The largest sources of imports in the first half of 2019, by quantity, were South Korea (50 percent of imports), Taiwan (15 percent), Vietnam (10 percent), Malaysia (8 percent), Japan (7 percent), and China (7 percent).[27] As of February 3, 2020, imports of CSPV cells subject to the safeguard measure during the year ending February 6, 2020, totaled 2.33 GW, accounting for 93 percent of the 2.5 GW of cells that are eligible to enter without paying safeguard duties.[28]

U.S. module producers appear to have had large inventories of imported cells available at the end of 2019. U.S. imports of CSPV cells exceeded the number of cells required for domestic module production using imported cells by more than *** in 2018 and by more than *** in 2019 (figure II-3). Estimated U.S. cell inventories, therefore, exceeded *** at the end of 2019.[29]

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[26] ***.

[27] Data for 2018 are based on *CSPV Monitoring*, while data for 2019 are based on official import statistics. USITC, *CSPV Monitoring,* 2020, V-12 to V-13; USITC DataWeb/USDOC (accessed February 9, 2020).

[28] U.S. Customs and Border Protection, “Commodity Status Report,” https://www.cbp.gov/document/report/commodity-status-report, February 3, 2020.

[29] There may have been some inventory carryover from prior years, but this is difficult to determine, given producer entries and exits. Further, most U.S. production capacity is by firms that newly entered in 2018 and 2019 that would not have inventory carryover from prior years. Based on U.S. imports in HTS 8541.40.6025 and data submitted in response to *CSPV Monitoring* questionnaires; *CSPV Modification Advice* written submissions; *CSPV Monitoring* briefs; proprietary U.S. Customs records; and company financial reports.

Figure II-3
U.S. CSPV module production using imported cells, and U.S. cell imports, 2018–19

* * * * * * *

U.S. CSPV Module Imports

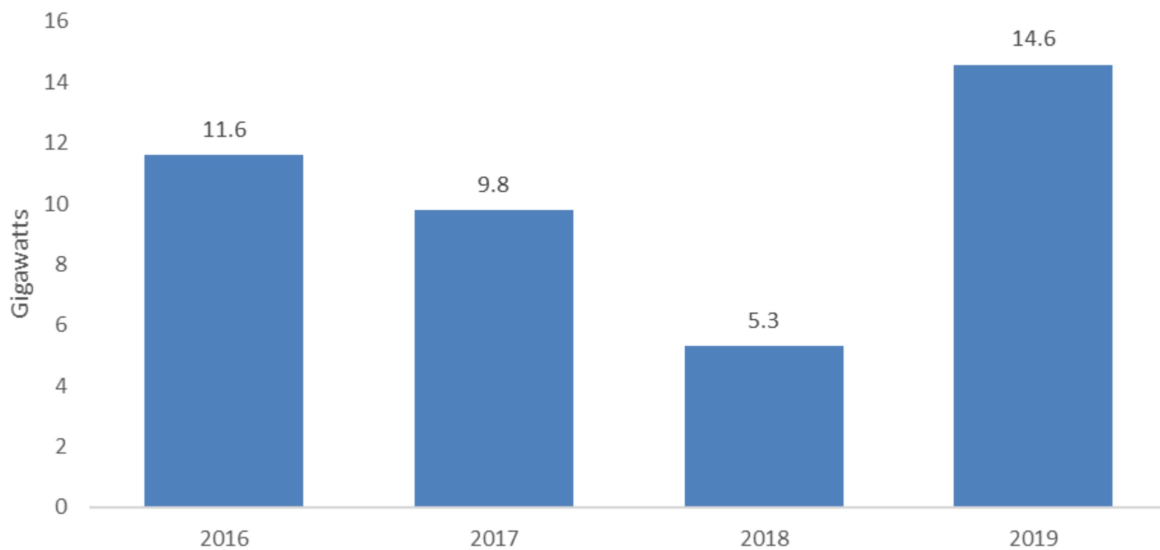
U.S. imports of CSPV modules, including products excluded from the safeguard measure, decreased from 11.6 GW in 2016 to 5.3 GW in 2018, then increased to 14.6 GW in 2019 (figure II-4).[30] The high level of imports in 2019 was driven, in part, by firms importing modules early so that project developers, installers, and other firms could qualify for the higher investment tax credit rate that applied to photovoltaic (PV) project construction begun in 2019. The credit is slated to decline in 2020 for construction begun during that year.[31] The value of imports

[30] USITC, *CSPV Monitoring,* 2020, V-20; USITC DataWeb/USDOC (accessed February 9, 2020).

[31] The investment tax credit is a tax credit that applies to certain capital expenditures, including new PV systems. To receive a tax credit of 30 percent, construction of the project must have started before the end of 2019. For construction begun in 2020, the credit declined to 26 percent, and it will further decline to 22 percent for projects begun in 2021. Projects must be completed by December 31, 2023, to receive the tax credits. After 2021 the credit for residential systems is scheduled to drop to zero, while commercial and utility credits will fall to a permanent 10 percent. Firms can meet the start of construction criteria by incurring 5 percent of the project costs, which many firms have done by purchasing modules. Internal Revenue Service (IRS), "Beginning of Construction for the Investment Tax Credit under Section 48," Notice 2018-59, https://www.irs.gov/pub/irs-drop/n-18-59.pdf, 10; USITC, *CSPV Monitoring,* 2020, II-13, II-26; Groom, "Expiring U.S. Solar Subsidy Spurs Rush for Panels," July 19, 2019; Roselund, "PV Module Shipments Spiked in September," November 15, 2019; Bloomberg, "US Solar Companies Are Stockpiling a Massive Amount," November 13, 2019.

decreased from $6.8 billion in 2016 to $2.2 billion in 2018, then increased to $4.9 billion in 2019. The average unit value declined from $0.589 per watt in 2016 to $0.419 per watt in 2018, then fell to $0.336 per watt in 2019. The leading sources of imports in 2019, by quantity, were Malaysia (34 percent of imports), Vietnam (29 percent), Thailand (10 percent), South Korea (9 percent), and Singapore (5 percent).[32]

Figure II-4
U.S. CSPV module imports, 2016–19



Notes: The 2019 data are U.S. imports in HTS 8501.31.8010, 8501.32.6010, 8501.61.0010, 8507.20.8010, 8541.40.6015, and 8501.40.6035 (rate provision codes 69 and 79 for 8541.40.6035).

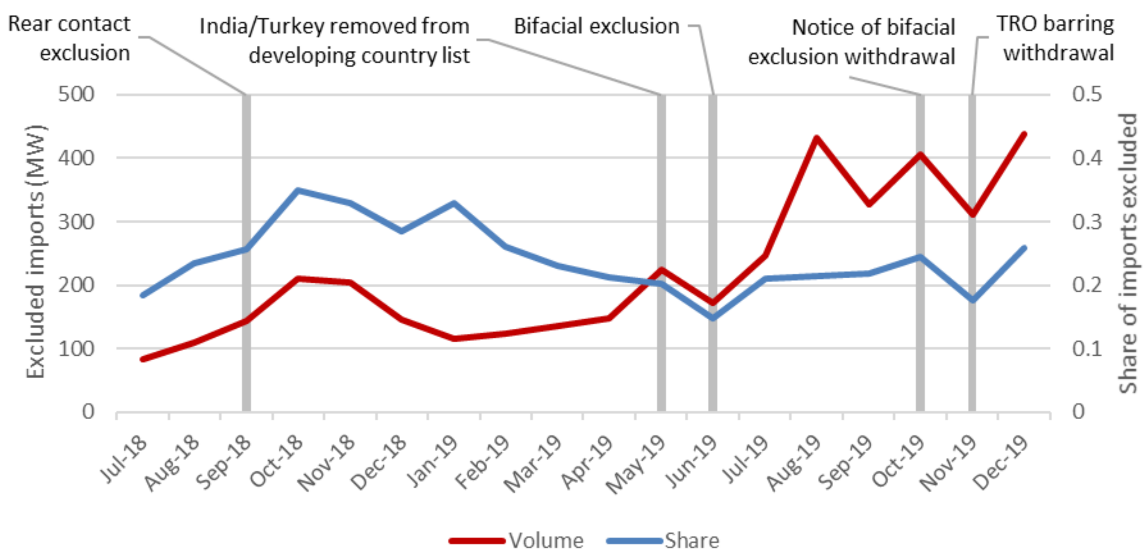
Source: USITC, *CSPV Monitoring,* 2020, V-20; USITC DataWeb/USDOC (accessed February 9, 2020).

There have been fluctuations in imports of goods not subject to the safeguard measure, reflecting changes in the covered countries and products excluded from the safeguard measure. The share of U.S. module imports not subject to the safeguard measure increased from less than 20 percent in July 2018 to 35 percent in October 2018, the month after rear

[32] USITC, *CSPV Monitoring,* 2020, V-21 to V-22; USITC DataWeb/USDOC (accessed February 9, 2020).

contact modules were excluded from the measure (figure II-5).[33] The share then declined to 15 percent in June 2019, after India and Turkey were removed from the list of developing countries exempt from the safeguard measure. With the exclusion of bifacial modules in June 2019, the share of U.S. module imports not subject to the safeguard measure increased from 15 percent in June 2019 to 24 percent in October 2019. The share then fell to 17 percent in November 2019, after the bifacial exclusion was originally scheduled to be withdrawn, and increased to 26 percent in December 2019 after a temporary restraining order on the withdrawal was issued in November.[34]

Figure II-5
U.S. CSPV module imports not subject to the safeguard measure, July 2018–December 2019



Notes: TRO = temporary restraining order. The data are based on U.S. imports in HTS 8501.31.8010, 8501.32.6010, 8501.61.0010, 8507.20.8010, 8541.40.6015, and 8501.40.6035 (rate provision codes 69 and 79 for 8541.40.6035). It excludes imports from Vietnam in July 2019 under rate provision code 10 (free under HS chapters 1 to 98), as there is a mismatch between the reported value and the quantity.

Source: USITC DataWeb/USDOC (accessed January–February 2020).

[33] Some manufacturers place metal contacts onto the rear side of the CSPV cell, creating back (or rear contact) cells. This provides several advantages such as reduced shading, improved cell interconnection, and better aesthetics. Rear contact cells and modules were excluded from the safeguard with respect to goods entered into the United States, or withdrawn from a U.S. warehouse for consumption, on or after September 19, 2018. For more on these products, see USITC, *CSPV Monitoring,* 2020, I-12, I-73.

[34] On July 1, 2018, new statistical reporting numbers were added to the HTS for CSPV cells and modules. Prior to this, CSPV and thin-film products were included in the same statistical reporting numbers.

The increase in imports not subject to the safeguard measure in the second half of 2019 primarily reflects imports of ***. As illustrated in figure II-6, imports of modules from India and Turkey not subject to the safeguard measure substantially declined after May 2019. Imports from Mexico, which are likely rear contact modules produced by SunPower, increased during 2019.[35] Imports from developing countries (excluding India and Turkey) also moderately increased. These imports were primarily from Cambodia, reflecting the development of the Cambodian industry and importers (including subsidiaries of Chinese module producers) increasingly sourcing modules from Cambodia.[36] Imports from South Korea represent ***.[37] The rise in module imports from all other countries is primarily imports from Southeast Asia and, to a lesser extent, China and ***.[38] Bifacial module imports in January 2020 ***.[39]

[35] Osborne, "SunPower's IBC Cells and Modules Excluded," September 18, 2018.

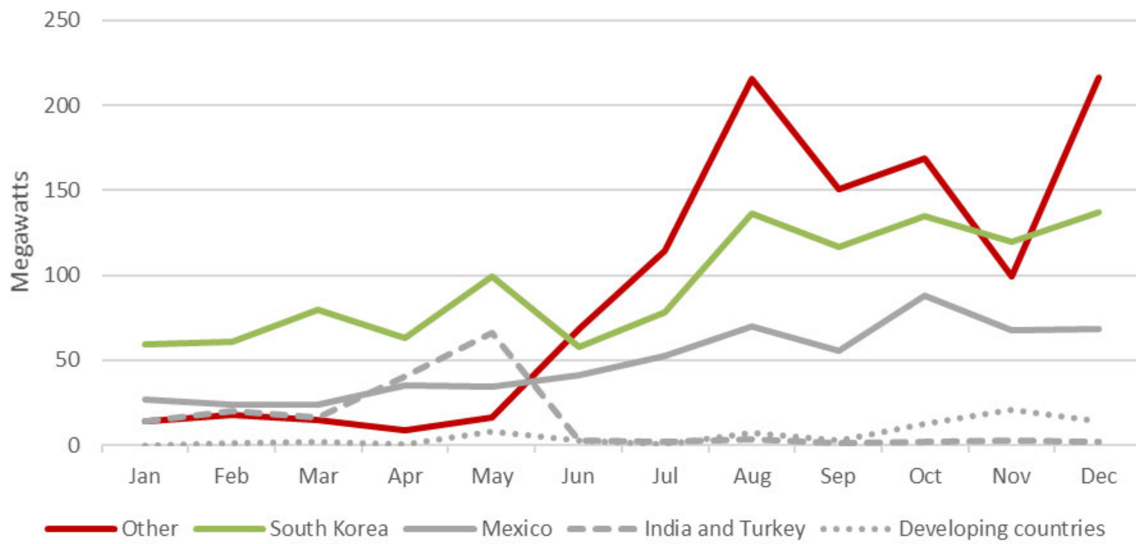
[36] Roselund, "ET Solar Is Back," August 6, 2019; Panjiva Website, https://panjiva.com/Enalex-Energy-Kh-Co-Ltd/62907711 (accessed February 9, 2020); New East Solar Energy Company Website, http://nesolar.biz/?about/29 (accessed February 9, 2020); Import Genius Website, https://www.importgenius.com/suppliers/enalex-energy-kh-co-ltd.

[37] ***.

[38] ***.

[39] ***.

Figure II-6
U.S. imports, CSPV modules not subject to the safeguard measure, 2019



Note: U.S. imports in HTS 8501.31.8010, 8501.32.6010, 8501.61.0010, 8507.20.8010, 8541.40.6015, excluding those dutiable under HTS Chapter 99.

Source: USITC DataWeb/USDOC (accessed February 2020).

Apparent U.S. Consumption of CSPV Modules

Apparent U.S. Consumption, 2016–22

Apparent U.S. consumption of CSPV modules declined from *** in 2016 to *** in 2017 and *** in 2018 (figure II-7).[40] Apparent U.S. consumption increased to *** in 2019, and is projected to reach *** in 2020.[41] SPV Market Research projects that apparent U.S. consumption, in its accelerated scenario, will total 20.4 GW in 2021 and 20.7 GW in 2022.[42]

[40] USITC, CSPV Monitoring, 2020, V-48.

[41] 2019 data are based on the production data shown above (figure II-2), excluding exports, and estimated full-year imports as discussed above (figure II-4). The 2020 data are based on firms' projections of U.S. production in 2020 (see "U.S. CSPV Module Industry" above) and data submitted in foreign producers' responses to questionnaires on projected 2020 exports to the United States. See appendix D for the full methodology. Production data were used for calculating apparent consumption as shipment data for full-year 2019, and projected shipments for 2020 were not available.

[42] See appendix D for more information on the SPV Market Research forecasts. SPV Market Research prepared three market scenarios: low, conservative, and accelerated. The low scenario "assumes slightly slower buying activity over 2019 due to inventory overhang. Beyond 2020 activity ramps modestly." The conservative scenario "assumes continued buying despite inventory overhang in anticipation of continued ramp down of ITC and high availability of bifacial and other modules." The accelerated scenario "assumes accelerated activity despite inventory overhang in anticipation of ITC ramp down and

Figure II-7
Apparent U.S. consumption of CSPV modules, 2016–22

*　　*　　*　　*　　*　　*　　*

Apparent consumption is driven by four primary market segments for CSPV products, including three grid-connected market segments—residential, nonresidential, and utility—and an off-grid segment. The largest segment is the utility segment, which accounted for 71 percent of photovoltaic (PV) installations, including thin film, in 2016. This segment declined to 59 percent in 2017, and remained at 58 percent in 2018 (figure II-8).[43] The utility segment

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high availability of inexpensive import modules due to soft demand in China." The accelerated scenario is used in the model, as the 18.6 GW estimated in that scenario in 2020 ***. SPV Market Research, Excel file transmitted to USITC staff, January 13, 2020.

