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ALERT

Blue Wafers in Solar Cell Manufacturing: Critical Compliance Risks for Solar Project Developers

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Summary

Solar manufacturers and project developers should be aware of an emerging and significant compliance risk concerning the origin of photovoltaic cells and modules for purposes of tax credits, customs and antidumping/countervailing (AD/CVD) laws, and certain tariffs. While a recent ruling issued by U.S. Customs & Border Protection (CBP) implies that these products originate in countries other than where the P/N junction is formed for purposes of now-terminated Section 201 duties, the ruling does not overrule prior CBP rulings or impact country of origin for purposes of other important tariff regimes, such as AD/CVD duties. Nor does the ruling impact domestic content analyses under important tax programs, such as the Domestic Content Bonus Credit under Section 45Y and Section 48E of the Internal Revenue Code and the Advanced Manufacturing Production Tax Credit under Section 45X. Even with respect to the very narrow circumstances to which the ruling directly applies, reliance on it is potentially hazardous, given its inconsistency with other, unmodified CBP rulings.

Below, we provide a brief overview of the history of how U.S. governmental agencies have analyzed the origin of photovoltaic cells and modules. We then describe the manufacturing process for such products, with a particular focus on "blue wafer" production, before analyzing two very different CBP rulings regarding solar product origin. Next, we explain how the origin of photovoltaic cells and modules is determined for purposes of AD/CVD duties. Finally, we

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discuss the very specific origin considerations that developers must take into account with respect to domestic tax credits.

Overview of Origin for Photovoltaic Cells and Modules

Solar project developers face a signifigant emerging compliance risk regarding the country of origin of certain photovoltaic cells and modules for purposes of tax credits, customs and AD/CVD laws, and certain tariffs. For years, U.S. government agencies have consistently held that the P/N junction of a solar cell – i.e., the feature of a solar cell that converts light to electricity – provides the essential character of a solar cell. This means that the country of origin of a solar cell is the country where the P/N junction is made.

A recent CBP ruling, HQ H296919 (June 25, 2025), contains language that seems to reach a contrary result. The ruling holds that the country in which solar "substrates" containing P/N junctions are processed into finished solar modules is the modules' country of origin for purposes of Section 201 duties. However, this recent ruling does not revoke, modify, or even address prior CBP rulings holding that the location of P/N junction formation controls origin for finished cells and modules. Nor does it affect origin for purposes of AD/CVD orders, which follows the location where the P/N junction formed.

Nonetheless, relying on the recent CBP ruling, certain solar manufacturers have begun importing into the United States silicon wafers that already have a P/N junction (so-called "blue wafers"), performing minor processing on the cells and assembling them into finished solar modules, and then claiming the resulting modules as being of U.S. origin. This practice raises material questions under U.S. trade law and tax credit programs. As described more fully below, these questions expose importers of solar cells and modules, as well as project developers that source U.S.-made solar modules that incorporate solar cells made with imported blue wafers, to significant compliance risk.

What Is a Blue Wafer?

The manufacture of crystalline silicon photovoltaic cells and modules follows a well-defined sequence of stages: solar grade polysilicon is processed into a wafer, which is then processed into cell, and finally, the cells are assembled into modules.

- A wafer is a thin slice of crystalline silicon semiconductor material that serves as the substrate for a photovoltaic cell; it is manufactured by forming an ingot from molten polysilicon and then slicing the ingot into wafers.
- Cell manufacturing typically involves the following steps:
  - First, the wafer undergoes inspection, followed by acidic isotexturing to prepare its surface.
  - The wafer then proceeds through a "doping" process involving diffusion of phosphorus oxychloride into a layer of the wafer to create a P/N junction.
  - Next, isolation and phosphosilicate glass removal is performed, followed by rear passivation, where a specialized dielectric layer is applied to the back of the cell to enhance efficiency.

- In a final series of finishing steps, an anti-reflective (AR) coating is added; laser contact opening is performed; and finally, gridlines and busbars are printed through metallization.

The creation of the P/N junction is a particularly critical stage. The P/N junction is what enables a crystalline silicon photovoltaic cell to convert sunlight into electricity by creating an electrical field across which a current of electrons, having been freed from their chemical bonds by exposure to light energy, are able to flow. Further, most of the capital investment required for cell production is associated with the steps leading to, and including, formation of the P/N junction.

Following the addition of the AR coating – which must happen immediately after the P/N junction is formed, to avoid quality degradation – the wafer takes on a blue color due to surface chemistry changes. At this point, it is commonly referred to as a "blue wafer." In contrast, an undoped wafer is gray in color, and is often referred to as a "gray wafer." Notably, the anti-reflective coating is added after the P/N junction is formed, making it easy to distinguish between a blue wafer, with a P/N junction, and a gray wafer without the P/N junction.

