Transactions on Economics, Business and Management Research
ISSN: 2960-1789, eISSN: 2960-2254 | Volume 9
GBMS 2024

Comparative Policy Analysis of Photovoltaic Industry Development: Case Studies of China and the United States

Xin Huang

Department of International Relations, Nanjing University, Nanjing, Jiangsu, 210023, China

221820330@smail.nju.edu.cn

Abstract. Amidst the challenges in achieving the Paris Agreement objectives, the 28th Conference of the Parties (COP28) has injected renewed impetus, with the photovoltaic (PV) industry assuming a pivotal role. China and the United States, as major players in the global solar PV sector, have tailored policies reflecting the current status of their PV industries. Notably, China has transitioned from a government-led to a market-oriented approach, while the United States has pursued localization and trade protectionism strategies. This paper initiates with an overview of the PV industry policies of both countries, followed by a comparative analysis of their similarities and differences. Employing a comparative method seeks to unveil the geopolitical factors implicit in these policies, hindering cooperation between the two nations. Despite these challenges, the analysis also underscores the significant potential for collaboration in global environmental governance. In addition to highlighting the barriers to cooperation, the study aims to provide insights into opportunities for enhanced collaboration between China and the United States. By fostering cooperation, these nations can collectively address the pressing challenges posed by climate change and contribute to the realization of the Paris Agreement goals.

Keywords: PV Industry; Chinese and America Policies; COP28.

1. Introduction

As the world grapples with the growing challenges posed by climate change, switching to renewable energy has become a major global priority. The photovoltaic (PV) industry is a key player in achieving net-zero emissions. In this context, the geopolitical landscape plays a significant role in shaping national policies that govern the development of the PV industry. This paper presents a comparative analysis of PV policies in China and the United States, two of the world's leading solar economies. These countries' energy priorities, technological capabilities, and geopolitical strategies for influencing global renewable energy markets are reflected in their approaches to the PV industry.

The urgency to curb global climate change under the Paris Agreement's framework has led to an intensified focus on national efforts to achieve carbon neutrality through innovative and sustainable energy policies, which was reinforced by the commitment of states in COP28.

In the United States, the policy landscape is characterized by a combination of fiscal incentives, regulatory frameworks, direct financial subsidies, and trade protection measures aimed at fostering a robust domestic PV market. The Biden administration's emphasis on synergistic promotion of supply and demand highlights a strategic pivot towards bolstering technological innovation and expanding the production capacities of high-tech enterprises in the renewable sector. Conversely, China's approach encapsulates a direct governmental intervention model, with policies that have evolved from active development to vigorous promotion under successive Five-Year Plans. The Chinese government's strategy is heavily policy-oriented, focusing on market stimulation and technological advancements to position itself as a global leader in the PV industry. This includes a range of policies from tax incentives to feed-in tariffs designed to accelerate the country's transition towards a sustainable energy future.

This paper examines the specific policies enacted by the two countries and the effectiveness of these policies in promoting the development of the PV industry in the context of the broader goals of energy

transition and carbon neutrality. It focuses on the two countries leading PV industries through PV industry case studies. The analysis aims to understand how China and the United States have used their PV industry policies not only to combat climate change but also to exert geopolitical influence in the global energy landscape. The comparison between the two countries reveals underlying motivations driven by economic, environmental, and geopolitical factors and sheds light on the complexities of global energy policy in an era of renewable energy transition.