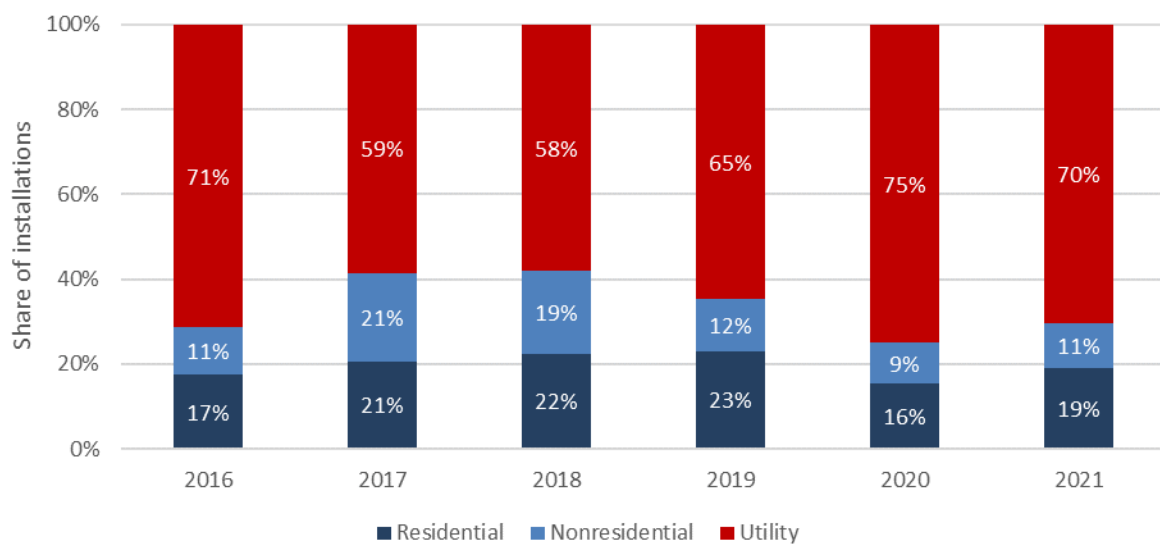
[43] Photovoltaic installations include installations of CSPV products as well as thin-film photovoltaic products (which are not included in the scope of the investigation). Thin-film modules convert sunlight to electricity using a several micron thick layer of a photosensitive semiconductor material such as amorphous silicon (a-Si), cadmium telluride (CdTe), or copper indium (gallium) (di)selenide (CI(G)S). USITC, *CSPV Monitoring,* 2020, I-54.

As noted, there are four primary market segments for CSPV products, including three grid-connected market segments—residential, nonresidential, and utility—and an off-grid segment. In the grid-connected market, installations are usually either ground-mounted or roof-mounted. Residential grid-connected systems are installed at individual homes. Nonresidential systems are installed at commercial, industrial, government, and similar buildings and sites. Utility systems are generally the largest systems, and provide electricity directly to the electric grid for sale to customers rather than for on-site use.

In addition to the CSPV module, there are other components of the installation, collectively called the balance of system (BOS). The BOS includes components such as the inverter and the racking on which the modules are installed. USITC, *CSPV Monitoring,* 2020, I-69 to I-71.

increased to an estimated 64 percent of installations in 2019 and is expected to reach 74 percent of installations in 2020. When looking just at CSPV, however, the utility segment will represent a smaller share of demand, since thin film will account for a significant share of the installations in that segment (see appendix D).[44]

Figure II-8
U.S. PV installations by market segment, 2016–21



Note: Historical data are Wood Mackenzie (WoodMac) data published in *Utility-Scale Solar*, while the figures for projected installations are U.S. Energy Information Administration (EIA) data converted from alternating current (AC) to direct current (DC) at the 2018 inverter loading ratios for each market segment.

Source: Bolinger, Seel, and Robson, *Utility-Scale Solar*, December 2019, data file; EIA, Short-term Energy Outlook Data Browser, table 8b, "U.S. Renewable Electricity Generation and Capacity," January 14, 2020; EIA, Form EIA-860, September 3, 2019; Barbose and Darghouth, *Tracking the Sun*, September 2019, public data file.

[44] Bolinger, Seel, and Robson, *Utility-Scale Solar*, December 2019, data file; EIA, Short-term Energy Outlook Data Browser, table 8b: U.S. Renewable Electricity Generation and Capacity, January 14, 2020; EIA, Form EIA-860, September 3, 2019; Barbose and Darghouth, *Tracking the Sun*, September 2019, Public Data File.

Apparent U.S. Consumption of Bifacial Modules

Apparent U.S. consumption of bifacial modules is expected to increase substantially during 2020–22, driven by the bifacial exclusion, low additional costs, maturation of the technology and supply chain, ease of switching to bifacial production with PERC technology, and benefits from additional rear side energy production.[45] Bifacial modules provide additional energy production due to their ability to absorb reflected sunlight that hits the back of the module. They are broadly substitutable for monofacial modules, and can be used in all applications. The level of additional benefit from reflected sunlight, however, depends on factors such as the surface and how much light is reflected, whether or not the installation uses trackers, cell technology, and the extent to which the balance of system (BOS) is designed for bifacial products.[46]

Multiple sources suggest production costs for bifacial modules are less than *** per watt higher than monofacial module costs.[47] In an April 2019 presentation, the National Renewable Energy Laboratory (NREL) calculated the production cost of comparable monofacial and bifacial PERC modules manufactured in Asia at $0.287 and $0.289 per watt, respectively, suggesting the additional cost to manufacture a bifacial module is only $0.002 per watt.[48] This cost is far lower than the safeguard duties (equivalent to $0.066 to $0.071 per watt in November 2019) on monofacial module imports from Malaysia, Thailand, and Vietnam.[49]

The switch from producing monofacial to bifacial modules in a plant is relatively straightforward, and firms are increasingly transitioning plants to bifacial products. According to ***, a CSPV cell or module production plant needs to be shut down for ***

[45] Projections of bifacial module demand during 2020–22 are presented in appendix D.

[46] Richardson, "Vermont's Largest Solar Canopy Comes Online," January 18, 2019; Crowell, "Sunpreme Bifacial Solar Panels Deployed," January 28, 2019; Natter and Efstathiou, "Solar Has New Way," June 12, 2019; Pickerel, "Trending in Mounting," May 14, 2018; Pickerel, "What Are Bifacial Solar Modules?" April 2, 2018; Thurston, "The Weekend Read: Tracker Market Is Adapting," February 17, 2018; *Solar Magazine*, "Bifacial Solar Panels," January 9, 2020; Solar Electric Supply Website, https://www.solarelectricsupply.com/canadian-solar-cs3u-365pb-ag-biku-bifacial-solar-panel (accessed February 8, 2020); CED Greentech Website, https://www.civicsolar.com/article/when-should-i-use-bifacial-modules (accessed February 8, 2020); Chunduri and Schmela, *Bifacial Solar Module Technology*, 2018, 4.

[47] ***.

[48] Woodhouse et al., "The International Supply Chain," June 5, 2019, 15.

[49] Imports in HTS 8541.40.6015. USITC DataWeb/USDOC (accessed January 2020).

*** to switch from producing monofacial to bifacial cells and modules.[50] *** indicates that it takes *** to upgrade a plant from producing monofacial cells and modules to bifacial cells and modules. They further indicated another *** is needed to ramp up production at the plant.[51] Production lines in Southeast Asia are currently being switched over to bifacial cell and module production, a process that will continue through 2020.[52] Firms do not need to switch all production at manufacturing plants to bifacial products; they can dedicate certain lines to primarily producing bifacial products for the U.S. market and continue to produce monofacial products on other lines.[53] In addition, some firms can produce monofacial and bifacial modules on the same production lines.[54]

Lenders are increasingly comfortable financing bifacial projects, which was a barrier in the past due to a lack of information on rear side module performance.[55] According to ***.[56] However, lenders are conservative in financing rear side energy production given uncertainties in the level of output, though it is expected that modeling of rear side output will improve as more rear side performance data becomes available.[57]

The difference in selling prices for bifacial and monofacial modules, ***. Comparing the unit values of bifacial imports for *** major importers to the unit value of monofacial imports *** indicates that the price differences were *** per watt in the first half of 2019 (figure II-9) when safeguard duties were

[50] ***.

[51] ***.

[52] Roth Capital Partners, "First Solar Inc.," Flash Note, June 13, 2019, 1. Provided as an attachment to U.S. Court of International Trade, Case 1:19-cv-00192-GSK, Document 15, filed October 22, 2019, https://morningconsult.com/wp-content/uploads/2019/11/4-Public-Motion.pdf.

[53] Martin, "Vietnamese PV Maker Dehui," January 20, 2020; Energy Monitor Worldwide, "Tainergy Shifting Capacities to Vietnam," December 31, 2019; Attachment 15 to U.S. Court of International Trade, Case 1:19-cv-00192-GSK, Document 15, filed October 22, 2019, https://morningconsult.com/wp-content/uploads/2019/11/4-Public-Motion.pdf.

[54] *PV Magazine*, "Interview with Trina Solar," December 17, 2019; Bank of America Merrill Lynch, "Sec 201 Exemption Goes Two-Face for Bifacial," June 12, 2019, 1. Provided as an attachment to U.S. Court of International Trade, Case 1:19-cv-00192-GSK, Document 15, filed October 22, 2019, https://morningconsult.com/wp-content/uploads/2019/11/4-Public-Motion.pdf.

[55] Zoco, "The Sun Rises," *PV Magazine*, June 12, 2019; Thurston, "The Weekend Read: Pursuing a 20% Bifacial Boost," July 27, 2019.

[56] ***.

[57] Thurston, "The Weekend Read: Pursuing a 20% Bifacial Boost," July 27, 2019.

applied to both monofacial and bifacial modules.[58] Without safeguard duties applied to bifacial modules, the unit value of bifacial module imports would have been about *** per watt *** than the unit value of monofacial module imports.

Figure II-9
Monofacial and bifacial CSPV module import price comparison, January–June 2019

*　　　*　　　*　　　*　　　*　　　*　　　*

At the time the U.S. bifacial module exclusion was announced in June 2019, there were already significant contracts in place in the United States for the delivery of bifacial modules. For example, two-thirds of Longi's orders were already for bifacial products and Canadian Solar signed a multi-year order in May 2019 for 1.8 GW of monofacial and bifacial modules for North American markets.[59] After the exclusion was announced, there were significant purchases of

[58] Unit values are based on landed duty-paid values inclusive of all applicable duties and charges.

[59] Bank of America Merrill Lynch, "Sec 201 Exemption Goes Two-Face for Bifacial," June 12, 2019, 1. Provided as an attachment to U.S. Court of International Trade, Case 1:19-cv-00192-GSK, Document 15, filed October 22, 2019, https://morningconsult.com/wp-content/uploads/2019/11/4-Public-Motion.pdf; Canadian Solar, "Canadian Solar Signs," May 29, 2019.

bifacial modules, with SEIA stating in November 2019 that $1 billion in contracts for bifacial modules had been signed since the announcement of the exclusion.[60] Given the average unit value (AUV) for bifacial module imports in the first half of 2019 of *** without tariffs, this estimated contract value translates to *** in orders.[61] Despite this significant bifacial activity, there were also many orders already in place for monofacial products, and manufacturers will continue to work through these orders even as they shift to bifacial modules for future orders.[62] Therefore, 2020 is likely to be a transition year from monofacial to bifacial products.

The growing role of bifacial products in the U.S. market is reflected in import data. U.S. imports of bifacial modules increased from *** in the first half of 2019 to more than *** in the second half of the year.[63] In January 2019 alone, imports were more than ***. At least *** firms exported bifacial modules to the U.S. market from January 2019 to January 2020.[64]

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[60] Toth, "Solar Firms Sought Senate Help," November 6, 2019.

[61] Compiled from data submitted in response to *CSPV Monitoring* questionnaires.

[62] Roselund, "Roth: Trump Administration Could End," October 4, 2019; Roselund, Christian, "It's Official," October 8, 2019; Parnell, "As Investors Get Comfortable," June 18, 2019.

[63] Import data for the second half of 2019 are likely *** as this only includes products that could *** in ***. ***.

[64] ***.

Part III: Probable Economic Effect of Modification

Increasing the tariff-rate quota (TRQ) on crystalline silicon photovoltaic (CSPV) cells would likely allow U.S. module producers to increase their capacity utilization, production, employment, price competitiveness, and operating income during the remaining two years of the safeguard measure. U.S. module producers currently rely predominantly on imported cells as inputs. As U.S. module producers have increased capacity to levels considerably above the in-quota volume level of 2.5 gigawatts (GW) on CSPV cells and project production levels in 2020 and 2021 that would exceed 2.5 GW, they will need to either (1) leave part of that capacity idle to avoid importing above-quota CSPV cells subject to safeguard duties and therefore reduce their coverage of fixed costs or (2) purchase above-quota imported cells subject to safeguard duties and incur additional variable costs of production. In either case, U.S.-produced modules will likely become less price competitive with imported modules, as producers would need to either absorb additional costs or pass on their higher costs to consumers.

According to model estimates, an increase in the in-quota volume level of the TRQ would allow domestic module producers to substantially increase capacity utilization and production. U.S. module producers would benefit from lower costs of production because fewer cell imports would be subject to the safeguard tariffs. The model estimates that imports of cells would not exceed a TRQ of 5.0 GW, and therefore there is no difference in economic results between a TRQ of 5.0 or 6.0 GW. Increases in module production resulting from the TRQ expansion would likely result in increases in employment ranging from *** to *** additional jobs (depending on the scenario and year) above the level that existed at the end of 2019. These benefits to module producers from an increase in the TRQ, however, would likely be more limited if the bifacial module exclusion were to remain in place.[1]

The TRQ expansion would affect the two U.S. cell producers—Panasonic, which is the only U.S. producer currently producing cells, and Suniva, which plans to restart production once it obtains the necessary capital investment—differently. Panasonic's sales of cells would likely be unaffected by the increase in the TRQ, as most of its sales are for the ***, and few U.S. module producers currently use the type of cells that Panasonic manufactures. In addition, Panasonic has confirmed that it is ending cell and module production by the end of May 2020. For these reasons, the probable economic effect analysis on CSPV cell production focuses on Suniva. If Suniva were to restart domestic production of cells, it would compete against imported cells for sales to a subset of U.S. module producers that use the type of cell

[1] The bifacial module exclusion is discussed in greater detail in part I. As discussed, the status of the bifacial module exclusion going forward is uncertain.

Suniva would produce. Suniva would face challenges selling to several of the larger U.S. module producers. This is because larger module producers either use a different technology or import cells from affiliated firms. If Suniva restarted production it would seek to maximize capacity utilization and has estimated it would hire over 200 workers if it did so. The model allows for the restart of Suniva's production and assesses its operating income in light of the economic changes that are likely to occur upon an expansion of the TRQ.[2] The model estimates that its operating income would decline as a result of competition with lower-priced cell imports.

Qualitative Assessment of the Impact of TRQ Expansion on the U.S. CSPV Industry

This section of the report provides a qualitative assessment of the impact of raising the TRQ on U.S. module producers, as well as on U.S. cell producers.[3] The discussion of the impacts on the cell industry covers the one existing producer (Panasonic), as well as the potential for Suniva to restart production and the impacts of raising the TRQ on the firm if it is able to resume production. For both cells and modules, the qualitative analysis examines the impact of increasing the TRQ on (1) price competitiveness, (2) investment in new plants, (3) employment and wages, and (4) spending on research and development. For cells, the analysis also examines the extent to which domestic cells could be used by U.S. producers, as well as the impact of increasing the TRQ on Suniva's potential sales to both the domestic and foreign markets.

Impact on U.S. CSPV Module Producers

Impact on Price Competitiveness without the Bifacial Exclusion

An increase in the TRQ would improve the price competitiveness and operating income of U.S. CSPV module manufacturers. As shown in figure III-1, in January–June 2019, imported modules *** comparisons, except *** in ***, notwithstanding the safeguard duties applied to imported modules.[4] The application of the safeguard duties on imported cells would add, on average, *** to the cost of U.S.-produced modules made with above-TRQ cells, which were already selling for *** per watt *** imports (excluding the ***).

[2] The model compares estimates of Suniva's revenue with estimates of Suniva's fixed and variable costs under the assumption that it would operate at full capacity utilization.
[3] Unless otherwise noted, this section refers to calendar years and not remedy years.
[4] As noted in part II, U.S. cell imports did not exceed the TRQ in 2019.

Figure III-1
U.S. and imported monocrystalline module prices, January–June 2019

* * * * * * *

An increase in the TRQ would significantly improve price competitiveness and operating income across the entire U.S. module industry, including both passivated emitter rear contact (PERC) and n-type module production. At the selling prices for U.S. modules that existed in January–June 2019, U.S. producers would likely be able sell modules *** when imported cells are within the TRQ (figure III-2). If imports of cells exceed the TRQ, this would either reduce the operating income of U.S. module producers or lead producers to increase prices.[5] Alternatively, in a "best-case" production cost scenario that might represent the costs of the most efficient U.S. producers, module assemblers ***. However, raising the TRQ would still increase revenues and enable firms to avoid increasing prices.