The Harmonized Tariff Schedule of the United States (HTSUS) does not use the terms "blue wafer" or "gray wafer." However, according to statistical Note 12 to Chapter 85 of the HTSUS, the term "crystalline silicon photovoltaic cell" encompasses items having "a thickness equal to or greater than 20 micrometers, having a p/n junction (or variant thereof) formed by any means," regardless of whether the item "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." So-called blue wafers therefore qualify as crystalline silicon photovoltaic cells for purposes of U.S. tariff classification.

Analyses in CBP Decisions

CBP has issued rulings that appear to reach inconsistent conclusions on whether the processing of *blue* wafers into finished photovoltaic cells (and not just modules) constitutes a "substantial transformation" for country-of-origin purposes. Understanding these competing analyses – and their implications for customs, duties, and tax credit purposes – is critical for solar project developers and importers. Below, we discuss these two rulings.

Merlin Solar Technologies Ruling

In Headquarters Ruling H301813 (May 24, 2019), CBP analyzed whether making a finished solar module from blue wafers constitutes a substantial transformation of those wafers. There, modules were produced in India from cells that had the P/N junction formed in Taiwan. CBP characterized the diffusion process that creates the P/N junction as "a critical partition in the functioning of a solar cell" and stated that the solar cells which had been doped in Taiwan had already undergone substantial processing prior to being shipped to India. CBP reasoned that the "essential characteristic of the solar cell is to convert sunlight into electricity, and it can do so *when the P/N junction is put in place*." In CBP's view, the addition of gridlines and circuitry allowed the cell to collect and forward electricity more efficiently but did not result in an article with a new "name, character and use" since the end use of the *solar cells was predetermined upon creation of the P/N junction*. CBP therefore found that the solar cells remained products of Taiwan despite undergoing post-P/N junction

processing in India. And because "solar cells impart the essential character of the solar panels and assembling solar cells into finished solar panels does not result in a product with a new name, character, and use," the origin of the solar modules also was Taiwan.

Cypress Creek Ruling

In Headquarters Ruling Letter H296919 (June 25, 2025), CBP analyzed whether modules produced in a third country using blue wafers made in the United States were products of South Korea for purposes of the Section 201 Solar Safeguard. While the ruling's holding concerned the origin of the finished modules, CBP indicated that the processing of blue wafers into finished cells *might* constitute a substantial transformation.

CBP's analysis focused on the change in the articles' character and use. While the blue wafers sent to the third country contained a P/N junction and could generate an electrical current, CBP found that they could not deliver that current externally and thus lacked utility as a power source. The subsequent third-country processing, particularly the deposition of metal lines (gridlines and busbars), enabled the current to flow outside the cell for the first time. CBP found that this transformation – from a substrate that could not dispense electricity to a finished cell that could – imparted the article with a "different character from the standpoint of electrical conductivity."

CBP also found that subsidiary factors supported its finding that the modules were products of the third country, including (1) most processing steps and 53% – 55% of capital expenditures occurred there, and (2) processing performed there transformed inputs that could only be used in further manufacturing into consumer goods. Accordingly, CBP determined that the solar modules were products of the third country for purposes of the Solar 201 safeguard.

In short, the Merlin Solar ruling clearly states that processing blue wafers into finished cells and modules is not a substantial transformation, whereas the Cypress Creek ruling suggests that further processing after the formation of the P/N junction can constitute substantial transformation. The Merlin Solar ruling has not been revoked and, remarkably, is not mentioned in the Cypress Creek ruling. Further, it took CBP seven years to issue the Cypress Creek ruling, and it ultimately did so only a few months before the Section 201 Solar Safeguard expired on February 6, 2026. In the absence of further clarity from CBP, a solar project developer who uses U.S. modules containing cells produced from imported blue wafers is exposed to significant compliance risk if they rely on the Cypress Creek ruling to claim the cells or modules are of U.S. origin.

Implications for Antidumping and Countervailing Duty Law

The U.S. Department of Commerce ("Commerce") has consistently determined in the context of AD/CVD law that the country where the P/N junction is formed is the country of origin of a solar cell. Under the AD/CVD orders on solar cells, a "cell" is defined as a product with a P/N junction, "whether or not the cell has undergone other processing ... to collect and forward the electricity that is generated by the cell." Commerce has repeatedly affirmed that processing steps that take place after the P/N junction is created, including metallization to add gridlines and busbars, do not change the origin of the cell. Commerce reasons that these subsequent steps only enable the cell to channel the energy it already creates and do not change its

essential character. Importantly, cells originating from China, Taiwan, Cambodia, Thailand, Vietnam, and Malaysia, as well as modules produced in any country with such cells, are subject to AD/CVD duties. Such duties will likely also apply in the future to cells from India, Laos, and Indonesia, on modules containing such cells, due to ongoing AD/CVD investigations.

