Suniva Trade Case Implications for International Trade and the United States Solar Boom

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Suniva Trade Case Implications for
International Trade and the United States Solar Boom

By
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University of Colorado at Boulder

A thesis submitted to the
University of Colorado at Boulder
in partial fulfillment
of the requirements to receive
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Thesis Advisors:

Adam Reed, Environmental Studies, Committee Chair
Keith Maskus, Economics
Dale Miller, Environmental Studies

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Abstract

The purpose of this thesis is to determine the impact of the Suniva Trade Case on international trade and the domestic solar industry. In order to analyze the Suniva Trade Case, I first determined the impact that the tariff is going to have on the price of solar cells for both the U.S. domestic market as well as the international market. The second portion is dedicated to determining the relationship between U.S. domestic solar manufacturing employment and solar installation employment due to the safeguard relief tariff. The background covers the development of the Suniva Trade Case, the International Trade Commission’s findings, an overview of relevant statutes and international trade law, as well as an analysis on how countries may successfully seek retaliation measures against the United States in a World Trade Organization dispute. In order to answer the two research questions, I developed a world market economic model as well as a domestic market economic model. Using these models, I calculated the economic impacts of a 30% tariff for six different elasticity groupings. Then with the most probable elasticity grouping, I calculated the economic impact over the course of a four year tariff that tapers 5% each year. Following these calculations, I discuss the limitations of the economic models and conclude that the safeguard tariff will have an overall negative impact on the domestic solar industry. Lastly, I discuss the environmental justice implications of the safeguard tariff and make recommendations for further research.
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Preface

During my undergraduate career at the University of Colorado Boulder, I became interested in the complexities associated with achieving a renewable energy transition. This interest was first sparked in Adam Reed’s environmental studies cornerstone class *Energy and Society*. During this course, I developed a particular interest in the intersection of energy justice and policy, and how the two relate to the promotion of sustainable development.

Our current reliance on fossil fuels has resulted in externalities that are disproportionately hurting the livelihoods of people across the globe. From a regional level all the way up to international, the transition to renewable energy has the potential to correct the unequal distribution of environmental ills. On an international scale, island nations and coastal areas are faced with increasing sea levels from the effects of climate change and numerous countries are combatting more frequent natural disasters. The effects of climate change are continuously worsening and these are some examples of the dire consequences of our reliance on fossil fuels. In the United States, not only would the reduction of fossil fuels provide benefits towards mitigating the effects of global climate change for both current and future generations, it would also help some of the most vulnerable in our society.

In the past decade, prices of solar panels have decreased enough to allow for a solar boom in the United States. However, these inexpensive solar panels have hurt U.S. solar panel manufacturers because they cannot compete at such low prices. This in turn drove some U.S. domestic manufacturers out of business, one of which was Suniva. After declaring bankruptcy, Suniva filed a petition under Section 201 of the Trade Act of 1974 for global safeguard relief. If granted their proposal of high tariffs, the cost of solar panels would increase. Irrespective of the type of solar project, the consumer would bear the cost. For example, in the case of an individual
home, the tariff raises costs and reduces the household’s income from the investment. Or in a third party financing case, the panel owner would incur higher costs and thus sell electricity to the homeowner at a higher rate. Due to these costly solar panels, solar contractors may install less systems in order to maintain a return on investment. Less solar installments would dampen the solar boom and hinder the progress of relieving some of the most vulnerable in our society of fossil fuel externalities.

The development of the events in the Suniva Trade Case happened to occur at a time in which I was deciding on an honors thesis topic. I quickly turned to this issue because it brought me back to my interest in the intersection of energy justice and policy. I became motivated to develop an understanding of international trade, in order to interpret the implications of the Suniva Trade Case on the U.S. solar industry. As an environmental studies major, I began this project with a sparse understanding of international trade, but was eager to learn. By pursuing this topic, I hoped to understand whether or not the initial 30% tariff will in fact help retain American jobs at the expense of the solar boom. This pursuit was only possible with the help of my three thesis advisors. I would like thank Adam Reed for helping me develop an understanding of international trade law and the intricacies of solar energy, Dr. Keith Maskus for helping me obtain data and teaching me how to create economic models, and Dale Miller for guiding me through the process of developing an honors thesis project.
Introduction

The purpose of this thesis is to analyze the potential impact of President Trump’s decision to impose tariffs on crystalline silicon solar PV cells on the U.S. solar market. This comprehensive analysis aims to understand how the U.S. solar industry will be affected through the hypothetical relationship between a 30% increase in tariff duties and the impact on both the domestic solar panel manufacturing industry as well as the solar installation industry. This thesis will strive to answer these two questions:

1. What impact is the tariff going to have on the price of solar cells for both the U.S. domestic and international markets?

2. What will be the relationship between U.S. domestic solar manufacturing employment and solar installation employment due to the safeguard relief tariff?

In order to answer these questions, I will create two equilibrium models. The first model is based on the international market of solar panels. This model will utilize international trade data from the Trade Policy Information System database for the five largest solar panel importers into the Unites States: Malaysia, South Korea, Vietnam, Thailand, and Mexico in order to determine the price impact on international market prices in relation to United States demand. The second equilibrium model will illustrate the relationship between the increase in United States solar panel manufacturing jobs with the decrease in domestic solar installations based on assumed elasticities. The purpose of these models will be to determine whether or not the imposed tariff will in fact help save American jobs as well as to what extent the solar installation industry will be impacted.
Background

On April 26, 2017 Suniva filed a petition under Section 201 of the Trade Act of 1974. In 2017, Suniva laid off 230 employees and closed its factory in Michigan and the company is now over $100 million in debt. After declaring bankruptcy in 2017, this majority Chinese owned solar manufacturing company is seeking global safeguard relief from imports of crystalline silicon solar PV cells and modules under the Trade Act of 1974. The Chinese company Shunfeng International Clean Energy holds 63% of Suniva’s stock and publicly opposes this petition. However, Suniva’s actions are controlled by SQN Capital Management, to whom Suniva owes more than $50 million.

This petition brought by Suniva proposes both a tariff of 40 cents per watt for solar cells produced outside of the U.S. as well as a 78 cents per watt price floor for panels. According to Goldman Sachs and Bloomberg New Energy Finance, the price of solar panels would double in the U.S. if Suniva’s proposal were placed into effect (“Suniva’s Solar Trade Case”, 2017). One month after Suniva’s initial petition, German-owned Solar World Americas joined as a co-petitioner after the parent company Solar World went bankrupt in Europe.