[5] If Suniva restarts production, this will reduce the volume of over-quota cell imports that module producers would need to purchase, though it would likely not eliminate over-quota cell purchases. LG, *CSPV Modification Advice* written submission to the USITC, January 6, 2020, 9–10; Heliene and Silfab, *CSPV Modification Advice* written submission to USITC, January 6, 2020, 7; Domestic Module Producers Coalition, *CSPV Modification Advice* written submission to USITC, January 6, 2020, 4, 6.

Figure III-2
U.S. module production costs, compared to average selling prices for U.S. produced modules, January–June 2019

*   *   *   *   *   *   *

Impact on Price Competitiveness with Bifacial Exclusion

The impact of an increase in the TRQ on U.S. module producers would likely be more limited if the bifacial module exclusion remains in place, as lower-priced bifacial modules would likely reduce demand for and production of U.S. modules. As discussed in part II and appendix D, bifacial modules are likely to account for a growing share of the market over the next few years and can substitute for monofacial products in all market segments. Imports of bifacial modules that are exempt from safeguard tariffs put significant price pressure on U.S. module producers, as these modules can be produced at virtually the same cost as monofacial modules.[6]

[6] USITC, *CSPV Monitoring* hearing transcript, December 5, 2019, 54 (Munro), 67 (Kerwin), 70–71, 119 (Rashid); Woodhouse et al., “International Supply Chain,” June 2019, 15; Hanwha, Mission, Auxin, and SolarTech, *CSPV Monitoring* prehearing brief on the issue of bifacial modules, November 26, 2019, 10–11, exhibit 8.

Bifacial modules were imported at an average unit value (AUV) of *** per watt in January–June 2019, including safeguard duties, and would be approximately *** per watt without safeguard duties. This compares to an AUV of *** per watt for all imported modules.[7] U.S. module producers, on the other hand, likely would not be able to produce for under *** per watt even in a "best-case" scenario. While this *** as safeguard duties on modules decline to 15 percent in 2021, lower-priced bifacial modules will likely drive down U.S. market prices for modules.[8] Even in a "best-case" scenario for U.S. production costs, firms likely *** if they were forced to reduce prices to compete with the price of bifacial module imports (figure III-3).[9]

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[7] Compiled from data submitted in response to *CSPV Monitoring* questionnaires.

[8] U.S. module producers Hanwha, Mission, Auxin, and SolarTech, in their prehearing brief on bifacial products, note that WoodMac revised its U.S. module price forecast downward following the announcement of the bifacial exemption. WoodMac's forecast multicrystalline module price, delivery duty paid, for modules supplied to the U.S. market by Tier 1 Chinese firms in Q4 2021 declined 13 percent from their forecast issued in June 2019 to their September 2019 forecast. The forecast mono PERC (including monofacial and bifacial) module price supplied to the U.S. market declined 14 to 16 percent, depending on the volume of the order. In contrast, changes in WoodMac's forecast prices for modules delivered to the EU and Japan ranged from a 4 percent decline in the price of multicrystalline modules delivered to the EU to a 4 percent increase in the price of multicrystalline module prices delivered to Japan. (Forecast mono PERC module price changes to these regions were smaller than forecast multicrystalline module price changes.) USITC, *CSPV Monitoring* hearing transcript, December 5, 2019, 54 (Munro), 67 (Kerwin), 70–71, 119 (Rashid); Hanwha, Mission, Auxin, and SolarTech, *CSPV Monitoring* prehearing brief on the issue of bifacial modules, November 26, 2019, 10–11, exhibit 8.

[9] Compiled from data submitted in response to *CSPV Monitoring* questionnaires.

Figure III-3
Bifacial and all import prices of modules compared to U.S. production costs, January–June 2019

* * * * * * *

U.S. manufacturers would be able to continue to sell their products, but would also likely be pushed increasingly to sell to market segments that provide a premium for higher-efficiency products. In the residential sector, for example, a large share of the market is made up of high-efficiency products from firms such as LG, Panasonic, and SunPower Manufacturing Oregon LLC (SunPower), which sell at a price premium.[10] The residential market supports more efficient modules, at least in part, because of space constraints on roofs.[11] The price premium in this market segment is *** in figure III-1.[12] ***.[13] Price *** in these segments, however, and ***

[10] EnergySage, *Solar Marketplace Intel Report: H2 2018 to H1 2019*, September 2019, 12; Roselund, "EnergySage Report," April 4, 2019; Solaris Website, https://www.solaris-shop.com/blog/lg-solar-vs-panasonic-whats-best/ (accessed February 4, 2019); Barbose and Darghouth, *Tracking the Sun*, October 2019, 31 and public data file; EnergySage Website, https://news.energysage.com/comparing-top-solar-manufacturers-sunpower-vs-lg-panasonic-solarworld-suniva/ (accessed February 4, 2020).

[11] Barbose and Darghouth, *Tracking the Sun*, October 2019, 10.

[12] Compiled from data submitted in response to *CSPV Monitoring* questionnaires.

[13] ***.

***.[14]

Moreover, demand in these premium market segments would not be able to compensate for the loss of sales in other market segments. The residential market is projected to account for only 17 percent of demand in 2020 and 20 percent in 2021. Also, imports compete in this market segment, so it would be difficult for the U.S. module industry to scale up production based on this demand alone.[15] Further, ***.[16]

New CSPV Module Plant Investment[17]

It is unlikely that an increase in the TRQ alone would incentivize a company to open a new U.S. module manufacturing plant, but it may have an impact on investment by existing manufacturers.[18] A new manufacturing facility can be brought online in less than a year from the time that it is publicly announced. For example, it took Hanwha eight months to open its

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[14] ***.

[15] EIA, Short-term Energy Outlook Data Browser, table 8b: "U.S. Renewable Electricity Generation and Capacity," January 14, 2020; EIA, Form EIA-860, September 3, 2019; Barbose and Darghouth, *Tracking the Sun*, September 2019, Public Data File.

[16] ***.

[17] This section will not assess the likelihood of investment in new plants overall, but will instead look at the potential impact on investment decisions of a change in the safeguard measure. Further, this analysis is based on policies currently in place, as stated in the USTR's request letter, and does not take into account the effect of any potential extension of the safeguard measure for a period of time or of any firm's expectations of extension of the safeguard.

[18] There are no known confirmed plans to open a new U.S. module manufacturing plant. As described in part II, Sunpreme announced plans in 2018 to open a 400 MW cell and module plant. India-based manufacturer GreenBrilliance announced plans in July 2018 to open a 125 MW module plant in Maryland. No additional updates on either plant are available. As of March 2019, Phono Solar was reportedly investigating module production in the United States. Pickerel, "GreenBrilliance to Open 125-MW Solar Panel," July 3, 2018; Gouras, "Phono Solar," March 28, 2019.

plant in Georgia. Jinko needed almost 11 months to open its plant in Jacksonville, Florida, from the time an incentive package was introduced for consideration by the city council.[19] However, it takes additional time to ramp up production at a plant, and the remaining time in the safeguard measure would be insufficient to ensure a return on investment in the plant. According to ***.[20]

Several firms have planned investments in additional capacity, and these investments are more likely to proceed with an increase in the TRQ. Auxin, for example, stated that it has plans to add two 125 MW production lines, but that "scaling up will not be enough to negate the added cost of a safeguard cell tariff."[21] ***.[22] ***.[23]

Employment and Wages

If an increase in the TRQ leads to substantial increases in module production at existing U.S. plants, this would likely result in the creation of ***, compared to the level that existed at the end of 2019.[24] Employment at seven firms that provided such data in written submissions is projected to increase from *** employees at the end of 2019 to *** employees (*** percent) in 2021, while production is projected to increase by *** percent (figure III-4).[25] Most of the new, large plants that opened following

[19] There is planning that takes place before the public announcement, which adds more time to the process. Pyper, "Hanwha Q Cells Korea Announces," May 30, 2018; Pickerel, "Hanwha Q CELLS Completes," February 28, 2019; Mathis, "JinkoSolar Launches Pilot Production," November 29, 2018; Bull, "Solar Company Proposes," January 5, 2018.

[20] ***.

[21] USITC, *CSPV Monitoring* hearing transcript, December 5, 2019, 71 (Rashid).

[22] Domestic Module Producers Coalition, *CSPV Modification Advice* written submission to USITC, attachment 4.

[23] Domestic Module Producers Coalition, *CSPV Modification Advice* written submission to USITC, attachment 3.

[24] The increase will be more substantial when compared with first half 2019 data, when many firms were in an earlier stage of ramping up production.

[25] These seven firms accounted for *** percent of estimated full-year 2019 production, and *** percent of first-half 2019 employment. Compiled from data submitted in *CSPV Modification Advice* written submissions. Employment at firms that did not provide employment projections, ***, is likely to ramp up in a similar way. *** 200 workers that Jinko expected to employ when it announced that it would open the plant. Jinko CSPV Monitoring U.S. producer questionnaire at II-15; Mathis, "JinkoSolar Launches," November 29, 2018.

the announcement of the safeguard remedy were *** their expected level of employment at full (or near full) capacity utilization by the end of 2019.[26] Smaller firms that expect to add new production lines to increase capacity are where the *** are likely to occur.[27] It is not known whether firms will reduce the number of employees if they are unable to meet their production goals. ***, for example, was ***, with the expectation of operating at *** percent capacity utilization in 2019 and *** percent in 2021.[28]

Figure III-4
Module production and employment, responding firms, 2019–21

* * * * * * *

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[26] ***. Domestic Module Producers Coalition, *CSPV Modification Advice* written submission to USITC, January 6, 2020, attachment 1.

[27] For example, as ***.[27] Similarly, as ***. ***.

[28] ***.

Tesla appears to use a more labor-intensive production process than the rest of the U.S. industry, and therefore any changes in production levels resulting from an increase in the TRQ may have a greater impact on employment than at many other module producers. Employment in Buffalo reportedly reached 1,500 workers in February 2020. Some of these workers are engaged in cell and module production for Panasonic, and some produce nonsolar products, but production of the Solarglass roof tile is the main driver of recent employment growth. Tesla is *** the process would be relatively labor intensive in comparison to the industry making standard-format modules.[29]

The relatively small growth in employment that would result from an increase in the TRQ reflects decreasing labor intensity at higher production levels. The labor intensity of U.S. module production, using the firm projections above and other available industry information, is projected to decrease from *** employees per MW in 2019 data to *** employees per MW in 2021 (figure III-5). Excluding Tesla, which makes a relatively unique product, labor intensity would decline to *** employees per MW in 2020, though there would be significant variation between producers. The National Renewable Energy Laboratory (NREL) uses a benchmark labor intensity for automated solar manufacturers of 0.5 to 0.7 employees per MW in its cost calculations. At the U.S. industry's projected level of production in 2021, this would bring U.S. manufacturers *** that labor intensity benchmark.[30]

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[29] Robinson, "Tesla Is Adding New Products," May 15, 2019; Vielkind, "New York State Writes Down Value," November 7, 2019; Tesla, "Form 10-Q," October 29, 2019, 41; WKBW Buffalo, "Musk Announces Tesla Event," February 10, 2020; Crider, "NY State Officials," February 10, 2020; ***. For more information on Tesla's operations in Buffalo, see USITC, *CSPV Monitoring*, 2020, III-6 to III-7; Yamazaki and Groom, "Panasonic to Exit Solar Production," February 25, 2020.

[30] Woodhouse et al., *Crystalline Silicon Photovoltaic Module*, February 2019, 33.

Figure III-5
Labor intensity of CSPV module production, 2019–21

* * * * * * *

Wages in module manufacturing tend to be *** than wages in cell manufacturing, unless production takes place ***. For employees in the same plant, wages are *** for cell and module workers.[31] For employees in different plants, a comparison of wage rates in the same region indicates that wage rates in module manufacturing ***. Comparing plants in Georgia, Suniva's rate for cell manufacturing was *** per hour in 2017, while Hanwha's rate for module manufacturing was *** per hour in January–June 2019.[32] In the Pacific Northwest, SunPower's average wage for cell production was *** per hour in 2016 and *** per

[31] *** reported *** to cell and module production-related workers in 2016 and 2017. In 2016, the sole year in which ***, average wages were *** per hour in cell manufacturing and *** per hour in module manufacturing. ***.

[32] Suniva, U.S. producer *CSPV Monitoring* questionnaire at II-11; Hanwha U.S. producer *CSPV Monitoring* questionnaire at II-15.

hour in 2017 at its plant in Oregon.[33] In comparison, Silfab's wages at its module plant in Washington were *** per hour on average in 2018, *** to *** per hour in the first half of 2019 as it ***.[34] Itek Energy, which owned the module plant in Washington before its acquisition by Silfab, paid *** per hour in 2016.[35]

Research and Development (R&D)

An expansion of the TRQ may *** affect investment in R&D by certain module manufacturers or *** the ability of some firms to achieve a return on past investments, particularly for certain ***. Excluding ***, *** U.S. module manufacturers invested in R&D in January–June 2019, with expenditures totaling ***. ***, however, made major R&D investments associated with its ***. *** R&D expenses *** from *** in 2016 to *** in 2018, and totaled *** in January–June 2019.[36] Further, SunPower Manufacturing Oregon is part of SunPower Corp., which has its R&D unit located in the United States and spent $82 million on R&D in 2018, though future levels of spending on R&D related to module manufacturing are unclear with the split of its parent company.[37]

Impact on U.S. CSPV Cell Producers

Overlap between Domestic Cell Production Technologies and Demand

The only cell type currently in commercial production in the United States is the heterojunction with intrinsic thin layer (HIT) cell produced by Panasonic, which ***

[33] SunPower, U.S. producer *CSPV Monitoring* questionnaire at II-11.
[34] Silfab, U.S. producer *CSPV Monitoring* questionnaire at II-11.
[35] Itek, U.S. producer *CSPV Safeguard* questionnaire at II-18.
[36] ***.
[37] In November 2019, SunPower announced plans to split into two companies, with the U.S.-based SunPower Corp. to focus on the downstream business and a new entity called Maxeon Solar (headquartered in Singapore) to take over the manufacturing operations outside the United States (which account for most of SunPower Corp.'s production). SunPower Manufacturing Oregon will remain with SunPower Corp. According to SunPower, the "two companies will cooperate to develop and commercialize next generation solar panel technologies, with early stage research conducted by SunPower's Silicon Valley-based research and development group, and deployment-focused innovation and scale-up carried out by Maxeon Solar." SunPower, "Form 10-K," February 14, 2019, 45, 67; SunPower, "Form 8-K," November 8, 2019, exhibit 99.2; Stromsta, "SunPower to Spin Off Manufacturing," November 11, 2019.

***, as discussed in part II.[38] This type of cell currently produced domestically is ***.[39] As discussed in part II, ***.[40]

It is unlikely that an increase in the TRQ would change a firm's decision about whether or not to purchase cells from Panasonic. If a firm does not currently use heterojunction cells, the process of switching cell technologies would take time and incur additional expenses. For example, new modules would need to be designed and certified, with the certification process taking several months.[41] Further, in many instances, module producers would need new tooling for cell interconnection to switch to heterojunction cells.[42] In addition, Panasonic's cells already ***.[43] Global production of heterojunction cells will increase, and it is possible that other factors may lead a firm to switch to producing heterojunction modules, but it is unlikely that the safeguard measure's remaining period is long enough for it to be a significant factor in these decisions. As a result, whether or not the TRQ is expanded, it is unlikely to have an impact on Panasonic's cell production and profitability.

If Suniva were to restart domestic production of cells, it would be able to serve a larger share of the market than Panasonic, given the type of cells it would produce, but it would still be limited by module producers' existing relationships and technologies. Figure III-6

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[38] Global production of heterojunction cells is expanding, and the International Technology Roadmap for Photovoltaic (ITRPV), which produces an annual report on the current status of the industry and future technology trends, projects that heterojunction cells will constitute more than 10 percent of global production in 2026. ITRPV, *Results 2018*, March 2019, 43.

[40] As noted in part II, Panasonic is planning to close its U.S. cell and module plant by the end of May 2020. This announcement, which was made late in the investigation, does not have a significant impact on the analysis and conclusions since ***.

[40] As noted in part II, Panasonic is planning to close its U.S. cell and module plant by the end of May 2020. This announcement, which was made late in the investigation, does not have a significant impact on the analysis and conclusions since ***.

[41] SGS Website, https://www.sgs.com/en/energy/energy-sources/solar/services-in-the-designing-phase/pv-module-certification (accessed January 19, 2020); Intertek, "Key Steps to Rapid Global PV Module Certification," n.d., 6 (accessed January 25, 2020).