2. Background

2.1. Global Climate Goals and National Responses: A Prelude to Comparative Analysis in the PV Industry

In 2015, the Paris Agreement was adopted by 196 countries. This historic treaty marked a new stage in the global effort to combat climate change together. The overarching goal of the Paris Agreement is to hold 'the increase in the global average temperature to well below 2°C above pre-industrial levels'; and pursue efforts 'to limit the temperature increase to 1.5°C above pre-industrial levels' [1]. The Paris Agreement adopts a flexible and innovative approach to implementation. It calls on countries to make Nationally Determined Contributions (NDCs) and to strengthen these commitments in subsequent submissions every five years, reflecting their highest possible level of ambition and progress over time, and to conduct a global stocktake every five years to assess collective progress towards the goals of the Agreement. Net-zero emissions are considered a crucial pathway to achieving this objective. In order to limit global warming to no more than 1.5°C, it is essential to reduce carbon emissions by 45% by 2030 and reach net zero by 2050, as called for in the Paris Agreement. However, the commitments made by governments so far fall far behind what is required. Current national climate plans, as combined by the 193 parties to the Paris Agreement, are projected to result in a significant increase of nearly 11% in global greenhouse gas emissions by 2030 compared to 2010 levels [2]. This is coupled with a range of externalities, such as bottlenecks in the development of energy technologies and disparities in the ability of different countries to combat climate change. The achievement of a 45% reduction in carbon emissions by 2030 and a net-zero reduction by 2050 is still not within reach. COP 28 was a historic opportunity to change tack and accelerate the solution to the climate crisis. It hosted the first-ever global stocktake to comprehensively assess the world's collective progress towards achieving the goals of the Paris Agreement, including assessing the effectiveness of national climate action plans and their consistency with limiting global warming to well below 2°C (compared to the 1.5°C target), leading to global progress towards net zero emissions. The report mentions explicitly 'tripling global renewable energy capacity and doubling the global average annual rate of energy efficiency improvement by 2030', with a focus on renewable energy development [3].

Table 1. Renewable electricity capacity additions by technology and segment, 2020-2028

Year	Solar PV (GW)	Wind (GW)	HydropowRenewable electricity capacity additions (GW)	Bioenergy (GW)	Geothermal (GW)	% of wind and PV
2020	151.2	107.9	20.7	9.2		89.5%
2021	170.5	94.7	27.8	9.9	0.3	87.5%
2022	228.4	74.4	31.9	7.3		88.5%
2023	374.9	107.8	17.5	6.1		95.1%
.....						
2028 (Accelerated case)	672.6	221.5	34.2	9.5		95.2%

(Source. IEA, Renewable electricity capacity additions by technology and segment, 2016-2028, Retrieved from: https://www.iea.org/data-and-statistics/charts/renewable-electricity-capacity-additions-by-technology-and-segment-2016-2028)

The estimated increase in global renewable power generation is expected to reach 507 GW in 2023, which is almost 50% higher than in 2022 [4]. This growth is being spurred by continued policy support in more than 130 countries, leading to a significant shift in global growth trends, as shown in Table 1.

In 2023, three-quarters of renewable capacity additions will come from PV alone. Renewable capacity additions will continue to accelerate over the next five years, with solar PV and wind accounting for a record 96 percent of capacity additions, as their generation costs are lower than fossil and non-fossil alternatives in most countries. Policies in all countries show a clear preference for their development. The forecast projects that solar PV will more than double by 2028 compared to 2022, reaching nearly 710 GW and continuing to break records [5]. The growth of solar PV is a major catalyst for achieving net-zero emissions and is key to government's response to the global climate challenge.

2.2. Solar PV Industry in the United States

Solar energy is booming in the United States, with a growth rate of 22 percent per year over the past decade alone. There is now more than 179 GW of installed solar capacity nationwide, enough to power nearly 33 million homes, driven by strong federal policies such as the Solar Investment Tax Credit, rapidly declining costs, and growing demand for clean energy in both the private and public sectors [6]. According to SEIA's report, the US solar market reached 32.4 GWdc of installed capacity in 2023, a whopping 51 percent increase over 2022 - the industry's biggest year to date. Solar power accounted for 53 percent of US grid additions, more than half of all new generation for the first time. Moreover, the report predicts that total US solar power generation will quadruple from 177 GWdc by the end of 2023 to 673 GWdc by 2034. Solar is projected to become the largest generating capacity in the US by 2040 [7].

Nevertheless, the domestic production capacity of the United States supply chain is currently de facto limited. Prior to recent developments, the majority of photovoltaic solar panels sold in the United States were not manufactured domestically. As previously stated, the majority of the raw materials originate from China or from factories constructed by Chinese enterprises investing in Southeast Asia. The United States currently possesses the capacity to produce metallurgical-grade silicon, polysilicon, steel, aluminum, resins, racks and mounts, and other key materials. However, significant gaps remain in the US solar supply chain. For instance, the United States currently lacks the capacity to produce solar ingots, wafers, or cells, as well as solar modules, inverters, and trackers. These deficiencies must be addressed while simultaneously enhancing the competitiveness of existing production capacity [8].