On May 23, 2017 the U.S. International Trade Commission (ITC) initiated an investigation into whether or not there has been serious injury or potential for serious injury to the domestic solar manufacturing industry. The ITC serves as an independent, bipartisan, quasi-judicial, federal agency that investigates and provides trade recommendations to the administration on trade matters (“Suniva’s Solar Trade Case”, 2017).

Section 201 “Action to Facilitate Positive Adjustment to Import Competition” of the Trade Act of 1974, provides those who have been seriously injured or threatened with serious injury can submit a global safeguard petition to the ITC for import relief. Unlike antidumping
laws, a finding of unfair trade practice does not need to be found to grant safeguard relief. An unfair trade practice is characterized as deceptive, fraudulent, or otherwise injurious.

Antidumping tariffs are enacted to combat unfair trade practices such as foreign exporters who intend to sell its products in the U.S. at below production cost, thereby causing injury to U.S. domestic companies. However, for safeguard relief, the threat of serious injury will suffice. If the Commission does in fact make an affirmative determination of threatened or serious injury, recommendations to either prevent or relive domestic industry of injury will be made to the President. Then, the President holds the final decision whether or not to provide relief and if so, the amount of relief to be granted (“Section 201, Trade Act of 1974”, 2018).

When making a determination in global safeguard investigations, the Commission must examine three statutory criteria. These three statutory criteria are as follows:

(1) An Article is being imported into the United States in increased quantities;

(2) The Domestic industry producing an article that is like or directly competitive with the imported article is seriously injured or threatened with serious injury; and

(3) The Article is being imported in such increased quantities as to be a substantial cause of serious injury or threat of serious injury to the domestic industry (19 U.S.C. § 2252(b)(1)(A)).

The statute defines “domestic industry” as “the producers as a whole of the like or directly competitive article or those producers whose collective production of the like or directly competitive article constitutes a major proportion of the total domestic production of such article” (19 U.S.C. § 2252(c)(6)(A)(1)). Legislative history has described “like” as “substantially identical in inherent or intrinsic characteristics (i.e., materials from which made
appearance, quality, texture, etc.),’ whereas “directly competitive” articles are those which, “are substantially equivalent for commercial purposes, that is, are adapted to the same uses and are essentially interchangeable therefor.”’ (USITC Pub. 4739 at 23).

Under section 202 of the Trade Act, the Commission’s determination will take into account the increase of imports, which may be “either actual or relative to domestic production” (19 U.S.C. § 2252(c)(1)(C)). Under Section 202 (c)(1)(A), the Commissions determination on injury will also include economic factors including “(i) the significant idling of productive facilities in the domestic industry, (ii) the inability of a significant number of firms to carry out domestic production operations at a reasonable level of profit, and (iii) significant unemployment or underemployment with the domestic industry”.

Section 202(c)(1)(B) of the Act states that in making a determination of injury, the Commission must include the economic factors “(i) a decline in sales or market share, a higher and growing inventory (whether maintained by domestic producers, importers, wholesalers, or retailers), and a downward trend in production, profits, wages, productivity, or employment (or increasing underemployment) in the domestic industry, (ii) the extent to which firms in the domestic industry are unable to generate adequate capital to finance the modernization of their domestic plants and equipment, or are unable to maintain existing levels of expenditures for research and development, {and} (iii) the extent to which the United States market is the focal point for the diversion of exports of the article concerned by reason of restraints on exports of such article to, or on imports of such article into, third country markets” (19 U.S.C. § 2252(c)(1)(B)). Additionally, the statute requires the Commission to examine “the condition of the domestic industry over the course of the relevant business cycle ... ” and directs the
Commission to consider “factors other than imports which may be a cause of serious injury, or threat of serious injury, to the domestic industry” (Section 202(c)(2); 19 U.S.C. § 2252(c)(2)).

The criteria for the Section 201 of the Trade Act is based on the criteria in article XIX of the General Agreement on Tariffs and Trade (GATT). This article is commonly referred to as the escape clause, due to the temporary ability to escape its obligations under the GATT regarding the particular import that has caused or is threatening to cause serious injury to the domestic industry. It is Section 201 that provides the legal framework under U.S. law for the President to provide safeguard relief under article 201.

GATT originates from the end of WWII, when the international community established the World Bank and the International Monetary Fund along with GATT. The original intention of GATT was to focus on tariff reduction and the ITO, a comprehensive framework governing international trade. The ITO negotiations were abandoned when US Congress did not want to ratify the agreement. The objective of GATT was to reduce trade barriers and remove distortions in international markets to ensure that goods and services were not discriminated against based on national origin. The underlying diplomatic objective was to increase trade ties and create better political ties to enhance international security after WWII.

In reviewing Suniva’s safeguard petition, the ITC utilized previous investigations from 2012 and 2015. In 2012, the Commission determined that United States solar manufacturers were materially injured by imports of crystalline silicon photovoltaic solar cells and modules from China after Solar World filed for antidumping and countervailing duty petitions in 2011. The Department of Commerce concluded that these solar cells were sold at less than fair value in the U.S. market due to being highly subsidized by the Government of China. As a result of this
finding, the Department of Commerce enacted antidumping duties for solar produced in China (USITC Publication 4519 at 3-4).

In February 2015, a similar finding was made, except this time for Taiwan. After Solar World filed another petition in 2013, the Commission determined that an industry in the United States was materially injured by crystalline silicon photovoltaic solar cells and modules from Taiwan. As a result, the Department of Commerce issued antidumping duties on imports from China as well as Taiwan in 2015 for solar cells made in Taiwan, modules assembled in Taiwan from cells made in Taiwan, as well as modules assembled in third countries other than China from cells made in Taiwan (USITC Pub. 4739 at I-7).

This time, Suniva’s petition has resulted in a much different outcome than Solar World’s petitions made in 2011 and 2013. Once serious injury was determined, the ITC made a recommendation to President Trump for global safeguard relief. The purpose of a safeguard relief tariff is to target all of the major importers. Below is a summary of the remedy recommended by Chairman Schmidtlein on behalf of the ITC to President Trump for solar cell imports:

<table>
<thead>
<tr>
<th>Chairman Schmidtlein’s Recommended Remedy</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-Quota Tariff Rate</td>
<td>10%</td>
<td>9.5%</td>
<td>9.0%</td>
<td>8.5%</td>
</tr>
<tr>
<td>In-Quota Volume Level</td>
<td>0.5 gigawatts</td>
<td>0.6 gigawatts</td>
<td>0.7 gigawatts</td>
<td>0.8 gigawatts</td>
</tr>
<tr>
<td>Out-of-Quota Tariff Rate</td>
<td>30%</td>
<td>29%</td>
<td>28%</td>
<td>27%</td>
</tr>
<tr>
<td>Modules: Tariff (Ad Valorem)</td>
<td>35%</td>
<td>34%</td>
<td>33%</td>
<td>32%</td>
</tr>
</tbody>
</table>
With this recommendation, the president has the discretion to do exactly what the ITC recommends, enact different tariff levels, or even do nothing at all. Despite President Trump’s previous rhetoric on hoping to impose heavy tariffs to protect American manufacturing jobs, he actually imposed less heavy handed tariffs than Suniva asked for as well as less than the recommendation made by the ITC. Since the average price of solar panels is 32 cents per watt, a 35% tariff equates to about an 11 cent increase per watt. The original petition brought by Suniva proposed a tariff of 40 cents per watt, so the ITC’s recommendation resulted to be less than what some solar developers were fearful of.

