

# Solar Panel Trade Between US and China

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## Process Overview

### Purpose of the Project:

Our group visualization project aims to illustrate the impact of the energy transition on global trade dynamics. Specifically, we focus on the solar panel industry, which has become a critical player in the ongoing geopolitical race. With the increasing investment in solar infrastructure, countries are vying for a competitive edge in this emerging market. However, this has also resulted in trade disputes between nations, particularly between China and the United States.

One of the main issues in this dispute is the accusation that Chinese manufacturers are selling their solar products at unfairly low prices, which has led to the imposition of tariffs by the United States. As a result, Chinese manufacturers have shifted their operations to Taiwan and Southeast Asia, where they continue to export their solar products to the United States. Notably, these factories often rely on raw materials sourced from China, like polysilicon. Our visualization project seeks to illustrate these complex trade dynamics and their impact on the global energy transition.

### Methodology:

In this project, we focused on the solar panel value chain and collected trade data between China and the United States. Our first visualization was a line graph that illustrates the trade balance between China and the US from 2017 to 2021. We specifically focused on the total balance primary value and quantity per year. Next, we created an interactive bar chart comparing China's export to Southeast Asian countries with their export to the US. To provide further contrast, we also created a bar chart that shows the top 5 solar panel import countries for the US from 2018-2022. Additionally, we analyzed journal texts related to the trade of photovoltaic products between the US and China and created a word cloud based on the frequency of specific keywords. Finally, we developed an interactive shiny map that shows the funding status of the solar industry in the United States.

### Data Description:

- Dataset: <https://www.energy.gov/eere/solar/solar-energy-research-database>

- o The data is from office of energy efficiency & renewable energy that lists all the solar energy projects at national laboratories, state and local governments, universities, nonprofit organizations, and private companies to improve solar technologies.

- o It includes all the active and inactive projects, locations, start dates, funding opportunity and program area.

- Dataset: <https://library.columbia.edu/help/howto/elink/fulltextln.html>

- o We will web scrape sentiment data from Columbia library with keywords such as 'solar panels', 'trade', 'China', etc. This will help us understand the trade relationship between China and the US, and whether it is maintaining a positive or negative relationship, and the causes of negative relationship if there is any.

- o The visualization will be word cloud and pyramid plot.

- Dataset: <https://catalog.data.gov/organization/doegov?capacity=public&tags=solarnhj%20uu>

- o This dataset includes solar photovoltaic R&D labs. It is a large-scale time-series database containing system metadata and performance data from a variety of experimental PV sites and commercial public PV sites.

## Findings and Implications:

Initially, China had a high trade surplus with the US in the export of silicon and photovoltaic cells, but this changed drastically in 2018, potentially due to the US-China Trade War. The surplus increased steadily from 2019 to 2021 as the US still relied heavily on China's exports. However, in 2022, an investigation on China's solar manufacturing caused a contraction in direct exports to the US. Interestingly, China's exports to Malaysia, Cambodia, and Thailand increased, indicating a transfer of solar exports to third-party countries before reaching the US. Moreover, import data on photovoltaic cells from the US revealed that China had been the top exporter until stricter export regulations were imposed, leading to Mexico becoming the leading exporter. This shift may be attributed to tariffs placed on Southeast Asian countries, prompting the trend of exporting solar panels to Mexico as a third-party country. Text analysis of journals on solar panel trade between China and the US highlighted key themes such as growth, power, economic impacts, domestic market, exports, government support, technology, environmental benefits, investment, and subsidies. These terms reflect the expansion of the solar panel industry, economic benefits, the role of government policies, technological advancements, environmental considerations, and the importance of investments and subsidies in driving the industry. Lastly, the Solar Energy Technologies Office (SETO) in the US provides funding to various entities to enhance the affordability, reliability, and effectiveness of solar technology on

the national grid. The SETO-funded projects can be viewed on a map and sorted based on criteria such as program area and funding scheme. The database includes project information dating back to 2007, supporting the development of solar technology in the US.

## Future Improvements:

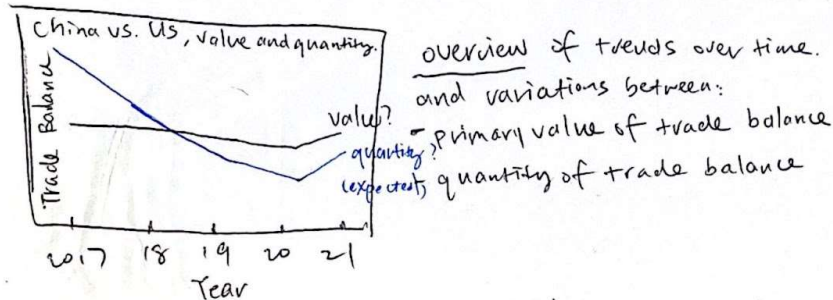
As we reflect on our solar panel trade data visualization project, we recognize that there are several areas for improvement in our analysis. Moving forward, we plan to explore the following:

1. Deeper data exploration: While our initial analysis provided useful insights into the solar panel trade between China and the US, there is still much more we can learn by digging deeper into the data. We will explore additional data sources to gain a more comprehensive understanding of the trends and patterns in this industry.
2. More sophisticated data visualization techniques: While we used a variety of visualization techniques in our project, we recognize that there are more advanced techniques that we can employ to better convey our findings. For example, we may consider using interactive data visualizations that allow users to explore the data on their own.
3. Integration of more diverse data sources: While we were able to gather data from a variety of sources, we recognize that there are many other factors that can impact the solar panel trade between China and the US. In future projects, we will seek to integrate data from a wider range of sources, including environmental and political data, to gain a more complete picture of this industry.
4. Enhanced natural language processing: While we were able to conduct some basic text analysis of 50 journals, we recognize that there is much more we can do in this area. By employing more sophisticated natural language processing techniques, we can extract more meaningful insights from textual data.

By focusing on these areas for improvement, we believe that we can enhance the accuracy and impact of our solar panel trade data visualization project, and better inform stakeholders in this industry.

# Process of Making Graphs

## Line Plot - Xinyi Shi:



| Period | HS6code | balance value | ... |
|--------|---------|---------------|-----|
| 2017   | 8541    | 882617676     | ... |
| 2018   | 854110  | 99782382      | ... |
| 2019   | 854110  | 5541052       | ... |
| ...    | ...     | ...           | ... |

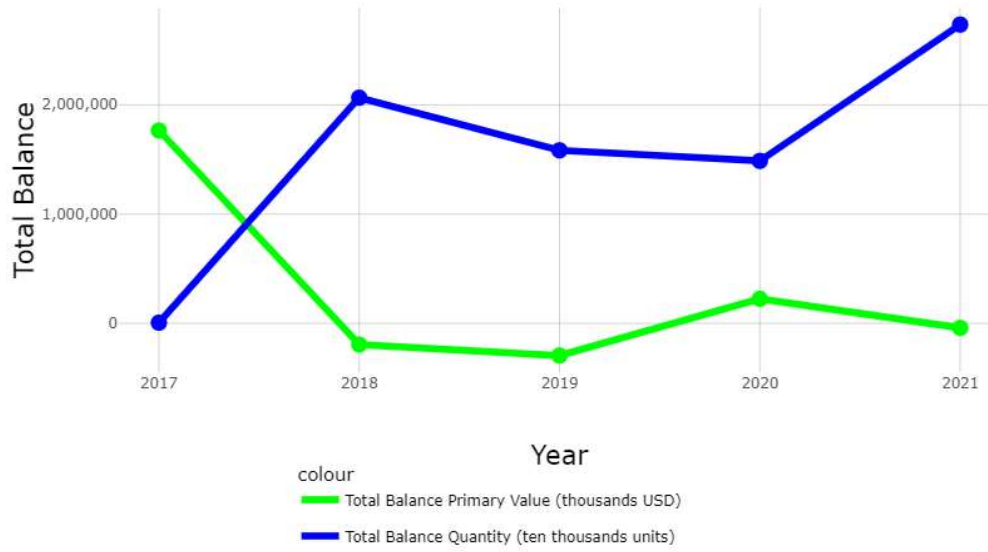
Data Table of trade balance =

- Selection of period, HS6code to help audience learn each category within. 8541 (photovoltaic)
- Sorting method to visualize the largest and smallest numbers.

The purpose of this first part is to visualize the overall trend of solar panel and related photovoltaic products trade between China and the US between 2017-2021. Since we have the complete data, I decided to start with a line graph to illustrate the trends and changes. Then I choose to combine the value and quantity lines on one plot because their units can be combined and people will have no confusion reading it. Then I also considered including a datatable for the raw data showing the products (denoted by HS6Codes), balance value and balance quantity. Users can select a period to view the data they are interested in. However, after thinking I believe this datatable is not necessary because first the HS6Codes have duplicates and new users may not understand what they mean, so they won't make a lot of sense. Second, it is not that important for users to learn the raw data of export and import but the general trend. So I decided to leave out the datatable and only include a polished and interactive line graph.