In 2022, the Inflation Reduction Act (IRA) significantly boosted prospects for solar energy in the United States. The legislation allocates $369 billion for energy security and climate investments, with the stated aim of reducing carbon emissions by 40 percent by 2030 [9]. This includes tax credits for all parts of the PV chain. Over the next five years, the IRA's long-term tax incentives and manufacturing provisions provide the market with the certainty required to increase the expected solar deployment by 38 percent compared to the IRA's previous projections [10]. The IRA reduces investment and holding costs and spurs willingness to invest through measures such as the earned income tax credit and excise tax deduction. In particular, it is recommended that the ITC (Investment Tax Credit) policy be extended and modified by extending the ITC policy for 10 years and adjusting the interest rates on credits for solar projects to favour residential, small commercial, and industrial projects. Furthermore, the Production Tax Credit (PTC) policy provides incentives for large enterprises and other entities to prioritize local manufacturing in the context of the Biden administration's high regard for the PV industry and other emerging energy sectors. Nevertheless, despite these apparent protectionist measures, the US solar industry maintains a strong connection to China and is significantly reliant on Chinese manufacturers, particularly for the supply of photovoltaic modules.

2.3. Solar PV Industry in China

In recent years, China's solar PV industry has consistently held a leading position in global rankings. By the end of 2022, China had reached a cumulative installed solar capacity of 392.04 gigawatts, accounting for over one-third of the world's total installed capacity [11]. Driven by the emergence of large-scale utility projects and government incentives, China's PV industry has seen steady development and increasing investment in PV projects. 216 GW of new solar PV capacity will be added in China in 2023, accounting for 14% of the world's total installed capacity [12]. Most of China's concentrated ground-mounted solar farms are located in the west, while electricity demand is concentrated in the east 2021 The Chinese government launched a national PV programme in 2021 to encourage rooftop solar construction, and the combination of centralised and distributed power generation is becoming a reality. By November 2023, 676 counties in 31 provinces had signed up for the programme, and around 157GW of rooftop solar had been built, twice as much as in the US [13].

China's dominant position in the PV panel supply chain has attracted a significant amount of global solar manufacturing capacity from Europe, Japan, and the United States to China. Since 2011, China has invested more than $50 billion in new PV supply capacity, creating 300,000 manufacturing jobs. Today, China's share of all solar panel manufacturing stages (e.g., polysilicon, ingots, wafers, etc.) exceeds 80 percent [14]. Furthermore, the Chinese government has identified solar PV as a strategic industry, as evidenced by the 14th Five-Year Plan [13]. (National Development and Reform Commission, National Energy Administration, etc, 2022) Chinese PV companies have achieved cost reductions of more than 80 percent through economies of scale and continuous innovation, enabling China to play an important role in reducing the cost of solar PV power globally, as high costs are a major factor preventing renewable energy from replacing traditional energy sources such as coal [15]. According to a report by the China Photovoltaic Industry Association (CPIA), due to the unrivaled price advantage of Chinese companies, in terms of PV product exports in 2023, silicon wafers exported 70.3 gigawatts (GW), up more than 93.6 percent year-on-year; batteries exported 39.3 GW, up 65.5 percent year-on-year; and modules exported 211.7 GW, up 37.9 percent year-on-year [16]. Chinese solar panel companies dominate the international market.

The achievements of the Chinese PV industry can be attributed to the effectiveness of the country's policy-oriented strategy. This strategy is not separable from the Chinese government's policy support and macro-control. The Renewable Energy "13th Five-Year Plan" set a target of 110 million kilowatts of solar power generation by 2020, a target that has been exceeded [6]. Following this, in June of 2022, China released its Renewable Energy 14th Five-Year Plan, an even more ambitious plan to achieve carbon neutrality and reach peak carbon emissions. This plan outlines a target of one-third of China's electricity being derived from renewable sources by 2025, with 18% coming from wind and solar energy.