Then in 2018, President Trump ultimately decided on a four year tariff that tapers 5% each year beginning at 30%. This subsequently meant 30% the first year, 25% the second year, 20% the third year, and 15% the final year. Despite an imposition of tariffs lower than the ITC’s recommendation, there is still significant pushback from the solar industry. The Solar Energy Industries Association (SEIA) has been leading the pushback against the imposition of tariffs since the initial petition from Suniva because they believe that tariffs imposed on the importer will increase the price of solar cells and reduce demand for solar projects. Additionally, since the domestic industry’s capacity is not large enough to meet existing demands, there will likely be a shift to alternative products (Hill, 2017).

The safeguard tariff excludes 100 countries, as referenced in the appendix (Kenning, 2018). For the countries not exempt and likely negatively impacted by the tariff, there is a possibility that they will challenge the solar tariffs at the WTO. If the WTO does not rule in favor of the U.S. safeguard tariffs, the WTO has the ability to limit the impact of a safeguard measure by prompting the U.S. to weaken or shorten the duration of the safeguard.
The WTO has ruled against every U.S. safeguard implemented since its founding in 1994 (Ryan, 2013). A way in which countries can challenge the tariffs to the WTO would be to question whether the sudden increase in solar cell imports into the U.S. was indeed “unforeseen”. WTO law requires that safeguard measures may only be implemented in response to “unforeseen developments”, yet U.S. law does not reference “unforeseen developments” (McMahon, 2018). But having learned from past safeguard reversals as a result of not evaluating an “unforeseen development” the ITC did address this in the investigation on solar cell imports. Therefore, it is likely that countries will not be successful if they use this method when challenging the safeguard imposition.

However, there are other ways in which the solar safeguard might not fare well with the WTO. The European Union has demanded compensation because European solar imports did not cause serious injury “due to their volume and higher prices”. Since the U.S. rejected the request, it is possible that retaliatory measures will be allowed if the WTO finds that the European Union was not a threat of serious injury. The largest threat to the safeguard imposition is that under the Section 201 process, the U.S. must discuss the tariff with affected countries prior to being imposed. Since the tariff was imposed, countries have submitted complaints to the WTO regarding the solar tariff due to the lack of “consultation” and “compensation” between trading partners (Pyper, 2018). Due to the lack of negotiations, it is possible that the WTO will not rule in favor of the U.S. and lead to retaliation from other countries.
Methods

The first step in my thesis was to conduct background research on the developments on the Suniva Trade Case, the 1974 Trade Act, how the U.S. International Trade Commission conducts investigations, and relevant historical trade disputes pertaining to anti-dumping and safeguard relief.

Then, with the help of Dr. Maskus, I gathered production data on solar cell imports from the Trade Policy Information System (TPIS) from the U.S. Department of Commerce. In order to gather this data, I determined that the North American Industry Classification (NAICS) code for solar panels code for solar panels is 334413 “semiconductor and related device manufacturing”. NAICS is a business classification system used by the United States, Canada, and Mexico. Businesses are classified by industry into six digit codes and the Census Bureau tabulates data at the two-digit level down to the six-digit NAICS level, six-digits being the most specific (“About NAICS”).

With the NAICS code, Dr. Maskus and I were able to narrow the search in TPIS for solar panel import data from China, Korea, Malaysia, Mexico, Thailand, and Vietnam. For each country we gathered the quantity of solar panels imported annually, the total U.S. dollar value for annual solar panel imports, and the unit value index of solar cell imports from 2005 through 2016. With this data I developed graphs for solar panel imports in U.S. Dollars as well as another graph which illustrates the quantity of solar panel imports into the United States from the five top importers from 2005 through 2016.

Next, I worked with Dr. Maskus to develop equilibrium economic models. The first model is based on the world trade market for the five largest importers into the United States. The supply curve is the sum of the quantity of imported solar panels from the top five countries.
based on 2016 TPIS data. The pre-tariff price of $77 is the calculated average of the five main importers. The initial demand curve is based on 2016 imports and the adjusted demand curve is based on the imposition of a 30% tariff. The calculations for this model are based upon assumed elasticities and are listed in the results section. The world market model allows us to calculate the change in domestic solar panel price as well as the change in world market solar panel price. This in turn allows us to calculate the change in annual solar panel imports.

Then, we developed a second economic model. This U.S. domestic market model utilizes employment data from both the domestic solar manufacturing industry as well as the U.S. domestic demand side solar installation industry. Using the calculated post-tariff U.S. price of solar panels, I solved for the maximum impact on employment in the U.S. domestic manufacturing and installment industries. By analyzing employment data from the Solar Energy Industry Association, we are able to draw conclusions on how each industry may potentially be impacted by the imposition of this safeguard relief tariff.

Once these two models were developed, I also took into account the annual 5% decrease in the tariff over the course of the next four years for what we deemed as the most probable elasticity grouping based on the nature of the world and U.S. domestic market. Once this was decided, I applied the models for 30%, 25%, 20%, and 15% tariff levels. Lastly, I drew upon all my calculations to draw conclusions on the impact of the Suniva Trade Case.
Results

With the gathered TPIS data, I first created graphs illustrating import trends of solar panels from China, Korea, Malaysia, Mexico, Thailand, and Vietnam for 2005-2016. The first graph shows the imports in U.S. dollars and the second graph shows the quantities of solar panels from each country. These graphs reveal how the demand for solar energy in the U.S. began to take off in 2010. Additionally, I have included a dotted line at 2012 on both graphs to reference the impact of the 2012 decision to place anti-dumping solar panel tariffs on China. As a result, we see that Malaysia developed a large market share.
Number of Solar Panel Imports into the United States by Country