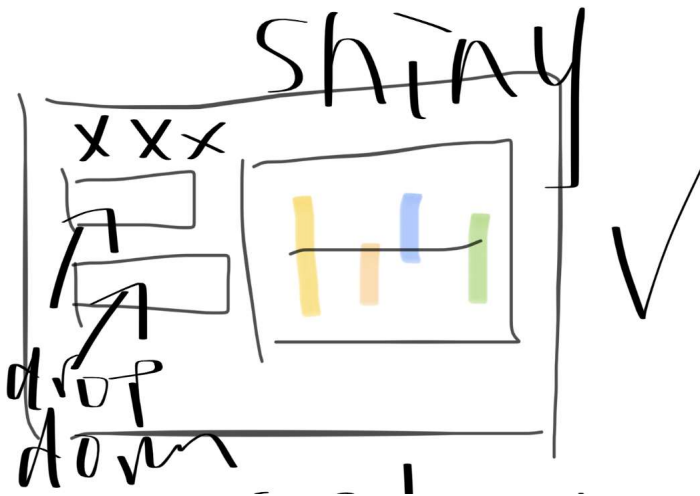
Final graph: Value and quantity of trade balance of photovoltaic products between China and US  
- Xinyi Shi

China vs. US: Balance Primary Value and Quantity per Year(2017-21)



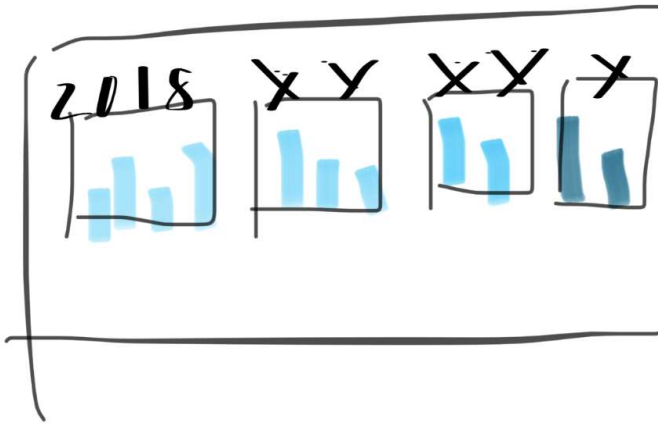
Bar Chart:

Process:



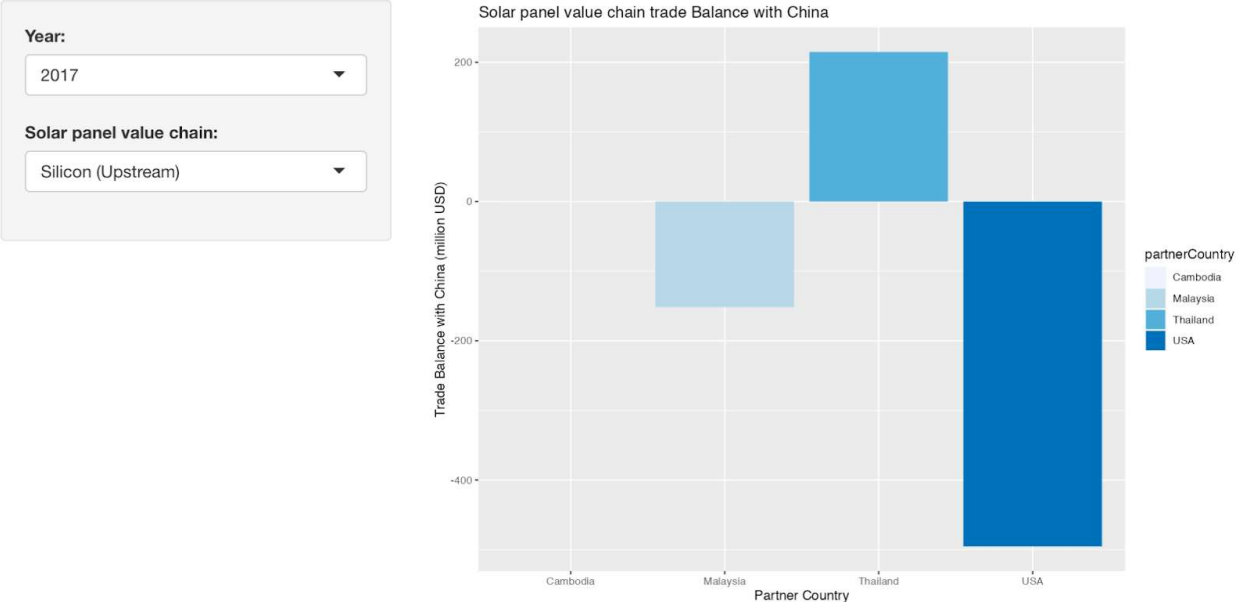


The Sanket didn't work out due to unknown reasons, which I wasn't able to fix with assistance. So I decided to create a bar chart grid.