3. Policy Comparison

3.1. US Policy

The United States is the world's second-largest PV market, for the global net-zero carbon emissions and energy transition are crucial to promoting the carbon neutrality goal has become a global consensus, the new energy development imperative, in which the policy is to promote the development of the industry is an important force. The Biden administration's new energy development policy emphasises the synergistic promotion of supply and demand, focusing on preferential policies to promote technological research and development, including various types of support for technological innovation, demonstration and application of new technologies, and expansion of production capacity of high-tech enterprises. The US federal and state governments at all levels have introduced policies to promote the development of new energy. From the perspective of PV industry development, the US policies can be divided into four major categories: fiscal incentives, management policies, direct financial subsidies, and Shi trade protection.

3.1.1. Fiscal incentives: boosting solar installations by cutting costs and taxes.

(1) ITC policy: The Inflation Reduction Act (IRA) proposes a 10-year extension of the ITC policy, increasing the credit from 26% to 30% for projects up to 1MW and reducing the credit from 26% to 6% for projects over 1MW (30% if conditions are met). The updated ITC policy will be favourable to residential, small commercial, and industrial projects and unfavourable to large corporate and other entities;

(2) PTC policy: similar to the ITC policy but favourable to projects with larger capital volumes. It is worth noting that the PTC's preference for local manufacturing, i.e., the use of all US steel products and meeting the 40% domestic content threshold (20% for offshore wind) for facilities to receive an additional 10% credit, reflects the Biden administration's determination to break the new energy industry's dependence on China.

3.1.2. Regulatory policy: clarifying market-based models through system design.

(1) Quota system: A quota system refers to a mandatory requirement in a country or region that a certain percentage (i.e., the quota standard) of the electricity supplied by the power system must be renewable energy supply. In the US, the quota target is set by each state individually. According to statistics, 31 states and 2 special districts in the US have set RPS/CES targets. The establishment of the quota system guarantees the new energy development targets of each region. States with RPS policies have seen an increase in eligible renewable energy generation, with significant increases in solar installations in states with strong RPS, such as California and New Jersey. California's RPS requires utilities to obtain 60 percent of their electricity from renewable sources by 2030 and 100 percent by 2045, according to the EIA. California is the US leader in solar power. By 2020, the state's installed solar PV capacity will reach approximately 29,000 megawatts (MW), accounting for nearly one-third of the total installed solar capacity in the United States [6].

(2) Net metering policy: Electricity companies are required to deduct their self-generated renewable energy from the total electricity consumed by customers, and the customer is required to pay the difference. According to DSIRE, as of August 2021, 39 states, including Washington, DC, and 4 overseas territories have mandatory net metering in place.

(3) PPA tariff: refers to the medium- and long-term energy purchase agreements signed between power users and power generation companies; PPA tariffs are mainly determined by the relationship between supply and demand, with lower PPA tariffs in resource-rich regions; when investment costs tend to be higher, power generation companies tend to increase PPA tariffs.

3.1.3. Financial subsidies: supporting industrial development through direct subsidies.

Table 2. Selected US Solar Industry Support Policies from 2020 to 2022

Policy	Date	Subsidy amount and project
Inflation Reduction Act	2022.8	$369 billion (In response to climate change, including a large number of new energy investment projects)
Infrastructure Investment and Jobs Act	2022.5	(1) $3.16 billion (to increase production of U.S.-made batteries) (2) Allocate $60 million (to support the secondary application of used electric vehicle batteries) (3) Launched the $505 million initiative (to facilitate deployment and reduce the cost of long-term energy storage) (4) Invest US$26 million (for solar, wind, and energy storage) (5) Allocate $10 million (for some communities to start solar energy)
Energy Storage Grand Challenge Roadmap	2021.3	$20 million (R&D to improve the manufacturability of neutral flow battery systems, increase the scale of energy storage and efficiency in the use of clean energy)
Energy Act 2020	2020	US$1 billion authorized over 5 years (Cross-domain Energy Storage Research and Development Demonstration Program)

(Source: EIA and Oriental Securities Institute)

From the perspective of direct subsidy policy in the past 3 years, focusing on new energy vehicles and energy storage industry, it is believed that financial subsidies mainly support emerging industries through government financial support, so the current stage of subsidies focuses on diversified energy storage technology and application of long-term energy storage (Table 2).