- China
- Korea
- Malaysia
- Mexico
- Thailand
- Vietnam

2012 Anti-dumping tariff against China
## ECONOMIC MODELS

<table>
<thead>
<tr>
<th>World market formula for 30% tariff</th>
<th>Domestic Market formulas</th>
<th>%Δ Output= λ(%ΔPUS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[θ(\frac{P_w^1}{77})-1 = \varepsilon[θ(\frac{P_w^1(1.3)}{77})-1]]</td>
<td>[= \frac{λ}{\lambda}]</td>
<td>[\frac{λ}{\lambda}]</td>
</tr>
<tr>
<td>[\frac{P_w^1}{77} = \frac{\varepsilon}{\theta}[\frac{P_w^1(1.3)}{77}] = (\frac{\varepsilon}{\theta})(-1)+1]</td>
<td>[\frac{1}{77}[\frac{P_w^1}{1-(\frac{\varepsilon}{\theta})(1.3)}]=(\frac{\varepsilon}{\theta})(-1)+1]</td>
<td>[\frac{\alpha}{\alpha}]</td>
</tr>
<tr>
<td>[\frac{P_w^1}{77} = \frac{\varepsilon}{\theta}(\frac{P_w^1}{1-(\frac{\varepsilon}{\theta})(1.3)})=(\frac{\varepsilon}{\theta})(-1)+1]</td>
<td>[\frac{1}{77}[\frac{P_w^1}{1-(\frac{\varepsilon}{\theta})(1.3)}]=(\frac{\varepsilon}{\theta})(-1)+1]</td>
<td>[\frac{\alpha}{\alpha}]</td>
</tr>
<tr>
<td>[\frac{P_w^1}{77} = \frac{\varepsilon}{\theta}[\frac{P_w^1(1.3)}{77}] = (\frac{\varepsilon}{\theta})(-1)+1]</td>
<td>[\frac{1}{77}[\frac{P_w^1}{1-(\frac{\varepsilon}{\theta})(1.3)}]=(\frac{\varepsilon}{\theta})(-1)+1]</td>
<td>[\frac{\alpha}{\alpha}]</td>
</tr>
</tbody>
</table>

### Knowns from 2016 TPIS Data:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial imports</td>
<td>91 million</td>
</tr>
<tr>
<td>Initial US and Market Price</td>
<td>$77</td>
</tr>
<tr>
<td>Initial domestic manufacturing jobs</td>
<td>38,000</td>
</tr>
<tr>
<td>Initial domestic installation jobs</td>
<td>260,077</td>
</tr>
</tbody>
</table>

### Elasticity Assumptions

<table>
<thead>
<tr>
<th>θ</th>
<th>ε</th>
<th>λ=1/4(ε)</th>
<th>α=1/3(ε)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>-1.5</td>
<td>0.375</td>
<td>-0.5</td>
</tr>
<tr>
<td>4</td>
<td>-2</td>
<td>0.5</td>
<td>-0.67</td>
</tr>
<tr>
<td>4</td>
<td>-3</td>
<td>0.75</td>
<td>-1</td>
</tr>
<tr>
<td>3</td>
<td>-1.5</td>
<td>0.375</td>
<td>-0.5</td>
</tr>
<tr>
<td>3</td>
<td>-2</td>
<td>0.5</td>
<td>-0.67</td>
</tr>
<tr>
<td>3</td>
<td>-3</td>
<td>0.75</td>
<td>-1</td>
</tr>
</tbody>
</table>
The following six calculations are for a 30% tariff on solar cells, but each calculation will have different assumed elasticities as listed.

**Calculation 1**

**30% Tariff**

Assume:

<table>
<thead>
<tr>
<th>θ</th>
<th></th>
<th>λ = -1/4(ε)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>-1.5</td>
<td>0.375</td>
<td>-0.5</td>
</tr>
</tbody>
</table>

**World Market**

\[ P_{w1} = \frac{77(\varepsilon/\theta + 1)}{[1 - \varepsilon/\theta(1.3)]} \]

\[ = 77\left[\frac{-1.5/4}{1} \right] \frac{1}{1 - (-1.5/4)(1.3)} \]

\[ = \frac{77(1.375)}{1 + 0.49} \]

\[ = 71.06 \]

**Domestic Market**

\[ \%\Delta Output = \lambda(\%\Delta P_{US}) \]

\[ \%\Delta Output = 0.375 \left[ \frac{92.38}{77} - 1 \right] = 7.4\% \]

\[ \frac{P_{US1}}{P_{US}} = \frac{1.3}{P_{w1}} \]

\[ = 2,812 \text{ manufacturing jobs gained} \]

\[ \%\Delta Installation = \alpha(\%\Delta P_{US}) \]

\[ \%\Delta Installation = -0.5 \left[ \frac{92.38}{77} - 1 \right] = -10\% \]

\[ \%\Delta EX = \theta \left[ \frac{P_{w1}}{77} - 1 \right] \]

\[ = 4 \left[ \frac{71.06}{77} - 1 \right] = -0.31 \]

\[ = -31\% \text{ Import Change} \]

\[ \text{Initial Import} = 91 \text{ million} \]

\[ \text{IM}_{1} = 91 \left( 0.69 \right) \]

\[ \text{IM}_{1} = 91(0.69) \]

\[ \text{26,007 installation jobs lost} \]

**Takeaways**

The world market price decreases from $77 to $71.06, while the U.S. import price increases from $77 up to $92.38. This results in a 32% decrease in solar panel imports into the U.S. and equates to a drop from 91 million solar panels down to 62.8 million. In the domestic market, this would result in a gain of 2,812 solar manufacturing jobs, but a loss of 26,007 solar installation jobs.
## Calculation 2

### 30% Tariff

Assume:

<table>
<thead>
<tr>
<th>$\theta$</th>
<th>$\varepsilon$</th>
<th>$\lambda = -1/4(\varepsilon)$</th>
<th>$\alpha = 1/3(\varepsilon)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>-2</td>
<td>0.5</td>
<td>-0.67</td>
</tr>
</tbody>
</table>

### World Market

\[
P_w^1 = 77[\varepsilon/\theta(-1)+1] / [1-\varepsilon/\theta(1.3)]
\]

\[
=77[(-0.5)(-1)+1]/[1-(-0.5)(1.3)]
\]

\[
=77(1.5)/1+0.65
\]

\[
70
\]

\[
P_{1US} = P_w^1(1.3)
\]

3,420 manufacturing jobs gained

### Domestic Market

\[
% \Delta \text{Output} = \lambda (% \Delta P_{US})
\]

\[
\lambda ((P_{US}^1/77)-1)
\]

\[
0.5[(91/77)-1]=9%
\]

\[
38,000(0.09)
\]