[42] Faes et al., "Metallization and Interconnection," September 2018, 170–71; Taiyang News, *Heterojunction Technology 2019*, March 23, 2019, 30, 33.

[43] The AUV of Panasonic's cells was *** per watt in January–June 2019, in comparison to an AUV for cell imports of all technologies of *** per watt. The AUV of ***, which were supplied by ***, was *** per watt. ***.

summarizes the type of cells used by U.S. manufacturers and their relationship with cell suppliers. On restarting production, Suniva would produce PERC cells, which are commonly used in U.S. module manufacturing.[44] However, many of the largest manufacturers use cells ***, some firms use *** n-type cells, and ***.[45] Further, while Hanwha produces modules using a PERC-type technology, it uses its own version of this technology. All of Hanwha's global production uses internally produced cells, and all of its production outside of China uses its Q.ANTUM cells, specifically.[46] ***.[47] Globally, Jinko uses cells manufactured by other firms (including through tolling arrangements, in which it provides the wafers but another firm does the manufacturing) in its global production, as its module production capacity exceeds its cell production capacity.[48] Therefore, Suniva's sales of PERC cells would likely be limited to a subset of current module producers not supplied by a related firm, but these remaining module producers are projected to have production capacity that far exceeds Suniva's annual cell production capacity.[49]

[44] The ITRPV projected that PERC and related technologies would account for about 50 percent of global cell production in 2019 and about 65 percent of global production in 2021. Even if Suniva chooses to produce bifacial cells, these can be used in both monofacial and bifacial modules. ITRPV, *Results 2018*, March 2019, 43, 45.

[45] Compiled from data submitted in response to *CSPV Monitoring* questionnaires, email message to USITC staff, company websites, and media reports; ITRPV, *Results 2018 Including Maturity Report 2019*, October 2019, 44.

[46] ***. Hanwha Website, https://www.q-cells.us/na/main/about/why_qcells/technology/QANTUM-TECHNOLOGY~QANTUM-TECHNOLOGY~.html (accessed January 19, 2020); Hanwha, "Form 20-F," April 27, 2018, 28–29; ***.

[47] ***.

[48] Jinko, "Form 20-F," April 10, 2019, 19, 54.

[49] More than *** U.S. module manufacturers, with a projected capacity of *** in 2021, currently use PERC cells that are not supplied by a related party. This is more than *** Suniva's annual cell production capacity. Compiled from data submitted in response to *CSPV Monitoring* questionnaires, *CSPV Monitoring* prehearing briefs, email message to USITC staff, company websites and documents, media reports, and state government documents.

Figure III-6
CSPV module manufacturers: Projected production capacity in 2021, technology used, and relationship with cell suppliers

*　　*　　*　　*　　*　　*　　*

Suniva's opportunity to supply the largest producers, at least in 2020, would also likely be hindered by the large inventories of cells these firms have on hand, as noted in part II of this report. Though exact comparisons are not possible for all firms, as they are not all importers of cells, it appears that *** had large inventories of cells on hand as of June 2019.[50] ***.[51]

[50] Compiled from data submitted in response to *CSPV Monitoring* questionnaires.
[51] LG Electronics, *CSPV Modification Advice* written submission, January 6, 2020, 3.

Impact on Price Competitiveness of U.S. CSPV Cell Producers

Domestic Market

Raising the TRQ would likely have a significant impact on Suniva's potential operating income and would reduce the price competitiveness of its products sold to domestic producers.[52] Suniva would *** sell cells to *** U.S. mono PERC module manufacturer *** when module producers are paying the above-TRQ rate for imported cells in 2020 (figure III-7). For cells within the expanded TRQ, Suniva's production costs would likely be ***. However, its production costs would ***. For the *** where Suniva's cells would be ***.[53]

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[52] This section compares Suniva's production cost to the price of imported cells in the first half of 2019. Imported cell prices for each firm are based on the average unit value of imports from questionnaire data and official trade statistics, as described in figure III-7. Since Suniva was not actively producing cells in the first half of 2019, this is an estimated cost at which the firm would have produced if it had restarted production before that time. First-half 2019 production costs are used for the purposes of making comparisons to data the USITC collected during *CSPV Monitoring*. These cost estimates are specific to Suniva and would not necessarily apply to other cell manufacturers. In particular, ***. See appendix D for the methodology used to calculate Suniva's production costs.

[53] Compiled from data submitted in response to *CSPV Monitoring* questionnaires and email message to USITC staff.

Figure III-7
Suniva's estimated production costs compared to import AUVs of U.S. module producers, January–June 2019

*   *   *   *   *   *   *

Export Sales

It is unlikely that if Suniva is harmed by an increase in the TRQ, it will be able to offset that harm with foreign sales.[54] Southeast Asian module producers may seek to export modules

[54] The Domestic Module Manufacturers Coalition states that exporting cells provides the best opportunity for Suniva, estimating that a duty-free imported module using U.S. cells would be $0.06 per watt less than a module subject to duties. Domestic Module Producers Coalition, *CSPV Modification Advice* written submission to the USITC, attachment 7. However, this calculation is based on an estimated module cost of $0.40 per watt, which is significantly higher than current module import prices.

to the United States using U.S.-origin cells, which would not be subject to safeguard tariffs on modules due to the safeguard measure's rules of origin. For these exporters, the cost tradeoff associated with purchasing a U.S.-origin cell from Suniva would be equivalent to (1) the purchase and transport cost to Southeast Asia of a Suniva cell or (2) the cost of the foreign module producer's (a) internal cell production or purchase of foreign cells, and (b) the associated safeguard tariffs applied on U.S. imports of modules made from those foreign cells.[55] Suniva's cost of production is *** the global market price, which is illustrated by the red line that is *** the dark blue columns in figure III-8. Nonetheless, Suniva's cells from the perspective of a foreign module producer *** (figure III-8). However, ***. With the bifacial module exclusion in place, none of the duties would apply on imports of bifacial modules, and from the perspective of a foreign module producer ***. One caveat to this analysis is that ***.

[55] Based on first-half 2019 costs and prices. Module production costs would be consistent regardless of the source of the cell.

Figure III-8
Foreign producer cost of using a Suniva cell compared to a non-U.S. cell

* * * * * * *

Sensitivity to Production Cost Estimates

The cost estimates presented above are based on the best estimate of what Suniva's costs would have been in January–June 2019, but the estimates are sensitive to the assumptions used in the analysis. In ***.[56] Its ability to realize lower wafer costs depends on its ability to (1) achieve high conversion efficiencies, (2) source a low-price wafer, and (3) source a wafer that is not subject to section 301 duties. ***.[57] Purchasing low-cost wafers is more challenging than in prior years, however, due to the section 301 duties on wafers from China. ***

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56 ***.

57 ***.

***. If Suniva were able to lower wafer costs, ***. On the other hand, if Suniva were not able to source a wafer from Southeast Asia (as assumed in the cost estimates used here) or another location outside of China and needed to purchase a wafer at the average market price and pay a 25 percent section 301 duty, it would be less cost competitive.[58] Other potential variations in the cost estimates are *** smaller and are detailed in appendix D.

Potential for Suniva to Restart Production

Based on a restart in 2020, Suniva appears to be able to generate a positive operating income over the remaining period of the safeguard measure, particularly if there is no change in the TRQ. Suniva could restart production for ***, depending on the technology upgrades needed. This means that it could *** of the initial investment during the period of the safeguard measure ***, as prices for above-TRQ cells would be *** its production costs.[59] Recouping this investment *** as, based on its estimated first half 2019 costs, *** (see figure III-7). If Suniva's investors are *** achieve a return on their investment upon restarting production during the safeguard period, ***. Conversely, ***.

The long-term challenge for Suniva stems from expected increases in foreign cell production. Foreign manufacturers are making large investments in new cell capacity, which will create two challenges for Suniva. First, these plants will likely have the latest equipment, allowing them to achieve the lowest production costs. Second, potential overcapacity in the global industry may put downward pressure on prices.

[58] China is the largest global wafer producer, accounting for 93 percent of global production in 2018, so there is a possibility that Suniva would need to source from China. The Chinese wafer would likely be subject to section 301 duties, though these duties may be refundable as drawback if the wafers are used in exported cells. USITC, *CSPV Monitoring*, 2020, F-20.

[59] This assumes the sales price for Suniva cells is equal to the price of imported cells. ***.

Suniva's production costs are *** global prices (see figure III-8), *** U.S. prices (see figure III-7), and investments outside the United States in new cell manufacturing would likely erode Suniva's competitiveness. Based on ITRPV forecasts of global technology shifts, Suniva's products would be similar to the most commonly manufactured global cells over at least the next five years (such as in wafer size and the use of PERC technology). If the firm invests in the upgrades that it is considering (such as in selective-emitter bifacial technology and ***), its products would be well positioned to take advantage of projected emerging technology trends reported by the ITRPV.[60] Most firms globally have made incremental investments in equipment and production processes in recent years, and if Suniva does the same, it likely will be able to keep pace with these firms in production improvements and cost reductions.[61]

Suniva will find it harder to keep pace with newer plants in Asia, however. These plants will likely use the most modern equipment, which has higher throughput and less downtime, resulting in lower production costs.[62] The contributions of processing advancements, efficiency gains, and economies of scale to lowering manufacturing costs is illustrated by NREL forecasts. Production costs in urban China—which are higher than in some Southeast Asian locations like Malaysia—for new factories are expected to decline from $0.144 per watt in 2019 to $0.072 per watt in 2025.[63] Some of these cost reductions could be captured by Suniva in the form of reduced wafer prices and lower costs for other materials. However, Suniva would find it harder to capture some of the cost reductions in cell processing, such as economies of scale (which are expected to drive 25 percent of non-wafer cost reductions) (figure III-9).[64]

[60] Suniva would likely not be able to make the largest wafer sizes currently planned (166 mm^2 or greater) on its existing equipment, but the ITRPV projects that these will remain relatively small share of the market over the next decade, accounting for less than 10 percent of production in 2021 and 30 percent of production in 2029. ITRPV, *Results 2018 Including Maturity Report 2019*, October 2019, 42–46; ***.

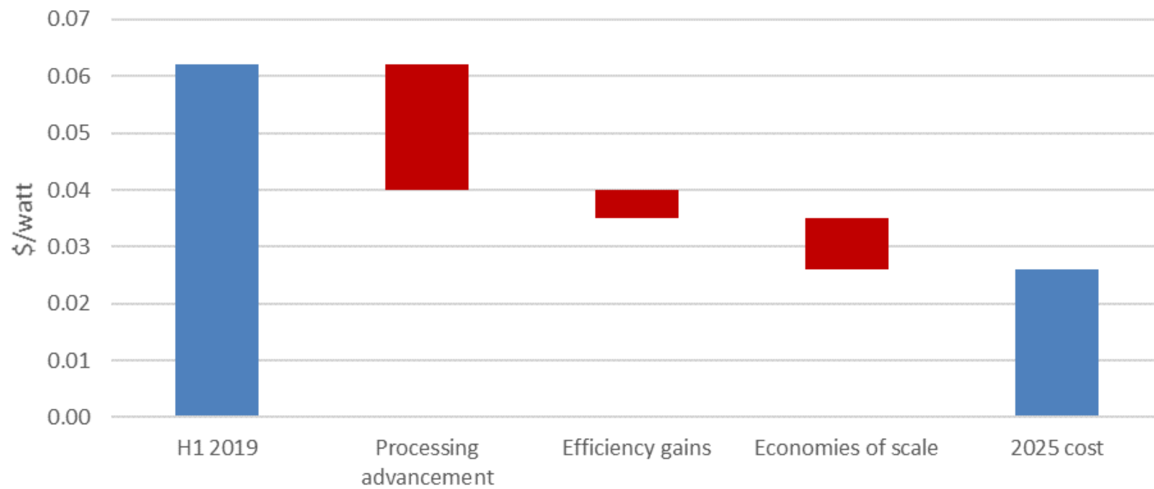
[61] ITRPV, *Results 2018 Including Maturity Report 2019*, October 2019, 25.

[62] ITRPV, *Results 2018 Including Maturity Report 2019*, October 2019, 23–25.

[63] Woodhouse et al., "The International Supply," June 5, 2019, 16.

[64] Woodhouse et al., "The International Supply," June 5, 2019, 16.

Figure III-9
Non-wafer global CSPV cell manufacturing cost reductions, 2019–25



Note: Cost reductions are for greenfield manufacturing facilities in urban China.

Source: Woodhouse et al., "The International Supply," June 5, 2019, 16.

Several sources expect substantial increases in global cell production capacity over the next few years, with manufacturers bringing large, new plants online. This may lead to oversupply that would put downward pressure on prices.[65] ***.[66] ***.[67] ***.[68]

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[65] LG Electronics' *CSPV Modification Advice* written submission to USITC, January 6, 2020, 11. ***.

[66] ***.

[67] ***.

[68] ***.

New CSPV Cell Plant Investment[69]

An increase in the TRQ would likely have little to no impact on firms' decisions to invest in U.S. cell manufacturing.[70] Given the time it takes to establish a new cell production facility, it is unlikely that any new cell plants for which plans are not already in place would be able to start production prior to the final year of the initial safeguard measure.[71] Based on a review of projects in Asia, the fastest timelines for a new production facility are 8 to 12 months from the time a new plant is announced to the start of production, including at least 6 months for the actual construction of the plant. Some plants take significantly longer to complete.[72] SunPower notes that cell plants take longer to build than module plants (and that there are also higher costs for permitting and environmental compliance).[73] Further, once a plant starts production, it takes a few months to ramp up to full capacity.[74] ***.[75] The timeframe for the return on investment in a cell plant would also be considerably longer than the time remaining in the safeguard measure.[76] Therefore, an expansion of the TRQ would not likely affect future investments in U.S. cell manufacturing, other than a potential Suniva restart, as described above.

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[69] This section will not assess the likelihood of investment in new plants overall, but will instead look at the potential impact on investment decisions of a change in the safeguard measure.

[70] As noted above, this analysis is based on policies currently in place, as stated in the USTR's request letter, and does not take into account the effect of any potential extension of the safeguard measure for a period of time or of any firm's expectations of extension of the safeguard.

[71] There are no known investments in new cell plants, other than the potential Suniva restart, the possible Sunpreme investment, and the possible order for heterojunction equipment (for which the firm purchasing this equipment and whether the production will be in the United States is not known). The lack of a domestic supply chain for cell manufacturing has also been cited as a barrier to investment in U.S. cell manufacturing. Domestic Module Producers Coalition, *CSPV Modification Advice* written submission to the USITC, January 6, 2020, 6. ***. ***.

[72] Based on a review of media reports and of company websites, documents, and press releases.

[73] SunPower, *CSPV Monitoring* posthearing brief, tab 1.

[74] Suniva, for example, stated that it could restart production within four months, but that it would take six months to reach full production. Similarly, Longi indicated that it plans to start production at its cell plant in Malaysia in Q1 2020, and that the plant will be ramped up to full production in Q2 2020. Suniva prehearing brief, attachment 12; Wong, "LONGi Invests Additional RM500mil," August 19, 2019.

[75] ***.

[76] LG Electronics, *CSPV Modification Advice* written submission to the USITC, January 6, 2020, 11.

Employment and Wages

Suniva projects that it would employ over 200 workers after restarting production at full capacity.[77] Suniva's average wage in 2016 and 2017 for PRWs was *** per hour.[78] Suniva specifically estimates *** PRWs for a cell production capacity of 520 MW.[79] This equates to *** PRW per MW. A review of publicly available information on global cell manufacturers and manufacturing plants indicates that this is *** the global average of about 0.381 employees per MW, though that includes non-PRWs. It is *** of a plant of less than 1 GW, which is about 0.551 employees per MW, though that average also includes non-PRWs.[80]

Research and Development (R&D)

According to questionnaire responses, there is currently *** U.S. spending on cell R&D by active cell manufacturers, so raising the TRQ will have *** impact on current cell R&D expenditures.[81] If an increase in the TRQ negatively impacts Suniva's re-entry, it could reduce potential future R&D spending on cells. *** spent *** on cell R&D in 2016.[82]

Estimated Quantitative Effects of the TRQ Expansion

This section quantifies the probable economic effects of modifying the safeguard TRQ on cell imports using an industry-specific, partial equilibrium model that links production and trade in cells and modules. The model estimates the effects of safeguard modification on U.S. domestic module and cell production, trade, employment, and operating income. It is an extension of the model used to assess the economic effects of alternative remedy recommendations in the Commission's 2017 original safeguard investigation on CSPV products (*CSPV Safeguard Remedy model*).[83]

The model shares the main features of the *CSPV Safeguard Remedy model*. It estimates the response of U.S. and foreign production and trade in cells and modules to changes in prices, taking into account the link between upstream cell production and downstream module

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[77] Suniva, *CSPV Monitoring* prehearing brief, attachment 12.