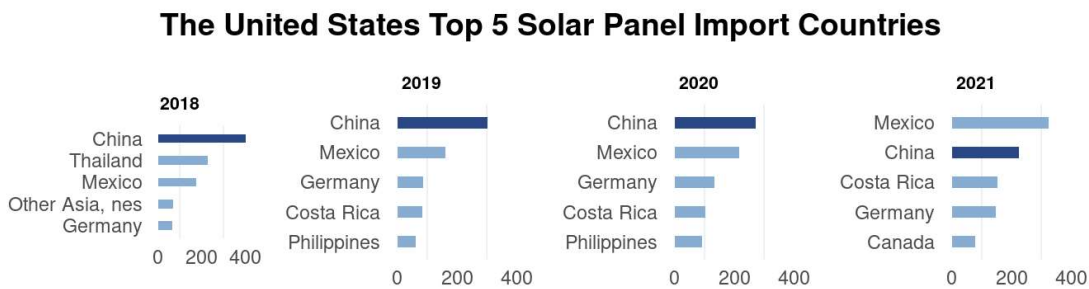
**China's export to the Southeast Asian countries - Huiling Zhou**

# China's Solar Panels Trade Balance



There is an interactive bar chart that shows China’s exports of silicon and photovoltaic cells to three Southeast Asian countries identified by the US, as well as to the US itself. By selecting “Photovoltaic cells (Downstream)”, we can see that China had a high trade surplus with the US, but this changed drastically in 2018, potentially due to the US-China Trade War launched in 2017. The surplus increased steadily from 2019-2021 as the US still relied heavily on China’s exports. However, in 2022, another investigation was launched on China’s solar manufacturing, which caused a contraction in China’s direct exports to the US. Along with this contraction, China’s exports to Malaysia, Cambodia, and Thailand increased, reflecting the idea that China is transferring its solar exports to third-party countries before sending them to the US.

## The United StatesTop 5 solar panel import countries (2018-2022) - Huiling Zhou



To further strengthen our previous assumption, we obtained import data on photovoltaic cells from the United States from the past four years. We identified the top five countries that export solar panels to the United States. China had been the top exporter until last year when stricter export regulations were imposed. Surprisingly, Mexico has now taken the lead. This may be due to the

tariffs that the United States placed on Southeast Asian countries, which has prompted the trend of exporting solar panels to Mexico as a third-party country.

## Text Analysis (Peizhi Zhang):



The text analysis visualizes the most frequently used words in 50 journals on solar panel trade between China and the US. We can see that in most of these documents, the keywords are “growth”, “power”, “economic”, “domestic”, “exports”, “government support”, “technology”, “environmental”, “investment”, “subsidies”, and so on. There are many frequently appeared themes from these terms, along with the context of the US and China trade war currently taking place. For instance, “growth” likely refers to the expansion of the solar panel industry in both China and the US, and the potential for further growth in the future. “Power” could refer to a number of things, including the use of

solar power as a renewable energy source, the economic and political power of China and the US in the global solar panel industry, or the potential for solar power to empower individuals and communities by providing access to energy.” “Economic” may refer to the economic benefits and impacts of the solar panel trade between China and the US, including job creation, economic growth, and the potential for new markets and industries to emerge. “Domestic” may suggest that the production and consumption of solar panels within each country's domestic market, as well as the potential for domestic policies and regulations to impact the solar panel trade between China and the US. “Exports” could mean the export of solar panels from China to the US, and the potential for this trade to drive economic growth and create jobs in both countries. “Government support” might refer to the role of government policies, regulations, and subsidies in supporting the solar panel industry in both China and the US. “Technology” refers to the technological advancements and innovations driving the solar panel industry, as well as the potential for new technologies to emerge in the future. “Environmental” likely refers to the environmental benefits and impacts of the solar panel industry, including the reduction of greenhouse gas emissions and the potential for solar power to mitigate climate change. “Investment” refers to the investments being made in the solar panel industry by companies, governments, and individuals, as well as the potential for future investments to drive growth



and innovation in this industry. “Subsidies” suggests the subsidies provided by governments to support the production and consumption of solar panels, as well as the potential for these subsidies to impact the competitiveness of the solar panel industry in different markets.

## **Map-Hanyi Wang**

SETO provides funding to a range of entities, including national laboratories, state and local governments, universities, nonprofit organizations, and private companies. The objective is to enhance the affordability, reliability, and effectiveness of solar technology on the national grid. The active and inactive projects funded by SETO can be viewed on a map. Additionally, the projects can be sorted and filtered according to various criteria, such as program area, funding scheme, or active/inactive status. The database includes information on projects dating back to 2007, sourced from project applications and documents negotiated with the Department of Energy.