### Initial Import 91 million

\[
IM_1 = 91(1-0.36)
\]

\[
IM_1 = 91(0.64)
\]

31,209 installation jobs lost

### Takeaways

The world market price decreases from $77 to $70, while the U.S. import price increases from $77 up to $91. This results in a 36% decrease in solar panel imports into the U.S. and equates to a drop from 91 million solar panels down to 58.24 million. In the domestic market, this would result in a gain of 3,420 solar manufacturing jobs, but a loss of 31,209 solar installation jobs.
Calculation 3
30% Tariff

Assume:

<table>
<thead>
<tr>
<th>$\theta$</th>
<th>$\varepsilon$</th>
<th>$\lambda = -\frac{1}{4}(\varepsilon)$</th>
<th>$\alpha = \frac{1}{3}(\varepsilon)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>-3</td>
<td>0.75</td>
<td>-1</td>
</tr>
</tbody>
</table>

**World Market**

$P_w^t = 77\left[\varepsilon/\theta(-1)+1\right] / \left[1-\varepsilon/\theta(1.3)\right]$

$=77\left[-0.75(-1)+1\right]/\left[1-(-0.75)(1.3)\right]$

$=77(1.75)/1+0.975$

$=68.23$

**Domestic Market**

$\% \Delta \text{ Output} = \lambda(\% \Delta P_{US})$

$\lambda(P_{US}/77)-1$

$0.75[(88.7/77)-1]=11.4\%$

$\% \Delta \text{ Installation} = \alpha(\% \Delta P_{US})$

$\alpha(P_{US}/77)-1$

$-1[(88.7/77)-1]=-15.2\%$

**Initial Import 91 million**

$IM_1 = 91(1-0.45)$

$IM_1 = 91(0.55)$

4,332 manufacturing jobs gained

39,531 installation jobs lost

Takeaways

The world market price decreases from $77 to $68.23, while the U.S. import price increases from $77 up to $88.70. This results in a 45% decrease in solar panel imports into the U.S. and equates to a drop from 91 million solar panels down to 50.05 million. In the domestic market, this would result in a gain of 4,332 solar manufacturing jobs, but a loss of 39,531 solar installation jobs.
Calculation 4
30% Tariff

Assume:

<table>
<thead>
<tr>
<th>θ</th>
<th>ε</th>
<th>λ = 1/4(ε)</th>
<th>α = 1/3(ε)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>-1.5</td>
<td>0.375</td>
<td>-0.5</td>
</tr>
</tbody>
</table>

**World Market**

\[ P_{w1} = \frac{77[\epsilon/\theta(-1)+1]}{[1-\epsilon/\theta(1.3)]} \]
\[ = \frac{77((-0.5)(-1)+1)}{[1-(-0.5)(1.3)]} \]
\[ = \frac{77(1.5)}{1+0.65} \]
\[ 70 \]

\[ P_{1US} = P_{w1}(1.3) \]

\[ %\Delta Output = \lambda(%\Delta P_{US}) \]
\[ = 3 \]
\[ 0.375[(91/77)-1] = 6.8\% \]

\[ 38,000(0.068) \]

\[ 2,584 \] manufacturing jobs gained

**Domestic Market**

\[ P_{1US} = P_{w1}(1.3) \]

\[ %\Delta Installation = \alpha(%\Delta P_{US}) \]
\[ %\Delta EX = \theta[P_{w1}/77-1] \]
\[ = 3[(70/77)-1] \]
\[ = -0.5[(91/77)-1] = -9.1\% \]

\[ 23,667 \] installation jobs lost

Initial Import 91 million

\[ IM_1 = 91(1-0.27) \]
\[ = 91(0.73) \]

Takeaways

The world market price decreases from $77 to $70, while the U.S. import price increases from $77 up to $91. This results in a 27% decrease in solar panel imports into the U.S. and equates to a drop from 91 million solar panels down to 66.43 million. In the domestic market, this would result in a gain of 2,584 solar manufacturing jobs, but a loss of 23,667 solar installation jobs.
Calculation 5
30% Tariff

Assume:

<table>
<thead>
<tr>
<th>θ</th>
<th>ε</th>
<th>λ = -1/4(ε)</th>
<th>α = 1/3(ε)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>-2</td>
<td>0.5</td>
<td>-0.67</td>
</tr>
</tbody>
</table>

### World Market

\[ P_{w^1} = 77[\varepsilon/\theta(-1)+1]/[1-\varepsilon/\theta(1.3)] \]

\[ = 77[-2/3(-1)+1]/[1-(-2/3)(1.3)] \]

\[ = 77(1.67)/1+0.87 \]

\[ P_{w^1} = 68.76 \]

\[ P_{US^1} = P_{w^1}(1.3) \]

\[ = 2964 \text{ manufacturing jobs gained} \]

\[ %\Delta EX = \theta[P_{w^1}/77-1] \]

\[ = 3[(68.76/77)-1] \]

\[ = -32\% \text{ Import Change} \]

### Domestic Market

\[ %\Delta Output = \lambda(\%\Delta P_{US}) \]

\[ %\Delta Installation = \alpha(\%\Delta P_{US}) \]

\[ = 38,000(0.078) \]

\[ = 27,048 \text{ installation jobs lost} \]

\[ %\Delta EX = \theta[P_{w^1}/77-1] \]

\[ = 3[(68.76/77)-1] \]

\[ = -32\% \text{ Import Change} \]

\[ IM_1 = 91(1-0.32) \]

\[ IM_1 = 91(0.68) \]

Takeaways

The world market price decreases from $77 to $68.76, while the U.S. import price increases from $77 up to $89. This results in a 32% decrease in solar panel imports into the U.S. and equates to a drop from 91 million solar panels down to 61.88 million. In the domestic market, this would result of a gain in 2,964 solar manufacturing jobs, but a loss of 27,048 solar installation jobs.
Calculation 6
30% Tariff

Assume:

<table>
<thead>
<tr>
<th>θ</th>
<th>ε</th>
<th>λ=−1/4(ε)</th>
<th>α=1/3(ε)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>-3</td>
<td>0.75</td>
<td>-1</td>
</tr>
</tbody>
</table>

**World Market**

\[ P^1_w = 77[\varepsilon/(\theta(-1)+1)] / [1-\varepsilon/(\theta(1.3))] = 77/((1)(1)+1)/(1/-1(1.3)) = 3 \]

66.96

\[ P^1_{US} = 3 \]

**Domestic Market**

\[ \%\Delta \text{ Output} = \lambda(\%\Delta P_{US}) \]

\[ \lambda[(P_{US}^1/77)-1] = 0.75[(87/77)-1] = 9.7\% \]

38000(0.097)

3,686 manufacturing jobs gained

**Installation**

\[ \%\Delta \text{ Installation} = \alpha(\%\Delta P_{US}) \]

\[ \alpha[(P_{US}^1/77)-1] = -1[(87/77)-1] = -13\% \]

260077(-0.13)

33,810 installation jobs lost

**Initial Import 91 million**

\[ IM_1 = 91(1-0.39) \]

\[ IM_1 = 91(0.61) \]

**Takeaways**

The world market price decreases from $77 to $66.96, while the U.S. import price increases from $77 up to $87. This results in a 39% decrease in solar panel imports into the U.S. and equates to a drop from 91 million solar panels down to 55.51 million. In the domestic market, this would result in a gain of 3,686 solar manufacturing jobs, but a loss of 33,810 solar installation jobs.
The following four calculations are for the same assumed elasticities, but account for the 5% reduction in tariffs over a four year period.