[78] ***.

[79] ***.

[80] Compiled from company and industry websites, media reports, and BloombergNEF database (accessed February 2020).

[81] ***. *CSPV Monitoring*, IV-17.

[82] ***.

[83] USITC, *CSPV Original Safeguard,* 2017.

production.[84] It allows for a tariff applied to imports of modules and a separate TRQ applied to imports of cells. It also allows for covered and non-covered module distinctions. If the market-clearing prices at full capacity are below the average variable costs of U.S. module producers, then domestic production levels and capacity utilization fall and market prices increase, until revenues exceed variable costs. While module capacity utilization is calculated inside the model on a monthly basis using this measure of short-run profitability, Suniva cell production is assumed to operate at full practical capacity in the model because the cell price is higher than the variable costs associated with producing.

Updates to the model include using 2019 data from questionnaire responses in *CSPV Monitoring* and several new features to better capture the conditions of competition that will characterize the U.S. CSPV industry in 2020 and 2021. It incorporates projections for new additions to U.S. module production capacity over the next two years and estimates the rate of capacity utilization based on pricing and profitability under the alternative TRQ levels. It estimates changes in market-clearing prices on a monthly (rather than calendar year) basis to better fit the model to the timing of capacity additions and to the operation of the annual TRQ, which is unlikely to fill until the later months in each February–January remedy year. The new model also considers the implications of Suniva restarting cell production in the United States and estimates Suniva's profitability upon re-entry. Finally, the new model takes into account the product exclusion for imports of bifacial modules, which is likely to have significant effects on prices and trade in both modules and cells.

Modification Model Inputs

The inputs of the model include projected module production capacity and projected total module demand in each of the remaining months of the remedy, as described in part II; detailed questionnaire data on the quantities and dollar values of trade and production; and the variable and fixed costs of module and cell production in the United States. The model also includes data on industry employment in the United States and several parameter values that reflect the interchangeability of products from different sources, as well as the supply response of foreign producers to the changes in prices. Appendix E provides additional detail about the

[84] U.S. cell production has declined since the remedy went into effect. Panasonic was the only U.S. cell producer when this report was written, and nearly all of their HIT cells were ***. In addition, as stated above, Panasonic has confirmed that it will be closing production of CSPV products in May 2020, further limiting its ability to supply the U.S. market during the remainder of the safeguard remedy. Because this model uses sources that supply the U.S. market, ***. The model only allows for Suniva domestic cell production to increase in the third and fourth remedy year.

model inputs, while appendix D describes the calculations of underlying data used within this analysis.

Isolating the Effects of the Potential Safeguard Modification

The model first projects the likely domestic production and imports of cells and modules for the last two years of the safeguard measure, allowing for Suniva to re-enter domestic cell production and assuming that the exclusion for bifacial modules is no longer in place. It then simulates the probable economic effects of three alternative TRQ modifications. The three alternatives all involve raising the level of the TRQ on cell imports for the two remaining years of the safeguard remedy (February 2020–January 2021 and February 2021–January 2022), from 2.5 GW per year to 4.0 GW, 5.0 GW, or 6.0 GW per year.

The economic effects are calculated as the difference between each economic outcome (e.g., prices, production quantities) in the last two remedy years under each alternative TRQ modification and the same outcome under the status quo TRQ (the baseline values over time, also called the dynamic baseline). This calculation isolates the incremental effect of the TRQ modification. In order to present alternative scenarios, the modeling analysis also considers the possibility that Suniva will not re-enter domestic cell production, the possibility that the current product exclusion for bifacial module imports will remain in place, and the possibility that bifacial modules will account for a growing market share in the next few years. These alternative scenarios are reported in appendix E.

Summary of Economic Effects

The proposed expansions of the TRQ on cell imports could have significant effects on U.S. imports, production, and pricing of cells and modules, depending on the expansion of domestic module capacity and total module demand for the remaining months of the remedy. Based on estimated import data, the 2.5 GW TRQ on cell imports did not fill in 2019, so if domestic supply and demand in the industry remained at 2019 levels, expanding the TRQ to 4.0, 5.0, or 6.0 GW would have no economic effects.[85] However, as discussed in part II, there will likely be a significant expansion of U.S. total demand for modules, both imported and domestically produced, and an expansion in domestic module production capacity that will increase the demand for imported cells. Because most U.S. modules are produced with imported cells, the increased demand for cells translates to an increase in demand for imported cells. If the increase in U.S. total demand for modules is large enough, this increased demand

[85] Unless otherwise stated, years presented in this section of part III, covering the model and model estimates, are remedy years. For example, remedy year 2019 is February 2019–January 2020.

would not be fully met by additional cell imports without exceeding the 2.5 GW TRQ. Cell imports above the TRQ would be subject to the above-quota duty rate under the safeguard measure, equal to 20 percent in the third year of the remedy and 15 percent in the fourth year.

If the TRQ level were raised to 4.0, 5.0, or 6.0 GW, this would allow the increase in U.S. imports of cells to occur without subjecting such imports to safeguard duties, resulting in a smaller increase in the price of cells and therefore a smaller increase in the price of modules. Compared to the status quo, a higher TRQ level would likely result in a greater increase in U.S. module production and employment, likely having a positive effect on capacity utilization of U.S. module producers. If Suniva re-enters and supplies domestically produced cells, an increase in the TRQ would probably reduce the demand for Suniva's cells, putting downward pressure on its pricing and profits. The next section reports model-based estimates of these economic effects.

Model Estimates

The dynamic baseline estimates for the 2.5 GW TRQ are reported in table III-1, which incorporates demand projections and increases to practical capacity. Tables III-2 to III-4 report estimates of economic effects of increasing the TRQ levels to 4.0 GW, 5.0 GW, and 6.0 GW respectively, including the percentage differences for each indicator from the 2.5 GW TRQ baseline. To best isolate the effects of the TRQ modification, these estimates assume that there is no safeguard exclusion for U.S. imports of bifacial modules. The estimate allows for Suniva to re-enter the market, producing cells at full practical capacity, and confirms that this allows Suniva to generate positive operating income for the remaining two years of the safeguard.[86] The model uses a conservative estimate for production capacity provided by Suniva, and assumes it sells all that it produces.[87]

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[86] As a sensitivity analysis, additional model results presented in appendix E are based on different assumptions, including an assumption that Suniva does not re-enter the market and an assumption that the bifacial exemption remains in place.

[87] Suniva reported its production capacity for bifacial cells at both 520 MW and 540 MW. This analysis uses the more conservative estimate of 520 MW. For the purposes of the report, it was assumed that Suniva is able to utilize the full 520 MW of production capacity. Practical capacity may be lower or higher, depending on factors such as the actual throughput on restarting production and the extent to which Suniva is able to increase cell efficiency over time.

Table III-1
CSPV dynamic baseline under the status quo 2.5 GW TRQ, 2019–21

	2019	2020	2021
U.S. module production	***	***	***
U.S. imports of covered foreign modules	***	***	***
U.S. imports of non-covered foreign modules	***	***	***
U.S. cell production	***	***	***
U.S. imports of covered foreign cells	***	***	***
Price of U.S. modules	***	***	***
Price of U.S. imports of covered foreign modules	***	***	***
Price of U.S. imports of non-covered foreign modules	***	***	***
Price of U.S. cells	***	***	***
Price of U.S. imports of covered foreign cells[88]	***	***	***

Note: Estimated baseline values incorporate demand projections and increases to modules' practical capacity. Quantities are in kilowatts, and prices are in $ per kilowatt. Average prices for the 12-month remedy year are reported. The 2019 data in this table are annualized from the first half of 2019.

Source: USITC estimates.

Based on the demand and capacity expansion projections, the model predicts that the TRQ will fill in the 2.5 GW TRQ baseline (in August of the remedy year) and the 4.0 GW TRQ alternative (in December of the remedy year) in both 2020 and 2021 and will not fill in the 5.0 GW and 6.0 GW alternatives in either year. The model estimates that the increase to the 4.0 GW TRQ level will have a positive effect on U.S. domestic module producers, as seen in table III-2. U.S. module producers that import their cells benefit from the lower prices of imported cells as more cell imports enter the country before the higher TRQ rates are applied. As a result, the model estimates lower average U.S. module prices in this scenario.[89] Domestic module production increases and U.S. imports of foreign-produced modules decrease as more consumers of modules source their products locally. Foreign module producers lower their prices slightly to remain competitive with lower U.S. module prices.

[88] Cell prices increase in the baseline as a result of two main effects. First, cell imports in 2020 and 2021 are above the baseline 2.5 GW TRQ level, so the average prices reported in table III-1 include the safeguard duties for some of the months of the remedy year. Second, the projected increases in module demand directly translate to increases in derived demand for cells.

[89] Module prices are lower even in the baseline reported in table III-1, due to the significant projected increase in U.S. module production capacity. The reduction in cell import prices adds to this effect.

Table III-2
Alternative 4.0 GW TRQ: Estimated levels of and changes in the production and trade of CSPV modules and cells (changes relative to the dynamic baseline with the 2.5 GW TRQ)

Variable	2020	2021	% change in 2020	% change in 2021
U.S. module production	***	***	***	***
U.S. imports of covered foreign modules	***	***	***	***
U.S. imports of non-covered foreign modules	***	***	***	***
U.S. cell production	***	***	***	***
U.S. imports of covered foreign cells	***	***	***	***
Price of U.S. modules	***	***	***	***
Price of U.S. imports of covered foreign modules	***	***	***	***
Price of U.S. imports of non-covered foreign modules	***	***	***	***
Price of U.S. domestic cells	***	***	***	***
Price of U.S. imports of covered foreign cells	***	***	***	***

Note: Estimated results are relative to a 2020 and 2021 baseline with a 2.5 GW TRQ. Quantities are in kilowatts, and prices are in $ per kilowatt. Average prices for the 12-month remedy year are reported.

Source: USITC estimates.

The TRQ does not fill during the remedy year for either the 5.0 GW or the 6.0 GW TRQ alternative, and for this reason the estimated economic effects are the same for both alternatives. As shown in tables III-3 and III-4, U.S. module production increases are larger than under the 4.0 GW TRQ scenario (*** percent in 2020 and *** percent in 2021 under both alternatives), because domestic producers who source cells from abroad pay no tariff throughout the year and produce at a lower cost. Capacity utilization of U.S. domestic module producers is also higher at the 5.0 GW and 6.0 GW TRQ level.

Under each of these alternatives, the model estimates that the prices of U.S. cell producers decline in response to increased competition from imported cells. The model estimates that ***.

Table III-3
Alternative 5.0 GW TRQ: Estimated levels of and changes in the production and trade of CSPV modules and cells (changes relative to the dynamic baseline with the 2.5 GW TRQ)

Variable	2020	2021	% change in 2020	% change in 2021
U.S. module production	***	***	***	***
U.S. imports of covered foreign modules	***	***	***	***
U.S. imports of non-covered foreign modules	***	***	***	***
U.S. cell production	***	***	***	***
U.S. imports of covered foreign cells	***	***	***	***
Price of U.S. modules	***	***	***	***
Price of U.S. imports of covered foreign modules	***	***	***	***
Price of U.S. imports of non-covered foreign modules	***	***	***	***
Price of U.S. domestic cells	***	***	***	***
Price of U.S. imports of covered foreign cells	***	***	***	***

Note: Estimated results are relative to a 2020 and 2021 baseline with a 2.5 GW TRQ. Quantities are in kilowatts, and prices are in $ per kilowatt. Average prices for the 12-month remedy year are reported.

Source: USITC estimates.

Table III-4
Alternative 6.0 GW TRQ: Estimated levels of and **changes in the production and trade of CSPV modules and cells (changes relative to the dynamic baseline with the 2.5 GW TRQ)**

Variable	2020	2021	% change in 2020	% change in 2021
U.S. module production	***	***	***	***
U.S. imports of covered foreign modules	***	***	***	***
U.S. imports of non-covered foreign modules	***	***	***	***
U.S. cell production	***	***	***	***
U.S. imports of covered foreign cells	***	***	***	***
Price of U.S. modules	***	***	***	***
Price of U.S. imports of covered foreign modules	***	***	***	***
Price of U.S. imports of non-covered foreign modules	***	***	***	***
Price of U.S. domestic cells	***	***	***	***
Price of U.S. imports of covered foreign cells	***	***	***	***

Note: Estimated results are relative to a 2020 and 2021 baseline with a 2.5 GW TRQ. Quantities are in kilowatts, and prices are in $ per kilowatt. Average prices for the 12-month remedy year are reported.

Source: USITC estimates.

The estimated effects of the various TRQ alternatives on U.S. employment in module production are reported in table III-5. Raising the TRQ level has a positive impact on U.S. module employment in each of the alternatives considered. The 5.0 GW and 6.0 GW TRQ show larger employment changes than the 4.0 GW TRQ because domestic module production levels are higher when the TRQ does not fill. The model does not attempt to estimate the change in employment levels for U.S. cell production, since there is *** U.S. cell production in the 2019 data. *** of the increase in U.S. employment in cell production would come from domestic cell producer Suniva, which has indicated that it would employ over 200 production workers if it were to restart production and operate at full practical capacity, as described above.

Table III-5
U.S. module producers' employment effects of raising TRQ (changes relative to the dynamic baseline with the 2.5 GW TRQ)

	4.0 GW TRQ		5.0 GW TRQ		6.0 GW TRQ	
	2020	2021	2020	2021	2020	2021
Change in no. of production workers	***	***	***	***	***	***
% change	***	***	***	***	***	***

Note: Results are relative to a 2020 and 2021 dynamic baseline with the 2.5 GW TRQ in place and include projections of demand and capacity. Module employment results were generated by the model.

Source: USITC estimates.

Estimated capacity utilization of U.S. domestic module producers under each of the TRQ alternatives is reported in table III-6. The calculation is based on estimated module producers' practical capacity, as described in part II. Capacity utilization is higher in all three TRQ alternatives relative to the baseline, but the 5.0 GW and 6.0 GW TRQ scenarios show the largest percentage increase in capacity utilization because the TRQ on cells as inputs for module production does not fill in the model simulations, allowing module producers duty-free access to imports of cells throughout the year, leading to lower per unit production costs. Capacity utilization in 2021 is lower than in 2020 in part because the tariff on U.S. imports of modules is lower in the fourth year of the remedy, so more modules are imported. Also, projected module capacity increases in 2021 relative to 2020, so more production would be required to retain similar levels of capacity utilization.

Table III-6
Capacity utilization of U.S. domestic module producers under each of the TRQ alternatives

	2.5 GW TRQ		4.0 GW TRQ		5.0 GW TRQ		6.0 GW TRQ	
	2020	2021	2020	2021	2020	2021	2020	2021
Capacity utilization	***	***	***	***	***	***	***	***

Note: Changes are relative to a 2020 and 2021 dynamic baseline with the 2.5 GW TRQ in place and include projections of demand and capacity. All estimates were generated by the model.

Source: USITC estimates.

The estimated effects of the TRQ change on U.S. cell producers' operating income are reported in table III-7. Estimated effects on U.S. module producers' operating income is not included because the model does not have enough information to quantify the effects. An increase in the TRQ level has a negative impact on U.S. cell producer operating incomes, as the additional duty-free cell imports lower the price of domestic cells. U.S. cell producer operating income would drop from $*** under the baseline scenario to $*** under the 4.0 GW scenario and $*** under the 5.0 GW and 6.0 GW scenarios.

Table III-7
Financial effects of raising TRQ on U.S. cell producers (changes relative to the dynamic baseline with the 2.5 GW TRQ)

	2.5 GW TRQ	4.0 GW TRQ	5.0 GW TRQ	6.0 GW TRQ
Operating income levels (million $)	***	***	***	***
Change in operating income (million $)	N/A	***	***	***
% change	N/A	***	***	***

Note: Results are relative to a 2020 and 2021 dynamic baseline with the 2.5 GW TRQ in place, and include projections of demand and capacity. All estimates were generated by the model.

Source: USITC estimates.

Appendix E reports additional model runs that assess the sensitivity of the model estimates to assumptions about Suniva re-entry, the bifacial exclusion, and an exogenous increase in bifacial module market share.