The Commerce AD/CVD analysis, which focuses on the formation of the P/N junction as the determinative step in defining the nature and origin of solar cells, is consistent with the HTSUS's definition of a solar cell, as well as CBP's approach in the Merlin Solar ruling. And while it is at odds with CBP's approach in the Cypress Creek ruling, project developers and importers should be aware that Commerce is not bound by CBP's origin rulings. This means that importers will continue to owe AD/CVD duties on cells or modules based on where the operations that impart the P/N junction occur. In other words, if an imported blue wafer is produced in a country subject to AD/CVD orders, importers are *required* to pay AD/CVD duties on the blue wafers. Likewise, where cells are finished or modules assembled a third country using blue wafers from another, the finished cell or module may be subject to AD/CVD duties imposed on the country where the blue wafer production took place. If importers do not make such duty payments, CBP could require payment and issue steep penalties.

Implications for the Domestic Content Bonus Credit Under I.R.C. Section 45Y and Section 48E

The Domestic Content Bonus Credit (frequently referred to as the domestic content adder (DCA)) under Sections 45Y and 48E of the Internal Revenue Code provide an additional tax credit for clean energy projects that meet domestic content requirements. To qualify for the DCA, any steel, iron, or manufactured product which is a component of a qualified facility, energy project, or qualified investment, as applicable, must be produced in the United States. Under the "Adjusted Percentage Rule," all of the manufactured products of such a facility, project, or investment are "deemed" to have been produced in the United States if not less than the adjusted percentage of the total cost of all manufactured products of such facility, project, or investment are attributable to manufactured products which are mined, produced, or manufactured in the United States.

For solar facilities, the current adjusted percentage is 50%. The country of origin of the photovoltaic cells is the single greatest determinant in reaching the 50% threshold. Guidance in 2025 from Treasury and the IRS creates an elective safe harbor pursuant to which U.S.-origin cells are deemed to constitute 38% – 66.6% of the total cost of all manufactured products of ground-mounted solar facilities, and 31.1% – 52.1% of roof-mounted solar facilities.

The use of imported blue wafers to create photovoltaic cells in the U.S. puts at risk any claim that the cells are "produced in the United States." Guidance from Treasury and the IRS suggests that all manufacturing processes of a manufactured product component must take place in the U.S. in order for the component to be deemed produced in the U.S.

A Manufactured Product is considered to be produced in the United States (U.S. Manufactured Product) if: (1) all of the manufacturing processes for the Manufactured Product take place in the United States; and (2) all of the Manufactured Product Components of the Manufactured Product are of U.S. origin. ***A Manufactured Product Component is considered to be of U.S. origin if it is manufactured in the United States, regardless of the origin of its subcomponents.***

IRS notice 2023-38 § 3.03(1) (emphasis added).

The term "manufactured" is defined to mean "produced as a result of ***the*** manufacturing process." *Id.* at § 3.01(2)(b) (emphasis added). And *the* manufacturing process, in turn, is defined to include the application of multiple processes:

'Manufacturing process' means the application of processes to alter the form or function of materials or of elements of a product in a manner adding value and transforming those materials or elements so that they represent a new item functionally different from that which would result from mere assembly of the elements or materials.

Id. at § 3.01(2)(e). Taken together, these definitions appear to suggest that all of the manufacturing processes that convert one or more subcomponents into a manufactured product component must occur in the United States. However, the production of subcomponents may take place outside the United States. Therefore, to comply with the DCA requirement for components to be manufactured in the United States, it becomes critical to properly identify subcomponents of a manufactured product component.

Critically, the IRS has provided updated guidance on the DCA in Notice 2025-8, which not only treats wafers as subcomponents of cells, but defines wafers specifically as gray wafers – not blue wafers. The guidance defines a "wafer" as "a thin slice, sheet or layer of crystalline silicon semiconductor material that comprises the substrate or absorber layer of one or more photovoltaic cells," and states that it "is manufactured by forming an ingot from molten polysilicon and then slicing it into wafers." There is no reference here to the doping process that imparts a P/N junction. Rather, by defining a wafer as the output of two manufacturing processes (i.e., a wafer is the item that results from the forming an ingot and the slicing of that ingot), the guidance implies that once a gray wafer has undergone the processing that produces a blue wafer, it is no longer a subcomponent but instead an unfinished cell.