Assumed elasticities:

<table>
<thead>
<tr>
<th>θ</th>
<th>ε</th>
<th>λ=-1/4(ε)</th>
<th>α=1/3(ε)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>-2</td>
<td>0.5</td>
<td>-0.67</td>
</tr>
</tbody>
</table>

Year 1: 30% Tariff

**World Market**

\[ P_{w1} = 77[\varepsilon/\theta(-1)+1] / [1-\varepsilon/\theta(1.3)] \]

\[ = 77[(-0.5)(-1)+1]/[1-(-0.5)(1.3)] \]

\[ = 77(1.5)/1+0.65 \]

\[ = 70 \]

\[ P_{1US} = P_{w1}(1.3) \]

\[ = 91 \]

\[ \%\Delta EX = \theta[P_{w1}/77-1] \]

\[ = 4[(70/77)-1] \]

\[ = -0.36 \]

\[ = -36\% Import Change \]

**Domestic Market**

\[ \%\Delta Output = \lambda(\%\Delta P_{US}) \]

\[ \lambda(P_{US1}/77)-1 \]

\[ = 0.5[(91/77)-1]=9\% \]

\[ \%\Delta Installation = \alpha(\%\Delta P_{US}) \]

\[ \alpha(P_{US1}/77)-1 \]

\[ = -0.67[(91/77)-1]=-12\% \]

\[ = 260077(-0.12) \]

Initial Import 91 million

\[ IM_1=91(1-0.36) \]

\[ = 31,209 installation jobs lost \]

\[ IM_1=91(0.64) \]

**Takeaways**

The world market price decreases from $77 to $70, while the U.S. import price increases from $77 up to $91. This results in a 36% decrease in solar panel imports into the U.S. and equates to a drop from 91 million solar panels down to 58.24 million. In the domestic market, this would result in a gain of 3,420 solar manufacturing jobs, but a loss of 31,209 solar installation jobs.
Year 2: 25% Tariff

<table>
<thead>
<tr>
<th>World Market</th>
<th>Domestic Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_w^1 = 77(e/\theta(-1)+1) / [1-e/\theta(1.25)]$</td>
<td>4</td>
</tr>
<tr>
<td>=77[(0.5)(-1)+1]/[1-(0.5)(1.25)]</td>
<td>%Δ Output=$\lambda(%\Delta P_{US})$</td>
</tr>
<tr>
<td>71.08</td>
<td>$\lambda(P_{US}/77)-1$</td>
</tr>
<tr>
<td>$P_1^{US}=P_w^1(1.25)$</td>
<td>0.5[(88.85/77)-1]=7.7%</td>
</tr>
<tr>
<td>88.85</td>
<td>38000(0.077)</td>
</tr>
<tr>
<td>%ΔEX=$\theta(P_w^1/77-1)$</td>
<td>2,926 manufacturing jobs gained</td>
</tr>
<tr>
<td>=4[(71.08/77)-1]</td>
<td>%Δ Installation=$\alpha(%\Delta P_{US})$</td>
</tr>
<tr>
<td>-0.31</td>
<td>$\alpha(P_{US}/77)-1$</td>
</tr>
<tr>
<td>=-31% Import Change</td>
<td>-0.67[(88.85/77)-1]=-10.3%</td>
</tr>
<tr>
<td>Initial Import 91 million</td>
<td>26,878 installation jobs lost</td>
</tr>
<tr>
<td>IM$_1$=91(1-0.31)</td>
<td></td>
</tr>
<tr>
<td>IM$_1$=91(0.69)</td>
<td></td>
</tr>
</tbody>
</table>

Takeaways

The world market price decreases from $77 to $71.08, while the U.S. import price increases from $77 up to $88.85. This results in a 31% decrease in solar panel imports into the U.S. and equates to a drop from 91 million solar panels down to 62.79 million. In the domestic market, this would result in a gain of 2,926 solar manufacturing jobs, but a loss of 26,878 solar installation jobs.
Year 3: 20% Tariff

**World Market**

\[ P_w^3 = \frac{77\left(\varepsilon/\theta(-1)+1\right)}{\left[1-\varepsilon/\theta(1.2)\right]} \]

\[ = \frac{77\left((-0.5)(-1)+1\right)}{\left[1-(-0.5)(1.2)\right]} \]

\[ = \frac{77(1.5)/1+0.6}{\left[1-\left(-0.05\right)(1.2)\right]} \]

\[ P_{1US} = P_w^3(1.2) \]

\[ = 72.19 \]

\[ 86.63 \]

\[ %\Delta EX = \theta\left(P_w^3/77-1\right) \]

\[ = 4\left[\left(72.19/77\right)-1\right] \]

\[ = -0.25 \]

\[ %\Delta Import = 25\% \]

**Domestic Market**

\[ \%\Delta Output = \lambda\left(%\Delta P_{US}\right) \]

\[ \lambda\left(P_{US}/77\right)-1 \]

\[ = 0.5\left[\left(86.63/77\right)-1\right] = 6.3\% \]

\[ 38000(0.063) \]

\[ 2,394 \text{ manufacturing jobs gained} \]

\[ %\Delta Installation = \alpha\left(%\Delta P_{US}\right) \]

\[ \alpha\left(P_{US}/77\right)-1 \]

\[ = -0.67\left[\left(86.63/77\right)-1\right] = -8.4\% \]

\[ 260077(-0.084) \]

\[ 21,846 \text{ installation jobs gained} \]

**Takeaways**

The world market price decreases from $77 to $72.19, while the U.S. import price increases from $77 up to $86.63. This results in a 25% decrease in solar panel imports into the U.S. and equates to a drop from 91 million solar panels down to 68.25 million. In the domestic market, this would result in a gain of 2,394 solar manufacturing jobs, but a loss of 21,846 solar installation jobs.
Year 4: 15% Tariff