APPENDIX A

REQUEST LETTER

THE UNITED STATES TRADE REPRESENTATIVE
EXECUTIVE OFFICE OF THE PRESIDENT
WASHINGTON

December 6, 2019

The Honorable David S. Johanson
Chairman
United States International Trade Commission
500 E Street, S.W.
Washington, DC 20436

Dear Chairman Johanson:

On January 23, 2018, the President issued Proclamation 9693 that imposed a safeguard measure, pursuant to Section 203 of the Trade Act of 1974 (19 U.S.C. 2253) (Trade Act), on imports of certain crystalline silicon photovoltaic (CSPV) cells, whether or not partially or fully assembled into other products (such as modules). The safeguard measure took the form of (1) a tariff-rate quota on imports of CSPV cells not partially or fully assembled into other products and (2) an increase in duties on imports of other CSPV products such as modules.

The Commission is currently preparing a report under section 204(a)(2) of the Trade Act to identify developments with respect to the relevant domestic industry, including any progress and specific efforts by workers and firms to make a positive adjustment to import competition following implementation of the safeguard measure.

Under the authority delegated to me by the President, I request that the Commission, pursuant to section 204(a)(4) of the Trade Act, provide its advice regarding the probable economic effect on the domestic CSPV cell and module manufacturing industry of modifying the safeguard measure. Specifically, I request that the Commission analyze the effect of increasing the level of the tariff-rate quota from the current 2.5 gigawatts ("GW") to 4, 5, or 6 GW, without other changes to the remedy. Economic modeling, entailing both qualitative and quantitative analysis, should be based on the most recent available data. While the Commission's advice in response to this request will be public, all confidential business information should be clearly identified and redacted from the public version.

My understanding is that the Commission will submit its report no later than February 7, 2020. I greatly appreciate the work the Commission and its staff have undertaken already and ask that it provide the advice requested above no later than 30 days from the date of that report.

Sincerely yours,

Robert E. Lighthizer

Robert E. Lighthizer

APPENDIX B

FEDERAL REGISTER NOTICE

The Commission makes available notices relevant to its investigations and reviews on its website, www.usitc.gov. In addition, the following tabulation presents the *Federal Register* notice issued by the Commission during the current proceeding.

Citation	Title	Link
84 FR 70565, December 23, 2019	*Crystalline Silicon Photovoltaic Cells, Whether or Not Partially or Fully Assembled Into Other Products: Advice on the Probable Economic Effect of Certain Modifications to the Safeguard Measure*	https://www.govinfo.gov/content/pkg/FR-2019-12-23/pdf/2019-27627.pdf

APPENDIX C

SUMMARY OF THE VIEWS OF INTERESTED PARTIES

In its Notice of Investigation, the U.S. International Trade Commission (Commission) stated that “persons wishing to have a summary of their written submission included in the report should include a summary along with their written submission and should specifically identify the summary as being for this purpose.”[1] The Notice specified that summaries should not include confidential business information (CBI) and should not exceed 500 words. One party included such a summary along with their written submission: a coalition including Hanwha Q CELLS USA, Inc., Mission Solar Energy, SunPower Manufacturing Oregon, LLC, and Auxin Solar.

Summary of the Views of Hanwha Q CELLS USA, Inc.; Mission Solar Energy; SunPower Manufacturing Oregon, LLC; and Auxin Solar

Context

The Commission’s advice on the cell TRQ should take account of several contextual points.

- Real concern: Concern about the adverse effect of an un-enlarged 2.5 GW allowance for duty free cells is well-justified, not speculative. The gap between domestic cell production (capacity and output) and domestic module production has been authoritatively documented. Cells are, cost-wise, the most important manufacturing input for CSPV module assembly. Having to pay tariffs on their primary production input would impair U.S. module producers’ competitiveness vis-à-vis foreign module producers.
- No unfairness: The fact that CSPV cell production has not seen a supply response in the United States during the first two years of safeguard relief does not mean the CSPV safeguard remedy was poorly designed or unfair to any party. The remedy was strategically designed to achieve what temporary import tariffs could achieve. It created commercial opportunities that different enterprises have responded to in different ways, with varying results.
- Consistent with positive adjustment: For the overall industry to have emphasized module assembly, and de-emphasized cell production, during the period of safeguard relief is entirely consistent with “positive adjustment” as defined in the safeguard law, which states that positive adjustment may include (1) improvement in the domestic industry’s ability to compete successfully with imports, or (2) orderly transfer of resources to different productive pursuits. Meanwhile, undermining or putting at risk the positive adjustment that is occurring, on account of other forms of positive

[1] 84 Fed. Reg. 70565 (December 23, 2019).

adjustment that are not occurring, makes no sense in the context of the law's text and policy underpinnings.

- National security: There is no national security imperative to restore cell-making on the same timetable as module assembly, or at the expense of module assembly.

Answers to Commission Questions

The Commission has asked about a larger TRQ's likely impact on current and future CSPV manufacturing investments.

- Current module producer investments: A larger TRQ is essential to continued viability.
- Future module producer investments: These are difficult to imagine under a cell TRQ that is plainly smaller than the demand represented by existing module producers. Indeed, Coalition members have expressly tied capacity-expanding investments to cell TRQ enlargement.
- Current cell-producing investments: The Coalition shares the view articulated by the biggest active CSPV cell producer that has made and is seeking a return on such an investment, Tesla/Panasonic, which long ago made clear its preference for a larger (at least 5 GW) cell TRQ.
- Future cell-making investments: A larger TRQ during years 3-4 of the safeguard measure would have no negative effect. Tariffing unassembled cells, while fully capable of undermining the economics of U.S. module assembly, is not by itself capable of incentivizing domestic cell production. Furthermore, the tariff on modules is already an incentive for U.S. cell production, as a result of the price premium that a U.S. cell producer could obtain by exporting. In any event, the best possible driver for future domestic cell production will be a sustainably healthy U.S. module production industry.

The full public written submission of Hanwha Q CELLS USA, Inc.; Mission Solar Energy; SunPower Manufacturing Oregon, LLC; and Auxin Solar is available on the Commission's Electronic Document Information System (EDIS) here: https://edis.usitc.gov/external/search/document/698518.

Additional written submissions and responses of interested parties

The Commission also received written submissions and responses to written submission from several other interested parties. These included:

Additional written submissions

- Heliene USA Inc. and Silfab Solar WA Inc. (EDIS link: https://edis.usitc.gov/external/search/document/698489)

- Hemlock Semiconductor Operations LLC; Wacker Polysilicon North America, LLC, and REC Silicon (EDIS link: https://edis.usitc.gov/external/search/document/698476)

- LG Electronics USA, Inc. and LG Electronics, Inc. (EDIS link: https://edis.usitc.gov/external/search/document/698494)

Responses to written submissions

- Solar Energy Industries Association (EDIS link: https://edis.usitc.gov/external/search/document/699073)

- Suniva, Inc. (EDIS link: https://edis.usitc.gov/external/search/document/699060)

- Tesla, Inc. (EDIS link: https://edis.usitc.gov/external/search/document/698881)

APPENDIX D

INPUTS FOR PROBABLE ECONOMIC EFFECTS ANALYSIS

Demand

This appendix provides an overview of the methodology for calculating the inputs for the model and the qualitative analysis in part III. Some of the inputs are based on historical data, while others are forward-looking for the purpose of estimating the impact of an increase in the tariff-rate quota (TRQ) in future years.

Apparent U.S. Consumption

Data Used in the Model

Apparent U.S. consumption during 2020–22 was estimated for the model using different approaches for each year, depending on the available data. The Commission's questionnaire collected data from U.S. and foreign producers on estimated production and shipments to the U.S. market in 2020. Projected 2020 domestic production (excluding domestic exports and production by ***) and shipments to the U.S. market by foreign producers total more than ***. The firms providing this information accounted for almost *** percent of U.S. apparent consumption in 2019. Assuming that suppliers' market share is the same in 2020, this implies a domestic market of ***, excluding ***. *** domestic production *** would increase apparent U.S. consumption to *** in 2020.[1]

For 2021 and 2022, questionnaire data were not available, so apparent consumption is based on forecasts developed by SPV Market Research, which projects apparent consumption of 20.4 GW in 2021 and 20.7 GW in 2022 in an accelerated scenario. SPV Market Research prepared three market scenarios: low, conservative, and accelerated. The low scenario, according to SPV Market Research, "assumes slightly slower buying activity over 2019 due to inventory overhang. Beyond 2020 activity ramps modestly." The conservative scenario "assumes continued buying despite inventory overhang in anticipation of continued ramp down of ITC and high availability of bifacial and other modules."[2] The accelerated scenario "assumes

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[1] Other data support that there are likely substantial imports not captured by these data. For example, responding foreign producers accounted for *** percent of cell and *** percent of 2018 module production capacity in the countries that are the largest exporters to the United States ***. Based on data submitted in response to *CSPV Monitoring* questionnaires, *CSPV Modification* written submissions, *CSPV Monitoring* briefs, proprietary Customs records, and publicly available information on U.S. and foreign producers.

[2] See part II for a discussion of the investment tax credit (ITC), step-down in rates, and incentives to acquire modules early to qualify for higher tax credits.

accelerated activity despite inventory overhang in anticipation of ITC ramp down and high availability of inexpensive import modules due to soft demand in China." The accelerated scenario is used in the model, as the 18.6 GW estimated in that scenario in 2020 ***.[3]

Checks of market forecasts

Alternative calculations were also prepared to check the accuracy of the forecasts for 2020 and 2021.[4] For 2020 and 2021, this calculation sums (1) projected exports to the U.S. market from questionnaire data; (2) data reported publicly by firms that did not provide a questionnaire response on orders for, or expected shipments to, the U.S. market in 2020; (3) annualized data for the first half of 2020 on arranged imports from Commission questionnaires, excluding firms that import from a company that provided a foreign producer questionnaire or for which public data were available; and (4) projected domestic production by U.S. manufacturers. Apparent consumption using these data totaled more than ***. These data, however, likely underrepresent U.S. imports, as they do not include all the major suppliers to the U.S. market and only include first-half 2020 imports that were arranged as of the time that firms submitted the questionnaire.[5]

Further, a rough calculation of shipments in 2021 was done based on photovoltaic (PV) installation forecasts. This calculation assumes (1) that modules for residential and nonresidential products are shipped *** before they are installed; (2) that there is a five-month lag between the time when a module for a utility project is shipped and the time when the project is commissioned; (3) that modules for 6 percent of installations were imported in prior years; and (4) that modules for 6 percent of remaining demand through 2023 are imported in 2021 (as the last possible year to safe harbor modules to qualify for the higher investment tax credit).[6] Estimated thin-film module shipments are then subtracted from this

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[3] SPV Market Research, Excel file, January 13, 2020.

[4] Only one month of data for 2022 is used in the model, so an alternative calculation was not used to check this estimate.

[5] *CSPV Monitoring* questionnaires were submitted between September and December 2019.

[6] ***. For utility projects, a review of available project information indicates that there is a range of time differences between shipment and installation, which is impacted by factors such as the size of the project. The average amount of time between shipments (or import into the United States for foreign production) and project commissioning was *** months for the projects reviewed. EIA, Short-term Energy Outlook Data Browser, table 8b, "U.S. Renewable Electricity Generation and Capacity," January 14, 2020; EIA, *Annual Energy Outlook 2020*, table 16, "Renewable Energy Generating Capacity and Generation," 2020; ***.

forecast. This results in estimated apparent consumption of ***, which is close to SPV Market Research's accelerated scenario of 20.4 GW.[7]

Comparison with Installation Forecasts

U.S. PV installation data also point to strong U.S. demand during 2020–21, though the pattern of installations and the level may vary from projected CSPV shipments. The U.S. Department of Energy (DOE) Energy Information Administration (EIA) estimated 2019 installations at 12.0 GW, and forecasts 23.7 GW of installations in 2020, 25.3 GW in 2021, and 27.7 GW in 2022, before a substantial decline in 2023 (figure D-1).[8]

[7] This is a rough estimate, and changing the lead time for modules for utility applications can have a significant impact on the estimate. Further, project schedules may change, and additional projects may be added.

[8] EIA data are converted from alternating current (AC) to direct current (DC) using the inverter loading ratio by market segment. EIA, Short-term Energy Outlook Data Browser, table 8b, "U.S. Renewable Electricity Generation and Capacity," January 14, 2020; EIA, Form EIA-860, September 3, 2019; Barbose and Darghouth, *Tracking the Sun*, September 2019, public data file.

Figure D-1
U.S. PV installations, 2016–23

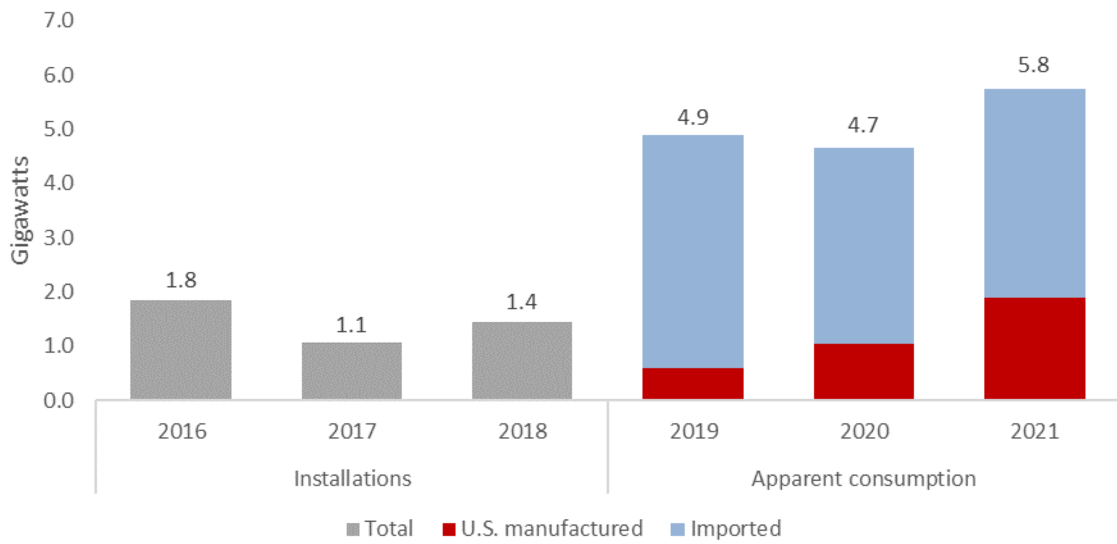
* * * * * * *

The differences between shipments and installations reflect both the early import of modules to qualify projects for tax credits and the growing shipments of thin-film products to the U.S. market. The increasing shipments of thin film reflect First Solar's increasing production capacity, the launch of First Solar's new series 6 modules, increasing activity in the U.S. market by Japanese thin film producer Solar Frontier, and the fact that thin film is not in the scope of the safeguard measure.[9] U.S. installations of thin-film modules were less than 2 GW annually

[9] First Solar shipped 2.6 GW in 2018, but expected to ship 5.4 to 5.6 GW in 2019, 5 to 5.5 GW in 2020, and about 6.5 GW in 2021. The firm had 3 GW of production capacity in 2018, 5.5 GW at the end of 2019, and expects to reach 6.7 GW at the end of 2020. Of this production capacity, 1.9 GW is in the United States. Groom, "Expiring U.S. Solar Subsidy," July 19, 2019; Roselund, "PV Module Shipments Spiked," November 15, 2019; Bloomberg, "US Solar Companies Are Stockpiling," November 13, 2019; First Solar, "Investor Overview," October 24, 2019, 15; First Solar, "Q3'19 Earnings Call," October 24, 2019, 11; First Solar, "Q2'19 Earnings Call," August 1, 2019, 6; First Solar, "Q4'18 Earnings Call, "February 21, 2019, 5; St. John, "First Solar Inks 1.7GW," September 24, 2019; Spector, "First Solar Speeds Ahead," March 2, 2018; Colville, "PV CellTech 2020," December 3, 2019; Schoeck, "Solar Frontier U.S. Power Development," January 22, 2019; Ludt, "Solar Frontier America Acquires," September 18, 2019; Misbrener, "Solar Frontier Americas Acquires 100-MW," September 10, 2019.

during 2016–18 (figure D-2). In 2019, however, apparent U.S. consumption of thin film reached about 4.9 GW. Apparent U.S. consumption is expected to be about 4.7 GW in 2020 and close to 6 GW in 2021.

Figure D-2
Thin film installations, 2016–18, and projected shipments to the U.S. market, 2019–21



Note: Historical installation data do not include residential and nonresidential applications, but these account for less than 1 percent of installations. Shipments in 2019 are full-year 2019 imports and estimated U.S. production. Shipments in 2020 and 2021 are estimates based on publicly reported information from First Solar earnings calls and information on Solar Frontier projects and construction schedules from BloombergNEF, media reports, and news releases.

Source: EIA, Form EIA-860, September 3, 2019; Barbose and Darghouth, *Tracking the Sun*, September 2019, public data file; Bolinger, Seel, and Robson, *Utility-Scale Solar*, December 2019, data file; First Solar earnings calls and presentations; media reports and news releases on Solar Frontier projects; ***; DataWeb/USDOC (accessed February 9, 2020).