3.1.4. Local trade protection: supporting local industry while entwined with China's chain through trade protection.

In November 2011, the US Department of Commerce announced that it would initiate a "double antidumping" and "countervailing duty" investigation into Chinese PV cell imports into the US. In May 2012, the US Department of Commerce announced that it would impose a preliminary antidumping duty (ADD) of 31% on Chinese PV cell imports, which would be combined with a new countervailing duty (CVD) of 2.9% to 4.7% on all Chinese crystalline silicon PV cell imports. In May 2012, the US Department of Commerce announced a preliminary antidumping duty (ADD) of 31% on imports of Chinese PV cells, which, together with a new countervailing duty (CVD) of between 2.9% and 4.7%, would apply to all imports of Chinese crystalline silicon PV cells. Even if the US implements trade protectionist measures, the Chinese industrial chain remains indispensable due to its significant cost advantage. According to EIA data, in 2021, the US will have 30.45 GW of available module shipments, of which imported PV modules will account for 22.97 GW, or 75%, and local production will account for only 4.23 GW, or less than 14%. Among the imported countries and regions, 49.2% are from Mainland China, Taiwan, Singapore, and Vietnam, most of which are Chinese manufacturers. 21.7% come from South Korea and Thailand, where Atlas, Trina Solar, TengHui, and Astronergy have factories (Figure 1). This means that more than half of the module supply in the US will have to rely on Chinese manufacturers, and Chinese companies will benefit from the rapid growth of the US market.

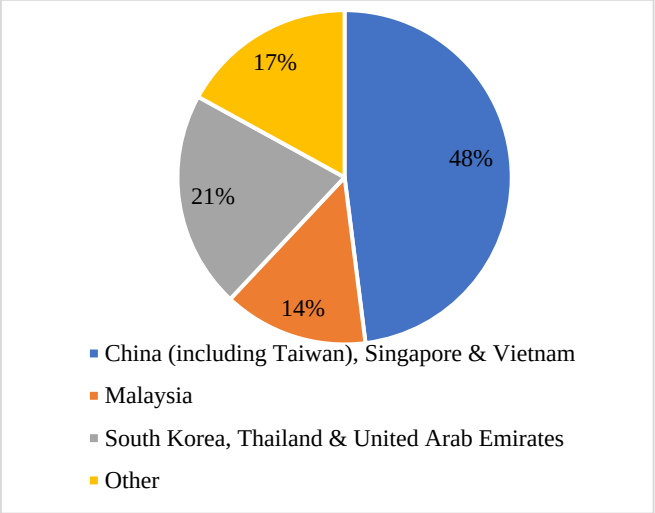

Figure 1. 2021 US PV module source countries and regions (Source: EIA and Oriental Securities Institute)

3.2. China's Policy

3.2.1. Overview of the development of China's PV industry based on policy perspectives.

The PV industry is an important engine for promoting China's energy transition, an important part of new energy, and an important way to achieve a "carbon peak and carbon neutrality" (Table 3). State support for the Chinese PVs industry has moved from 'actively developing' to 'focused developing' and then to 'strongly promoting' in the course of the successive 5-year plans from 1996 to 2025, moving from a general new energy concept to specific PVs power generation initiatives [17]. It has gone through the process from the concept of new energy proposed at the national macro level to the clear development of PV power generation to the inclusion of the PV industry in the strategic emerging industries, and the focus on planning and promoting the optimisation and upgrading of the

path of energy structure, China has made a leapfrog development in less than 20 years, and owns the world's largest PV industry chain. China's PV industry has made remarkable achievements, which is an example of the success of the Chinese government's policy-oriented strategy. Strategy cannot be separated from the strong policy support and macro-control of the Chinese government. China's PV industry policy took the Circular on Matters Relating to PV Power Generation in 2018 as a turning point and experienced a market-oriented reform from a large-scale direct financial subsidy policy to an incentive policy based on stimulating the vitality of market players, which has transformed China's PV industry from a policy-oriented one to a vibrant market player-oriented to the market and scientific and technological innovation. In terms of the PV power generation assembly field, also from the original government-led centralised PV power plant to centralised and distributed PV power generation and promote the diversified development of regional PV power generation assembly.