**World Market**
\[ P_w^1 = 77\left[\frac{\varepsilon\theta(-1)+1}{1-\varepsilon\theta(1.15)}\right] \]
\[ = 77\left[\frac{(-0.5)(-1)+1}{1-(-0.5)(1.15)}\right] \]
\[ = 77\left(\frac{1.5}{1+0.575}\right) \]
\[ = \frac{77}{1.575} \]
\[ = 73.33 \]

**Domestic Market**
\[ P_{US}^1 = P_w^1(1.15) \]
\[ = 73.33(1.15) \]
\[ = 84.33 \]

\[ \%\Delta EX = \theta\left(P_w^1/77-1\right) \]
\[ = 4\left(\frac{73.33}{77}-1\right) \]
\[ = -0.19 \]
\[ = -19\% \text{ Import Change} \]

Initial Import 91 million
\[ IM_1 = 91(1-0.19) \]
\[ IM_1 = 91(0.81) \]

Takeaways

The world market price decreases from $77 to $73.33, while the U.S. import price increases from $77 up to $84.33. This results in a 19% decrease in solar panel imports into the U.S. and equates to a drop from 91 million solar panels down to 73.71 million. In the domestic market, this would result in a gain of 1,824 solar manufacturing jobs, but a loss of 24,967 solar installation jobs.
Discussion

In order to develop these economic models, we had to make some assumptions. As a result, these models do have limitations in its application to the real world. First, for the world market model, it was necessary to assume that the suppliers are perfect substitutes. Then, we decided on six likely groupings of assumed elasticities. These elasticities are based on how responsive the world market is as well as the U.S. domestic market. In other words, since this is a safeguard relief tariff placed on all importers of solar panels into the United States, the world market is more elastic because suppliers can turn to another country to export their goods to in the case of high tariffs. Since the United States has made it less profitable for other countries to import solar panels, it is likely that the large importers will divert their supply to another country. Therefore, we concluded that the more likely supply elasticity for the world market is 4. Additionally we assumed a likely demand elasticity to be -2. This means that for every 10% increase in price, there will be a 20% decrease in import demand. Similarly, we had to make assumptions as to how responsive businesses and households will be to an increase in the price of solar panels. Ultimately we decided that for the purposes of this model, the U.S. domestic market supply elasticity would be calculated as 1/4 of the world market supply and the U.S. domestic market demand would be 1/3 of the world market demand.

Due to the uncertainty of knowing what the elasticities in question actually are, I calculated the impact of the tariff for six different elasticity groupings. As shown in the results section, the differences in elasticities were not drastic enough to make a large difference. Regardless, I found that that there was always a much smaller amount of manufacturing jobs gained in comparison to the amount of installation jobs lost.
However, the most important limitation to take into account is that these models are maximum responses to the imposition of tariffs. Here is a summary of employment results, taking into account the annual 5% drop:

<table>
<thead>
<tr>
<th>U.S.A.</th>
<th>Year 1: 30% Tariff</th>
<th>Year 2: 25% Tariff</th>
<th>Year 3: 20% Tariff</th>
<th>Year 4: 15% Tariff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic solar manufacturing jobs</td>
<td>+3420</td>
<td>+2926</td>
<td>+2394</td>
<td>+1,824</td>
</tr>
<tr>
<td>Domestic solar installation jobs</td>
<td>-31,209</td>
<td>-26,878</td>
<td>-21,846</td>
<td>-16,644</td>
</tr>
</tbody>
</table>

Although the installation sector will undoubtedly be largely negatively impacted and the manufacturing industry should benefit to an extent, I do not suspect that future impacts will reach such drastic levels for the following reasons. First, U.S. installers have contracts with these suppliers and it is likely too costly to void these contracts. Second, many installation companies began stockpiling cheap solar panels once Suniva’s petition for safeguard relief became publically known. Therefore, this will likely have an impact on actual U.S. import demand. Third, it is unlikely that installation companies will want to lay off so many employees if the tariff will only be imposed for four years as well as decrease by 5% each year. Although it will be costly to keep so many employees during the years with imposed tariffs, it is not sensible in the long run to lay off 18% of employees because it would be costly to train new employees once the cost of solar panels decreases. Lastly, it is unlikely that the manufacturing industry will benefit to such an extent because it is difficult to ramp up production in the short run.

Despite these limitations, the models ultimately reveal a much larger decrease in domestic jobs in the installation sector in comparison to the amount of jobs gained in domestic solar manufacturing. Although it is more likely that these maximum effects will not be reached, there will still be an overall decrease in American jobs. With an average tradeoff of gaining a
maximum of 2,641 jobs to lose 24,144 jobs, it is apparent that this tariff will hurt American jobs regardless of whether or not the full impact is reached. Even if half of the projected job loss in installation is reached, the solar installation industry as well as the U.S. solar market will likely be negatively impacted. In the short run, it seems apparent that consumers may likely bear the burden of higher electricity costs in states that must meet renewable energy policy and regulatory requirements. Whether or not there will be a time lag in the process of relieving the environmental justice associated with poor air quality from coal powered plants located near poor minority communities is uncertain because renewable energy projects already in place through contracts may not suddenly be halted. However, it is possible that some projects could run out of funding due to the price change in solar panels.

In conclusion, although there will undoubtedly be a hit to the U.S. solar market, I believe that the industry will recover and will not be largely impacted in the long run, assuming no additional tariffs are imposed after four years.
Implications

A potential benefit of a renewable energy transition is to help relieve some of the most vulnerable in our society from environmental externalities. Often times, the environmental ills caused by pollution are most deeply felt by poor minority communities of color. For example, coal plants are most often located near poor communities of color and emit mercury, lead, sulfur dioxide, nitrogen dioxide, and carbon dioxide. These emissions are a large public health issue as they diminish the health and livelihoods of those living near the coal plants. Due to the close proximity of pollutants located near these communities, it has been found that an African American child is three times more likely than a white child to go to the emergency room due to an asthma attack (Toomey, 2013).