Apparent U.S. Consumption of Bifacial Modules

As discussed in appendix E, certain modeling simulations assume that the market for bifacial modules will grow to levels beyond the status quo in 2019. The Commission's calculation of bifacial apparent consumption, for the technology change scenario in the model, used January 2020 imports as the starting point. First, bifacial imports in January 2020 were calculated ***. Assuming a gradual scaling of bifacial modules as production capacity is switched over and new orders are placed, the volume of bifacial imports was assumed to increase by the same percentage each month until 100 percent of utility and nonresidential installations were supplied by bifacial products in January 2022.[10] The assumption that bifacial modules will grow to supply most of the market was based on a variety of assessments, most of which indicate a market dominated by bifacial products:

- BloombergNEF projected that the U.S. utility market will switch to 100 percent bifacial products.[11]
- Jinko Solar stated that it expects bifacial modules to become the "mainstream" product used in the United States.[12]
- Invenergy stated at *CSPV Monitoring* hearing that "almost all of our utility-scale projects are designed for bifacial modules."[13] According to ***, Invenergy has *** of projects scheduled for completion in 2020 and *** of projects in 2022.[14]
- One developer indicated that bifacial modules are now the default choice for PV systems installed with trackers.[15] Projects with trackers accounted for 59 percent of large U.S. installations in 2017–18.[16]
- In June 2019, NEXTracker forecast a 50 percent market share for bifacial products within three years, though it is unclear if this forecast takes into account the bifacial exclusion.[17]
- In August 2018, one module producer indicated that it expects most customers to switch to bifacial modules in one to two years.[18]

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[10] Bifacial products can also be used in residential applications, but there was very limited information on which to base a forecast of market penetration in the sector. Therefore, estimates of bifacial demand growth were based on market penetration in the utility and nonresidential sectors.

[11] Natter and Efstathiou, "Solar Has New Way to Duck Trump's Tariffs," June 12, 2019.

[12] Stromsta, "Jinko Solar Sees Surge of Demand," July 1, 2019.

[13] USITC, *CSPV Monitoring* hearing transcript, December 5, 2019, 211.

[14] BloombergNEF database (accessed January 2020).

[15] Parnell, "As Investors Get Comfortable," June 18, 2019.

[16] EIA, Form EIA-860, September 3, 2019.

[17] Kelly-Detwiler, "NEXTracker's Dan Shugar," June 26, 2019.

[18] Merchant, "As Bifacial Solar Modules Inch toward the Mainstream," August 17, 2018.

- Canadian Solar is switching all production capacity for the U.S. market to bifacial products.[19]

For 2020, this results in a forecast for apparent U.S. consumption of bifacial modules of ***, which is approximately *** percent of apparent consumption in 2020. This is a more conservative estimate than other recent projections.[20] For example, Trina estimates that bifacial modules will account for 40 percent of U.S. demand in 2020.[21] In a presentation to the Office of the U.S. Trade Representative (USTR) in June 2019, the domestic industry used the assumption that bifacial shipments to the U.S. market would be 7 GW in 2020.[22] ***.[23] Additional data collected on the extent of bifacial activity in the U.S. market in 2020 are listed in table D-1, but these are not comprehensive or mutually exclusive, as the module provider for all of the Invenergy projects is not available.

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[19] Attachment 15 to U.S. Court of International Trade, Case 1:19-cv-00192-GSK, Document 15, filed October 22, 2019, https://morningconsult.com/wp-content/uploads/2019/11/4-Public-Motion.pdf.

[20] In September 2019, WoodMac also issued a forecast for the global bifacial market through 2024, with a breakout for North America. That forecast is not used in this analysis, as ***, at least in terms of shipments. Further, WoodMac has significantly increased its overall forecast for the U.S. market (by 9 GW over five years) since issuing its bifacial forecast in September. ***; WoodMac and SEIA, *U.S. Solar Market Insight Q4 2019*, Executive Summary, December 2019, 5; Sun, "WoodMac: Bifacial Solar Market Set to Grow Tenfold by 2024," September 24, 2019.

[21] *PV Magazine*, "Interview with Trina Solar," December 17, 2019.

[22] Attachment 15 to U.S. Court of International Trade, Case 1:19-cv-00192-GSK, Document 15, filed October 22, 2019, https://morningconsult.com/wp-content/uploads/2019/11/4-Public-Motion.pdf.

[23] ***.

Table D-1
Known bifacial activity in 2020

Firm	2020 (MW)	Description
Suppliers		
***	***	Projected exports to the U.S. from foreign producer questionnaire.
Dehui Solar	900	Share of module capacity "reserved" for bifacial U.S. utility solar projects.
ET Solar	400	Orders for U.S. market in the second half of 2020 (as of August 2019), which include both monofacial and bifacial products.
***	***	Projected exports to the U.S. from foreign producer questionnaire.
***	***	Projected exports to the U.S. from foreign producer questionnaire.
Other firms	***	Identified January 2019 imports from other foreign suppliers ***. This may understate the volume of shipments, as ***.
Developers		
Invenergy	***	Invenergy stated at *CSPV Monitoring* hearing that "almost all of our utility-scale projects are designed for bifacial modules." ***.

Note: These data are not comprehensive or mutually exclusive, as the module provider for all Invenergy projects is not available.

Source: Martin, "Vietnamese PV Maker Dehui," January 20, 2020; USITC, *CSPV Monitoring* Hearing Transcript, December 5, 2019, 211 (Fletcher); Roselund, "ET Solar Is Back in the U.S. Market," August 7, 2019; ***; responses to *CSPV Monitoring* foreign producer questionnaires.

For 2021, this results in estimated apparent U.S. consumption of bifacial modules of ***. This is *** than the 10 GW estimated by the domestic industry in the June 2019 presentation to USTR.[24] It *** of the foreign industry to supply to the U.S. market. Roth projects 13 GW of bifacial production capacity outside of China in 2020.[25] Projected monthly apparent consumption of bifacial modules during the period of the safeguard is included in figure D-3.

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[24] Attachment 15 to U.S. Court of International Trade, Case 1:19-cv-00192-GSK, Document 15, filed October 22, 2019, https://morningconsult.com/wp-content/uploads/2019/11/4-Public-Motion.pdf.

[25] Roth Capital Partners, "First Solar Inc.," Flash Note, June 13, 2019, 1. Provided as an attachment to U.S. Court of International Trade, Case 1:19-cv-00192-GSK, Document 15, filed October 22, 2019, https://morningconsult.com/wp-content/uploads/2019/11/4-Public-Motion.pdf.

Figure D-3
Projected apparent U.S. consumption of monofacial and bifacial modules, February 2020–January 2022

*   *   *   *   *   *   *

Supply

Historical Data

The model used information on imports, exports, and shipments gathered from data submitted in response to Commission questionnaires in the model (table D-2). Data were collected only for the first half of 2019, so these data were annualized.

Table D-2
Annualized 2019 model inputs from questionnaires

	Value	Quantity
	1,000 $	***kilowatts***
Cell imports		
Covered	***	***
Not covered	***	***
Module imports		
Covered	***	***
Bifacial	***	***
Not covered (excluding bifacial)	***	***
Exports		
Domestic exports of modules	***	***
Domestic exports of cells	***	***
Shipments		
Domestic commercial shipments of modules using U.S.-origin cells	***	***
Domestic commercial shipments of modules using foreign-origin cells	***	***
Domestic commercial shipments of cells	***	***

Note: Annualized first-half 2019 data. For cells and modules, not covered goods are *** modules.

Source: Compiled from data submitted in response to *CSPV Monitoring* questionnaires.

U.S. Cell Production Capacity

U.S. cell production capacity during 2020–22 for Panasonic is based on ***. For Suniva, it is assumed that if the firm restarts production on February 1, 2020, it will have the practical capacity to produce 520 MW annually and would produce at up to 100 percent capacity. Suniva stated that it could re-start production within 100 days and be at full capacity in 6 months. Calculation of Suniva's monthly capacity data assumes that it would re-start at month 4 and ramp up capacity through month 6.[26]

[26] Suniva has stated that it could restart production of either monofacial or bifacial cells. Bifacial cells are used here, as that is the product for which they documented that they were in negotiations to restart production. Bifacial cells can be used in either monofacial or bifacial modules, so this does not change the end demand segments for its modules, though it does increase the potential production capacity from 450 MW to over 500 MW, as noted in part II. Suniva reported its production capacity for bifacial cells at both 520 and 540 MW. This analysis uses the more conservative estimate of 520 MW.

U.S. Module Production Capacity

Forecasts of U.S. module production capacity are based on estimates provided by firms. For producers that did not provide a forecast for production capacity in a given year, the data are based on their production capacity in the nearest prior year. Since 2019 production capacity includes data submitted in 2020 with full year 2019 data, it varies from annualized first-half 2019 data. Where a firm is expecting to bring new production online partway through a year, the new capacity is included only from the month when it is expected to become operational. Forecasts for production capacity include firms that did not provide questionnaire responses or written submissions, and therefore these estimates include all known U.S. module manufacturers.

U.S. Module Exports

The forecast for U.S. module exports, which is incorporated into the model, is based on information provided by firms in their written submissions. Given that ***.[27]

U.S. Module Employment

Employment in module production is unlikely to scale at the same rate as employment growth over 2019, as each additional unit of production requires fewer workers, as discussed in part III. Therefore, the labor intensity of production at manufacturers' forecasted levels of production was calculated. U.S. module production was calculated using data provided by firms, and other available data sources (table D-3). The same approach was then used to calculate employment. The 2019 full-year data are used in the model's baseline, and 2020 and 2021 data are used in the qualitative section of part III to show labor intensity as production increases.

Suniva, *CSPV Monitoring* prehearing brief, attachment 12; Suniva, *CSPV Monitoring* posthearing brief, attachment 1, 15; ITRPV, *2018 Results*, March 2019, 45.

[27] Domestic Module Producers Coalition, *CSPV Modification* written submission to the USITC, January 6, 2020, attachment 1.

Table D-3
Expected employment at various production levels

	2019	2020	2021
Production (kilowatts)	***	***	***
Employment	***	***	***

Note: Firms accounting for *** percent of 2019 production provided forecasts of their 2020 production and firms accounting for *** percent of 2019 production provided 2021 production forecasts. For firms that did not provide forecasts, production (or projected production for firms that only provided 2020 projections) in the closest prior year was used. Employment was calculated in the same way, except Tesla public information on expected future employment levels was used, as described in Part III.

Source: Compiled from data submitted in response to *CSPV Monitoring* questionnaires, *CSPV Modification* written submissions, *CSPV Monitoring* briefs, proprietary Customs records, company financial reports, and state government documents.

Production Costs

Suniva

Suniva's production costs are the estimated cost at which the firm would have produced in the first half of 2019 had it been in operation. This enabled comparisons with data collected in the response to Commission questionnaires. Costs are for monocrystalline passivated emitter rear contact (PERC) selective-emitter bifacial cells, as that is the product for which the firm has documented that it was in negotiations to restart production.[28]

Suniva's annual fixed cost of production would have been an estimated *** if it had been producing in 2019. The fixed costs of production were based on:

(1) Suniva's actual lease payments for 2019;[29]
(2) Recent costs of gas equipment rental from Linde;[30]
(3) R&D expenses ***;[31]
(4) SG&A expenses ***;[32]

[28] Suniva *CSPV Monitoring* prehearing brief, January 6, 2020, attachment 12.
[29] Suniva Inc., United States Bankruptcy Court for the District of Delaware, Case 17-10837-KG, Document 1193, filed April 9, 2019.
[30] Suniva Inc., United States Bankruptcy Court for the District of Delaware, Case 17-10837-KG, Document 438, filed December 26, 2017.
[31] ***.
[32] ***.

(5) Depreciation on investment in new equipment purchased to restart production ***, assuming five-year straight-line depreciation and no residual value;[33] and

(6) ***.[34]

Suniva's variable costs of production in the first half of 2019 were estimated at *** per watt. Estimates of Suniva's variable costs were based on:

(1) The estimated cost of a wafer from Southeast Asia, based on ***;[35]

(2) The cost of other materials, based on an average of the National Renewable Energy Lab's (NREL's) estimated first-half 2018 costs and ***.[36]

(3) Labor, based on ***, and the average share of compensation accounted for by production workers from the Bureau of Labor Statistics;[37]

(4) Electricity costs, ***.[38]

(5) Equipment maintenance costs, based on NREL's calculation that these are equal to 3 percent of the purchase value of equipment.

The largest potential source of divergence in the estimated variable costs for Suniva is in the cost of the wafer, which is discussed in part III. Suniva's other variable costs also include other materials, labor, electricity, and maintenance. In order to check the accuracy of the cost projections used in the model, low and high estimated costs were calculated, and costs were also compared to NREL's estimate for a 1 GW greenfield plant in the United States in 2018. The *** are primarily based on ***, though some of these costs are projections for ***. The high forecast (1) directly calculated silver and aluminum costs, using prices paid by smaller manufacturers in India and rates of use in cell production from the ITRPV,

[33] ***.
[34] ***.
[35] ***.
[36] Woodhouse et al., "Crystalline Silicon Photovoltaic Module," February 2019, 28; ***.
[37] ***; BLS, *Employer Costs for Employee Compensation*, March 2004–September 2019, 533.
[38] ***.

and applies U.S. tariff rates (including section 301 duties on aluminum);[39] (2) NREL's 2018 price for other materials; (3) a higher labor rate, based on a comparable-size Taiwan manufacturer;[40] (4) electricity costs based on NREL's rate for cell production and electricity prices in Georgia; and (5) NREL's estimated maintenance costs from 2018. The costs used in the model vary by *** per watt or less from the other estimates, which are presented in figure D-4.

Figure D-4
Variable costs use in probable economic effect analysis compared to other estimates

*   *   *   *   *   *   *

[39] Small manufacturers in India are used as a proxy to control for any potential economies of scale. A review of available information indicates that ***. ***.

[40] This would include non-PRWs, which would be captured in fixed costs, and therefore may overstate the labor intensity of cell manufacturing.

U.S. Module Manufacturers

U.S. module manufacturing costs are based primarily on U.S. questionnaire data. As most companies were in start-up mode in the first half of 2019, however, their costs are not necessarily representative of industry-wide costs going forward. Therefore, their estimated U.S. production costs, excluding cells, are based on the weighted average costs of three producers that started production prior to 2019 and had more than *** of sales in 2018: ***. As "other factory costs" in questionnaire data do not separate other variable costs (such as electricity and equipment maintenance) from fixed costs, NREL's 2018 estimate of $0.07 per watt was applied to variable costs and subtracted from other fixed cost to create a fixed-cost estimate. These costs are intended to represent the industry-wide production cost for the first half of 2019, if firms were operating at scale. Some firms may achieve substantially lower production costs. *** labor costs, for example, were *** of the average used here.[41]

The estimate of module assembly costs, excluding cell input costs, is presented in figure D-5 (labeled "all U.S. industry") and, for perspective, is compared with three other sets of module assembly costs. A "best-case" module assembly cost was also estimated, which represents the lowest costs achieved by a major U.S. producer for each cost element.[42] These might best represent the cost of a highly efficient and scaled U.S. producer. Also presented are NREL's estimate of U.S. costs of production for a greenfield plant capable of producing more than 1 GW, assuming global material prices and not including tariffs.[43] The estimated costs for the entire industry are *** the best-case and NREL's estimate, but *** given the lack of scale of some U.S. producers, older production lines at some firms, and tariffs on many imported components (see *CSPV Monitoring* for more information on tariffs on imported components).[44]

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[41] ***.

[42] Excludes other factory costs for ***, which reported a ***. ***.

[43] Woodhouse et al., "Crystalline Silicon Photovoltaic Module," February 2019, 33.

[44] ***.

Figure D-5
U.S. module manufacturing costs, excluding cells

*   *   *   *   *   *   *

APPENDIX E

MODELING APPENDIX

Introduction

This appendix provides a technical description of the economic model. The first section describes the model's structural features. The second section lists the data and parameter inputs of the model. The third describes the model's limitations. The final section reports a set of additional model runs under alternative assumptions to illustrate the sensitivity of the estimated economic effects to these assumptions.