Table 3. Key Policies for China's PV Industry before 2018

Policy	Date	Substance
Renewable Energy Act	2005.2	Promote the development and utilization of renewable energy, increase energy supply, improve energy structure, ensure energy security, protect the environment, and achieve sustainable economic and social development
Interim Measures for the Management of Financial Subsidy Funds for the Golden Sun Demonstration Project	2009.7	In principle, grid-connected power generation projects receive subsidies covering 50% of the total investment in the power generation system and related transmission projects, while independent solar PV systems in remote areas receive subsidies for 70% of the total investment.
Several opinions on promoting the healthy development of the PV industry	2013.7	Expanding the domestic market, enhancing technical capabilities, and accelerating industrial transformation are essential for the sustainable and healthy growth of the PV industry.
Comprehensive standardized technical system for solar PV industry	2017.4	By 2020, a sophisticated and coordinated PV industry standard system will be in place, achieving comprehensive coverage of essential standards necessary for the industry's development.

(Source: EIA and Oriental Securities Institute)

3.2.2. China's PV industry milestone transformational development.

As of 2018, the industry is caught in a dilemma due to the implementation of the "Notice on Matters Related to PV Power Generation in 2018" (hereinafter referred to as the "531" policy), which further lowered the standard tariffs and subsidy thresholds for PV power generation projects under the new construction standards [18]. The standard tariff for ordinary PV power plants was reduced by 0.05 yuan, with rates for different regions ranging from 0.5 to 0.7 kilowatt-hour. Additionally, subsidies for the "self-surplus" mode in distributed PV generation were decreased by 0.05 yuan to 0.32 yuan/kilowatt-hour. Following the implementation of the "531" policy in 2018, China's new PV capacity declined to over 43 GW, representing a year-on-year decline of 18%. This was accompanied by a 31% reduction in centralized installations, which fell to approximately 23 GW [19]. The policy also led to industry consolidation, with major players such as Tongwei and Longjie emerging as dominant forces. From 2018 to 2020, the number of new PV enterprises declined annually by 24% [20].

There is no doubt that the "531" policy shocked the PV industry, but it was inevitable and encouraged the industry to enter a new era. With the advent of the PV parity era, the production cost and power generation cost of China's PV products are also falling under the dual drive of technological progress and market demand. In 2019, for PV modules, the cost of monocrystalline PERC modules will fall to

about 1.31 yuan/W, and the total initial investment cost of PV systems will fall to about 4.55 yuan/W, with the cost falling to 0.2 yuan/W. The current Chinese PV market is proving that the Chinese PV industry can not only survive but thrive without huge government subsidies. According to Boqiang Li and Yufang Chen, the Chinese government has historically employed feed-in tariff (FiT) policy adjustments as a means of promoting the PV industry. Initially, these policy adjustments took the form of large tax incentives during the early stages of PV industry development [21]. Over the past decade, however, there has been a gradual shift towards encouraging technological innovation. Adjustments in feed-in tariff policies can result in the production costs of renewable energy being overlooked, which in turn can increase the responsiveness of producers, attract more patent applications, and thus promote technological innovation. As a result, the Chinese government has adopted different feed-in tariff policies at different stages of the PV industry's development, ensuring that China's PV industry has flourished despite the many challenges it has faced.

According to the Outline of the 14th Five-Year Plan (2021-2025), building a modern energy system and clarifying the centralised and decentralised development of the PV industry provides a clear and ambitious blueprint for China's PV industry. It points out that China's renewable energy is at a new historical starting point and will be a large-scale, high-proportion, market-oriented, high-quality development with new features [22]. Meanwhile, a staggering amount of annual renewable energy generation - about 3.3 trillion kilowatt-hours - has been set for 2025, with a focus on wind and solar power generation, and the hope that the total amount will be doubled [23].