The reason for which these harmful coal plants are often located in poor communities of color is due to the phenomenon known as the Not In My Backyard “NIMBY”. This is a characterization of opposition by residents to a development proposal that would be located near their community (Gerrard, 1994). Typically, more affluent predominately white communities are able to make sure that an unwanted development does not end up near their community because they have the time and financial means to submit formal appeals, litigate, protest, and gain public support for their case. However, for a poor community faced with the same issue, most of these families are busy working multiple jobs and do not have the time or financial means to match the pushback of more well off communities. As a result, these communities are the path of least resistance and are a target for harmful development projects such as coal plants. More specifically, African American neighborhoods are especially vulnerable to unwanted land uses. This phenomenon of NIMBY “creates and perpetuates privileges for whites at the expense of people of color” (Bullard, 1990).
The newly imposed safeguard relief tariff on solar cells will lessen the pace of a renewable energy transition and result in the release of more pollutants in the U.S. due to less solar installations. By enacting the tariff, it will in turn cause an increase of 7 million metric tons of CO2 equivalent per year by 2030. To place this into perspective, 7 million metric tons of CO2 is equivalent to the emissions of 1.5 million cars per year in 2030 (Page, 2017). The 7 million metric tons of CO2 equivalent would have originally been the reduction by 2030, but this tariff on solar cells is instead causing an increase of CO2 that would have otherwise been avoided. Rather than decreasing fossil emissions and mitigating the impacts of climate change, this additional CO2 will play a role in exacerbating the increasingly devastating effects of climate change.

As a result of continued reliance on fossil fuels to meet growing energy demands, it is likely that these poor communities of color will continue to suffer both health and financial impacts. Prior to the imposition of the tariff, the cost of solar had become less than the price of coal powered electricity. Now that it is likely that domestic solar installation industry will be hurt by the tariff, it is probable that a larger portion of the energy grid will be composed of more costly fossil fuels as opposed to an increasing amount of solar energy. This in turn will burden the poor because a larger portion of their salary will go towards higher electricity costs. In order to alleviate some of our most vulnerable members of society from both financial and health burdens, it is crucial to pursue a renewable energy transition that does not place additional financial hardship on the poor.
**Recommendations**

Since the development of the Suniva Trade Case has occurred recently and trade relations will continue to evolve in the next few years, I believe that there are impactful areas of research beyond this thesis. My recommendation for future research is to build upon these findings and develop possible retaliation measures that could be taken against the United States by the top five solar cell importers through the usage of game theory. Another recommendation is to research possible solar manufacturing subsidy policies that could help increase U.S. domestic solar production and employment in combination with the safeguard relief tariff. At this time, the safeguard relief tariff itself is not enough to increase domestic production substantially and it would be beneficial to research how a domestic solar manufacturing subsidy may benefit the objective of increasing domestic solar production.
Works cited


Section 202(c)(2); 19 U.S.C. § 2252(c)(2).


Toomey, Diane. “Coal Pollution and the Fight for Environmental Justice.” Yale Environment 360, 19 June 2013,

USITC Publication 4519 at 3-4 (November 2012).


19 U.S.C. § 2252(b)(1)(A)

19 U.S.C. § 2252(c)(6)(A)(1)


**Appendix**

Trade Policy Information System Data:

1. Solar Panel Imports into the United States in U.S. Currency from 2005 to 2016:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>21,329,410</td>
<td>68,389,240</td>
<td>183,628,483</td>
<td>227,224,135</td>
<td>408,026,470</td>
<td>1,150,671,684</td>
<td>2,652,451,836</td>
<td>1,667,531,148</td>
<td>1,142,505,701</td>
<td>1,607,032,812</td>
<td>1,695,707,429</td>
<td>1,498,168,419</td>
</tr>
<tr>
<td>Korea</td>
<td>149,778</td>
<td>79,272</td>
<td>38,760</td>
<td>132,730</td>
<td>2,432,280</td>
<td>13,970,128</td>
<td>47,482,867</td>
<td>139,041,925</td>
<td>36,085,691</td>
<td>108,035,151</td>
<td>391,273,138</td>
<td>1,284,144,251</td>
</tr>
<tr>
<td>Malaysia</td>
<td>149,902</td>
<td>83,401</td>
<td>0</td>
<td>2,387</td>
<td>54,853,927</td>
<td>139,004,423</td>
<td>562,695,042</td>
<td>1,444,536,552</td>
<td>1,207,554,037</td>
<td>808,770,483</td>
<td>1,254,485,898</td>
<td>2,427,974,263</td>
</tr>
<tr>
<td>Thailand</td>
<td>35,585</td>
<td>38,123</td>
<td>7,670</td>
<td>2,900</td>
<td>16,902</td>
<td>53,475</td>
<td>7,435</td>
<td>345,100</td>
<td>640,519</td>
<td>39,832,449</td>
<td>519,703,671</td>
<td></td>
</tr>
<tr>
<td>Vietnam</td>
<td>35,585</td>
<td>38,123</td>
<td>7,670</td>
<td>2,900</td>
<td>16,902</td>
<td>53,475</td>
<td>7,435</td>
<td>345,100</td>
<td>640,519</td>
<td>39,832,449</td>
<td>519,703,671</td>
<td></td>
</tr>
</tbody>
</table>

2. Quantity of Solar Panel Imports into the United States

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>650,678</td>
<td>1,356,622</td>
<td>2,627,620</td>
<td>2,633,426</td>
<td>5,124,878</td>
<td>10,794,901</td>
<td>44,183,681</td>
<td>18,001,434</td>
<td>10,115,175</td>
<td>14,208,157</td>
<td>22,194,649</td>
<td>14,498,410</td>
</tr>
<tr>
<td>Korea</td>
<td>30,051</td>
<td>4,537</td>
<td>724</td>
<td>32,307</td>
<td>6,345</td>
<td>45,467</td>
<td>322,611</td>
<td>3,078,715</td>
<td>1,327,794</td>
<td>1,282,108</td>
<td>3,362,024</td>
<td>8,051,587</td>
</tr>
<tr>
<td>Malaysia</td>
<td>63,680</td>
<td>40,283</td>
<td>0</td>
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<td>413,356</td>
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3. Unit Value Index of Solar Panel Imports into the United States

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4. Exempt Countries from Solar Cell Tariffs

The exempted countries include: Afghanistan, Albania, Algeria, Angola, Armenia, Azerbaijan, Belize, Benin, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Burkina Faso, Burma, Burundi, Cambodia, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo (Brazzavile), Congo (Kinshasa), Cote d’Ivoire, Djibouti, Dominica, Ecuador, Egypt, Eritrea, Ethiopia, Fiji, Gabon, The Gambia, Georgia, Ghana, Grenada, Guinea, Guinea-Basson, 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, Sao Tome and Principe, Senegal, Serbia, Sierra Leone, Solomon Island, Somalia, South Africa, South Sudan, Sri Lanka, Suriname, Swaziland, Tanzania, Timor-Leste, Togo, Tonga, Tunisia, Turkey, Tuvalu, Uganda, Ukraine, Uzbekistan, Vanuatu, Yemen, Zambia and Zimbabwe.