Structure of the Model

The quantitative analysis of the economic effects of alternative modifications of the tariff-rate quota (TRQ) uses an industry-specific partial equilibrium model that links production and trade in crystalline silicon photovoltaic (CSPV) cells and modules. The model is designed to allow for different types of safeguard measures at different levels of CSPV production: there is a tariff on U.S. module imports and a separate TRQ on U.S. cell imports. Market equilibrium is solved in the model on a monthly basis for two reasons: (1) to better fit the monthly projections for additions to domestic module production capacity described in part II of this report (Overview of U.S. CSPV Industry and Market), and (2) to address the fact that the annual TRQ is more likely to fill during the later months of the February–January remedy year of the safeguard.[1]

The model assumes that domestic modules and cells compete with imports. A calculation of short-run profitability determines capacity utilization in U.S. module production each month. The model has monthly market clearing that takes into account initial inventories. The starting point is projected domestic module production capacity for each month, as described in part II, which the model treats as exogenous inputs. If the market-clearing prices at full capacity are below the average variable costs of U.S. module producers, then domestic production levels and capacity utilization fall, and market prices increase, until short-run profitability is restored.

The projections for future total demand in the United States from part II of this report are used to calibrate the baseline scenario of the model. Total industry demand in the TRQ modification scenarios is then endogenously determined, using the calibrated parameters from the baseline as inputs. The demand for cells is derived from the level of module production.

[1] Technically, the model estimates the effects in each month in the remaining remedy years, and then model estimates are time-aggregated to the changes in annual values reported in table III-1. Remedy years for CSPV products are from February 7th of one year to February 6th of the following year. The model assumes a February-to-January remedy year.

One gigawatt (GW) of domestic module production requires one GW of cells, either imported or domestically produced.

The model allows for Suniva to restart its production of cells in the United States and operate at full capacity. The model evaluates the operating income resulting from re-entry under the different TRQ alternatives and confirms that Suniva would recover its startup costs and potentially earn additional revenues if it re-enters the market during the remaining two years of the safeguard.

Data and parameter inputs

The model is calibrated with the following data:[2]

Variable	**Source**
Monthly module production capacity projection, in kilowatts (kW)	Compiled from aggregated *CSPV Monitoring* questionnaire responses, *CSPV Monitoring* briefs, *CSPV Modification Advice* written submissions, and publicly available information
Monthly module demand using apparent consumption, in kW	Compiled from aggregated *CSPV Monitoring* questionnaire responses, *CSPV Monitoring* briefs, *CSPV Modification Advice* written submissions, proprietary U.S. Customs records, SPV Market Research, Excel file transmitted to USITC, January 13, 2020, and publicly available information
Baseline (2019) trade values and quantities, for cells and modules	Aggregated *CSPV Monitoring* questionnaire responses
Cost data	Compiled from aggregated *CSPV Monitoring* questionnaire responses, *CSPV Monitoring* briefs, *CSPV Modification Advice* written submissions, ***, and publicly available information
Baseline (2019) employment data	Aggregated *CSPV Monitoring* questionnaire responses and from *CSPV Modification Advice* written submissions, and publicly available information

[2] Appendix D contains additional information regarding input data used within the model.

The model also uses the following parameter values:

Parameter	Value used in the model	Source
Elasticity of substitution between domestic and foreign modules	4	USITC, *CSPV Safeguard Investigation*, 2017
Total industry demand elasticity for modules	-1	USITC, *CSPV Safeguard Investigation*, 2017
Supply elasticity for imported cells	7	USITC, *CSPV Safeguard Investigation*, 2017
Supply elasticity for imported modules	7	USITC, *CSPV Safeguard Investigation*, 2017

Limitations of the Model

One limitation of this complex model is that it applies a simple rule for determining capacity utilization in module production: firms will reduce capacity utilization until prices rise to the point where short-run profits are positive or zero. The model does not try to capture the complicated strategic interactions that likely occur in the industry.

A second limitation is that the projections of future module demand and additions to domestic module production capacity described in part II are forward-looking and subject to uncertainty.[3] An additional caveat to the approach is that the model does not include projected future growth in low-cost cell imports outside of the growth in response to market prices in the model.

Third, the model assesses Suniva's operating income from re-entry, which can be compared to the fixed costs of restarting cell production. It does not include any sort of profitability assessment beyond the two-year period of the safeguard or other concerns, such as the ability to secure financing.

Finally, while the model estimates trade, production, and prices at a high frequency (monthly) to better match the projections for increases in domestic module production capacity

[3] Module capacity projections used in the model are inclusive of Panasonic's module capacity, which may therefore lead to model estimates being slightly overstated due to the expected closure of Panasonic in May 2020. However, Panasonic accounted for ***, so impacts on model estimates from this inclusion are expected to be minor.

and the way that the TRQ operates (the out-of-quota safeguard tariff only applies in the months after the annual TRQ has been exceeded), the model does not try to capture the complex dynamic interactions that are possible with inventory adjustments.

Sensitivity Analysis

Bifacial Module Exclusion

In part III, the modeling results were estimated under the assumption that there will be no bifacial exclusion on U.S. imports of bifacial modules during the next two remedy years. However, it is possible that the current exclusion from the safeguard measure on imported bifacial modules will remain in place.[4] Tables E-1 and E-2 show estimates of the economic effects of each of the alternative TRQs with the assumption that bifacial modules would not be covered by the safeguard measure. Estimates are percentage changes relative to the dynamic baseline (2.5 GW TRQ) with non-covered bifacial modules. The scenario assumes that the bifacial module exclusion is in place at the start of the third remedy year.

[4] See part I of this report for a discussion of the bifacial module exclusion and ongoing developments related to that exclusion.

Table E-1
Alternative 4.0 GW TRQ with bifacial module exclusion in place: Estimated levels of and changes in the production and trade of CSPV modules and cells (changes relative to the dynamic baseline with the 2.5 GW TRQ)

Variable	2020	2021	% change in 2020	% change in 2021
U.S. module production	***	***	***	***
U.S. imports of covered foreign modules	***	***	***	***
U.S. imports of non-covered foreign modules	***	***	***	***
U.S. imports of bifacial modules	***	***	***	***
U.S. cell production	***	***	***	***
U.S. imports of covered foreign cells	***	***	***	***
Price of U.S. modules	***	***	***	***
Price of U.S. imports of covered foreign modules	***	***	***	***
Price of U.S. imports of non-covered foreign modules	***	***	***	***
Price of U.S. imports of bifacial modules	***	***	***	***
Price of U.S. domestic cells	***	***	***	***
Price of U.S. imports of covered foreign cells	***	***	***	***

Note: Estimated results are relative to a 2020 and 2021 baseline with the 2.5 GW TRQ. Quantities are in kilowatts, and prices are in $ per kilowatt. Average prices for the 12-month remedy year are reported.

Source: USITC estimates.

Table E-2
Alternative 5.0 or 6.0 GW TRQ with bifacial module exclusion in place: Estimated levels of and changes in the production and trade of CSPV modules and cells, (changes relative to the dynamic baseline with the 2.5 GW TRQ)

Variable	2020	2021	% change in 2020	% change in 2021
U.S. module production	***	***	***	***
U.S. imports of covered foreign modules	***	***	***	***
U.S. imports of non-covered foreign modules	***	***	***	***
U.S. imports of bifacial modules	***	***	***	***
U.S. cell production	***	***	***	***
U.S. imports of covered foreign cells	***	***	***	***
Price of U.S. modules	***	***	***	***
Price of U.S. imports of covered foreign modules	***	***	***	***
Price of U.S. imports of non-covered foreign modules	***	***	***	***
Price of U.S. imports of bifacial modules	***	***	***	***
Price of U.S. domestic cells	***	***	***	***
Price of U.S. imports of covered foreign cells	***	***	***	***

Note: Estimated results are relative to a 2020 and 2021 baseline with the 2.5 GW TRQ. Quantities are in kilowatts and prices are in $ per kilowatt. Average prices for the 12-month remedy year are reported.

Source: USITC estimates.

Bifacial Module Exogenous Growth

As discussed at the beginning of part III, bifacial modules are likely to account for a growing share of the market over the next few years. Many foreign mono-facial module producers are converting their technology to produce bifacial modules. If these changes continue and the bifacial module exclusion remains in effect, many in the industry expect that imported bifacial modules will account for a larger share of the U.S. market in 2020 and 2021. In this sensitivity analysis, the model imposes an exogenous growth in bifacial module market share to capture a possible increase in both supply (technology) and demand (preferences) for bifacial modules. Data inputs used in this sensitivity analysis to target a bifacial module market share are described in appendix D. In this sensitivity analysis, the model targets future projections on bifacial module import levels and prices to capture exogenous growth in bifacial production beyond the changes generated in the model from changes in market prices. 2020 is a ramp-up year as monofacial module producers convert their production technology to produce bifacial modules. The full growth in bifacial module market share is in place in 2021. These simulations assume that bifacial modules are exempt from import tariffs and allow for a Suniva re-entry. As shown in table E-3, the TRQ fills only in the 2.5 GW TRQ baseline in 2020 for this scenario. There are no economic impacts of raising the TRQ level in 2021 because the TRQ does not fill under any TRQ level, including the baseline TRQ of 2.5 GW.

Table E-3
Alternative 4.0, 5.0 or 6.0 GW TRQ with bifacial module exogenous growth (and bifacial exclusion): Estimated levels of and changes in the production and trade of CSPV modules and cells (changes relative to the dynamic baseline with the 2.5 GW TRQ)

Variable	2020	2021	% change in 2020	% change in 2021
U.S. module production	***	***	***	***
U.S. imports of covered foreign modules	***	***	***	***
U.S. imports of non-covered foreign modules	***	***	***	***
U.S. imports of bifacial modules	***	***	***	***
U.S. cell production	***	***	***	***
U.S. imports of covered foreign cells	***	***	***	***
Price of U.S. modules	***	***	***	***
Price of U.S. imports of covered foreign modules	***	***	***	***
Price of U.S. imports of non-covered foreign modules	***	***	***	***
Price of U.S. imports of bifacial modules	***	***	***	***
Price of U.S. domestic cells	***	***	***	***
Price of U.S. imports of covered foreign cells	***	***	***	***

Note: Estimated results are relative to a 2020 and 2021 baseline with the 2.5 GW TRQ. Quantities are in kilowatts and prices are in $ per kilowatt. Average prices for the 12-month remedy year are reported.

Source: USITC estimates.

Suniva Re-entry

In part III, the modeling results were estimated under the assumption that Suniva would re-enter the market by restarting U.S. cell production. The assumption was then tested post-estimation by comparing break-even profits. Suniva re-entry would have an effect on prices in the market and on U.S. imports of cells, and the probable economic effects of the proposed modifications would depend on whether Suniva re-enters or not. This section first considers the case in which Suniva does not re-enter and gives modeling results in tables E-4 and E-5 below. The simulations in tables E-4 and E-5 assume that there is no bifacial exclusion in place, so bifacial module imports are covered under the safeguard, consistent with the assumption used in the part III modeling results. This section also considers the case in which Suniva does not re-enter and the bifacial exclusion is in place. Modeling results for this scenario are found in tables E-6 and E-7. A comparison of all sensitivity analyses is found in table E-8.

Table E-4
Alternative 4.0 GW TRQ with no Suniva re-entry and no bifacial exclusion: Estimated levels of and changes in the production and trade of CSPV modules and cells (changes relative to the dynamic baseline with the 2.5 GW TRQ)

Variable	2020	2021	% change in 2020	% change in 2021
U.S. module production	***	***	***	***
U.S. imports of covered foreign modules	***	***	***	***
U.S. imports of non-covered foreign modules	***	***	***	***
U.S. cell production	***	***	***	***
U.S. imports of covered foreign cells	***	***	***	***
Price of U.S. modules	***	***	***	***
Price of U.S. imports of covered foreign modules	***	***	***	***
Price of U.S. imports of non-covered foreign modules	***	***	***	***
Price of U.S. imports of covered foreign cells	***	***	***	***

Note: Estimated results are relative to a 2020 and 2021 baseline with the 2.5 GW TRQ. Quantities are in kilowatts and prices are in $ per kilowatt. Average prices for the 12-month remedy year are reported.

Source: USITC estimates.

Table E-5
Alternative 5.0 or 6.0 GW TRQ with no Suniva re-entry and no bifacial exclusion: Estimated levels of and changes in the production and trade of CSPV modules and cells (changes relative to the dynamic baseline with the 2.5 GW TRQ)

Variable	2020	2021	% change in 2020	% change in 2021
U.S. module production	***	***	***	***
U.S. imports of covered foreign modules	***	***	***	***
U.S. imports of non-covered foreign modules	***	***	***	***
U.S. cell production	***	***	***	***
U.S. imports of covered foreign cells	***	***	***	***
Price of U.S. modules	***	***	***	***
Price of U.S. imports of covered foreign modules	***	***	***	***
Price of U.S. imports of non-covered foreign modules	***	***	***	***
Price of U.S. imports of covered foreign cells	***	***	***	***

Note: Estimated results are relative to a 2020 and 2021 baseline with the 2.5 GW TRQ. Quantities are in kilowatts and prices are in $ per kilowatt. Average prices for the 12-month remedy year are reported.

Source: USITC estimates.

Table E-6
Alternative 4.0 GW TRQ with no Suniva re-entry and bifacial exclusion: Estimated levels of and changes in the production and trade of CSPV modules and cells (changes relative to the dynamic baseline with the 2.5 GW TRQ)

Variable	2020	2021	% change in 2020	% change in 2021
U.S. module production	***	***	***	***
U.S. imports of covered foreign modules	***	***	***	***
U.S. imports of non-covered foreign modules	***	***	***	***
U.S. imports of bifacial modules	***	***	***	***
U.S. cell production	***	***	***	***
U.S. imports of covered foreign cells	***	***	***	***
Price of U.S. modules	***	***	***	***
Price of U.S. imports of covered foreign modules	***	***	***	***
Price of U.S. imports of non-covered foreign modules	***	***	***	***
Price of U.S. imports of bifacial modules	***	***	***	***
Price of U.S. imports of covered foreign cells	***	***	***	***

Note: Estimated results are relative to a 2020 and 2021 baseline with the 2.5 GW TRQ. Quantities are in kilowatts and prices are in $ per kilowatt. Average prices for the 12-month remedy year are reported.

Source: USITC estimates.

Table E-7
Alternative 5.0 or 6.0 GW TRQ with no Suniva re-entry and bifacial exclusion: Estimated levels of and changes in the production and trade of CSPV modules and cells (changes relative to the dynamic baseline with the 2.5 GW TRQ)

Variable	2020	2021	% change in 2020	% change in 2021
U.S. module production	***	***	***	***
U.S. imports of covered foreign modules	***	***	***	***
U.S. imports of non-covered foreign modules	***	***	***	***
U.S. imports of bifacial modules	***	***	***	***
U.S. cell production	***	***	***	***
U.S. imports of covered foreign cells	***	***	***	***
Price of U.S. modules	***	***	***	***
Price of U.S. imports of covered foreign modules	***	***	***	***
Price of U.S. imports of non-covered foreign modules	***	***	***	***
Price of U.S. imports of bifacial modules	***	***	***	***
Price of U.S. imports of covered foreign cells	***	***	***	***

Note: Estimated results are relative to a 2020 and 2021 baseline with the 2.5 GW TRQ. Quantities are in kilowatts and prices are in $ per kilowatt. Average prices for the 12-month remedy year are reported.

Source: USITC estimates.

Table E-8
Sensitivity analysis: Estimated levels of and changes in the production and trade of CSPV modules in 2020 (changes relative to dynamic baseline with the 2.5 GW TRQ)

Variable	No bifacial exclusion; Suniva re-entry (levels)	Bifacial exclusion; Suniva re-entry (levels)	Bifacial exclusion/ growth; Suniva re-entry (levels)	No bifacial exclusion; no Suniva re-entry (levels)	Bifacial exclusion; no Suniva re-entry (levels)	No bifacial exclusion; Suniva re-entry (%)	Bifacial exclusion; Suniva re-entry (%)	Bifacial exclusion/ growth; Suniva re-entry (%)	No bifacial exclusion: no Suniva re-entry (%)	Bifacial exclusion; no Suniva re-entry (%)
4.0 GW TRQ										
U.S. module production	***	***	***	***	***	***	***	***	***	***
Price of U.S. modules	***	***	***	***	***	***	***	***	***	***
U.S. cell production	***	***	***	***	***	***	***	***	***	***
Price of U.S. cells	***	***	***	***	***	***	***	***	***	***
5.0 or 6.0 GW TRQ										
U.S. module production	***	***	***	***	***	***	***	***	***	***
Price of U.S. modules	***	***	***	***	***	***	***	***	***	***
U.S. cell production	***	***	***	***	***	***	***	***	***	***
Price of U.S. cells	***	***	***	***	***	***	***	***	***	***

Note: Estimated results are relative to a 2020 baseline with the 2.5 GW TRQ established for each scenario. Quantities are in kilowatts and prices are in $ per kilowatt. Average prices for the 12-month remedy year are reported.

Source: USITC estimates.

APPENDIX F

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