While contrary arguments are theoretically possible, they rely on treating blue wafers with P/N junctions that convert sunlight into electricity as "functionally different" from a finished photovoltaic cell, which also can convert sunlight into electricity. But from a pure policy standpoint, the DCA was designed to maximize U.S. solar production and investment. This suggests that Treasury and the IRS would not look favorably on an effort to characterize blue wafers as subcomponents, as doing so would allow companies to take advantage of tax credits without making the type of investment that the credits are meant to encourage.

Importantly, because the DCA credit is claimed by the taxpayer and not the manufacturer, a manufacturer that takes an unduly permissive interpretation of the DCA creates potentially substantial risk for its customers. To avoid this problem, project developers may wish to validate claims that the photovoltaic cells used in the

modules on their projects were, in fact, produced in the U.S. using gray, rather than blue, wafers.

Implications for the Section 45X Advanced Manufacturing Production Tax Credit

Solar developers do not directly claim the advanced manufacturing production tax credit established by Section 45X of the Internal Revenue Code. Rather, manufacturers claim Section 45X credits for the cells they produce in the U.S. The manufacturer, and not the solar project developer, bears the risk of any mistakenly claimed Section 45X credits.

Nonetheless, solar project developers should be aware of the risks to manufacturers who claim as U.S.-origin cells that were finished in the U.S. from imported blue wafers. Three features of the Section 45X statute and regulations, when considered together, indicate that P/N junction formation must occur in the U.S. in order to claim Section 45X credit for cells.

First, to be eligible for the credit, the U.S. production operations on the cell must result in a "complete and distinct eligible component". A cell produced from a blue wafer that already has the P/N junction is not a "distinct eligible component."

Second, the Section 45X regulations expressly exclude "partial transformation" as the basis for claiming credits. The regulations state that the term "produced by the taxpayer" does not include "partial transformation that does not result in substantial transformation of constituent elements, materials, or subcomponents into a complete and distinct eligible component". Because a blue wafer already converts light into electricity, processing it to produce a finished cell could easily be considered a partial transformation.

Third, blue wafers appear to meet the definition of a "cell" for purposes of Section 45X – and not to meet the definition of "wafer." Section 45X defines a photovoltaic cell as "the smallest semiconductor element of a solar module that performs the immediate conversion of light into electricity." A blue wafer can convert light into electricity, meaning that it qualifies as a "cell." Further, Section 45X defines a wafer as a "a thin slice, sheet, or layer of semiconductor material of at least 240 square centimeters – (I) produced by a single manufacturer either – (aa) directly from molten or evaporated solar grade polysilicon deposition of solar grade thin film semiconductor photon absorber layer, or (bb) through formation of an ingot from molten polysilicon and subsequent slicing, and (II) which comprises the substrate or absorber layer of one or more photovoltaic cells." There is no reference in the "wafer" definition to any processing that imparts a P/N junction or gives a "wafer" the ability to convert light into electricity.

A Word of Caution to Solar Project Developers and Importers

In the absence of express regulatory guidance from Treasury and the IRS, the use of CSPV cells produced in the U.S. from imported blue wafers creates substantial compliance risk for solar project developers. CBP's inconsistent rulings only heighten the risk of trade remedy exposure and tax credit ineligibility.

Project developers should be vigilant in scrutinizing the supply chain for modules they purchase. The use of cells made from imported blue wafers – as opposed to cells manufactured entirely from gray wafers in the United States – may result in: (1) unexpected exposure to antidumping and countervailing duties; (2) disqualification from Section 45X credits claimed by manufacturers, potentially affecting module pricing or creating successor liability exposure; and (3) failure to satisfy domestic content requirements, resulting in loss of the DCA credit.

To mitigate these risks, solar project developers may wish to conduct thorough supply chain due diligence, specifically requesting documentation confirming the location where P/N junction formation occurred. Second, developers may wish to require contractual representations and warranties from suppliers regarding the manufacturing location and processes for all solar cells to be delivered. Third, developers should seek indemnification from suppliers for any loss of tax credits, imposition of duties, or penalties resulting from noncompliance with country of origin requirements. Fourth, developers should monitor regulatory developments, as Treasury, the IRS, and CBP may issue additional guidance clarifying these issues.

The stakes are high. CBP has for many years pursued enforcement actions against importers of solar cells and modules. Those efforts continue today. Failing to ensure that modules contain cells manufactured entirely in the United States from gray wafers could jeopardize the financial viability of projects and expose developers to significant liability. Importers of blue wafers, cells, and modules also face a significant risk of exposure to AD/CVD duties based on where P/N junction formation takes place.

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