3.3. Common Grounds in US and China PV Industry Policies

The US and China have implemented policies with considerable similarities with respect to the development of the PV industry, particularly in terms of the two countries' key policies targeting the US IRA and China's "531" policy. From the outset, both China and the United States have demonstrated a strong commitment to supporting the PV industry. This is largely because the PV industry plays a crucial role in enabling countries to achieve their Paris Agreement commitments and to contribute to global climate governance. Consequently, the development of PV industry policies in both countries reflects consistency in their respective carbon peak objectives. From a policy effectiveness perspective, both countries have implemented policies that aim to facilitate the growth of the PV industry. However, the effectiveness of these policies has been limited by a number of factors. The two policies, which were published at the beginning of the PV industry, have brought challenges to the industry to a certain extent. The growth rate of newly installed PV capacity in the two countries has experienced a significant decline. However, at this stage and in the forecast, it is not yet clear whether the policies will have a positive or negative effect on the industry. The policies of the two countries are regarded as an important factor in stimulating the vitality of the PV industry. From the perspective of policy realisation, the United States and China rely on the strength of their state finances to provide a large number of tax subsidies or exemptions in order to achieve the development of the PV industry in their respective countries. However, this kind of direct financial subsidy inevitably has disadvantages, including a reduction in the industry's ability to innovate independently. Such direct financial subsidies inevitably result in the reduction of the industry's independent innovation capacity. However, both countries have effectively addressed these issues to a certain extent.

3.4. Policy Divergence and Strategic Implications in US and China PV Industry Policies

Furthermore, there are notable differences in the policies of the two countries. With regard to policy sustainability, it is evident that China's long-term policies are more viable than those of the United States. The divergence between the political systems of the two countries has led to a divergence in the bipartisan stance of the United States on the climate issue. The PV industry, which represents the new energy support policy, depends on the maintenance of the Democratic Party, and this almost depends on the presidential election. It remains unclear whether the United States will experience a Trump period in the future, with the possibility of withdrawing from the Paris Agreement. The focus

of policy differs between the two countries, with the United States prioritising localisation as a symbol, while China emphasises a market-oriented approach. The two countries have disparate policy agendas. The United States is focused on localisation, whereas China is market-oriented. The former is attempting to promote manufacturing reshoring and achieve industrial reindustrialisation, while the latter is encouraging market players to be fully energised in order to ensure the global leadership of China's PV industry.

According to Cheng and Fan's research, the development and use of clean energy facilitates a transition from a resource-dependent to a technology-dependent global energy system. This transition is characterised by China's ascension to a dominant position within the global value chain, while the United States, concerned about China's potential to exert control over the global value chain system, has introduced the IRA, a trade-protective bill with the rationale of energy security. In May, the Indo-Pacific Economic Framework for Prosperity (IPEF) was established with the objective of strengthening the industrial supply of chips, key minerals, and other materials in order to reduce reliance on China. This initiative is designed to break China's central position in the Asia-Pacific industrial chain and supply chain [24]. In light of the multitude of measures directed towards countering China's emergence in the realm of new energy, including the IRA and IPEF, it can be observed that the United States harbours considerable unease and apprehension with regard to its position in this domain, with the photovoltaic industry representing a particularly salient concern. This anxiety can be understood within the broader context of the United States' strategic approach to identifying potential risks in order to ensure national security in the face of a range of geopolitical challenges and other variables.

4. A New Chapter in US-China Climate Cooperation: The Sunnylands Statement and the Future Direction of Global Climate Governance

Nevertheless, China and the United States still have considerable scope for collaboration. The resumption of China's cooperation on climate change is not only a prerequisite for the flourishing of the new energy industry on both sides but also an unavoidable necessity to address the challenges of global climate governance. Prior to the opening of COP28, China and the United States jointly released the "Sunnylands Statement on Enhancing Cooperation to Address the Climate Crisis" (hereinafter referred to as "the Sunnylands Statement"). This document announced the launching of the Sunnylands Statement on Enhancing Cooperation to Address the Climate Crisis. The Statement announced the establishment of the US-China " Working Group on Enhancing Climate Action in the 2020s" and identified specific cooperation plans and projects in key areas such as energy transition, methane, circular economy, low-carbon cities, etc. This has the effect of promoting the institutionalisation, concretisation, and pragmatisation of cooperation [25]. In the context of a complex international political landscape, the two countries have the opportunity to reaffirm their commitment to combating climate change. This demonstrates that, despite their differences, they are willing to transcend these and work together to address the challenges facing humanity. The warming up of US-China climate cooperation sends a key message to the world that climate cooperation should not be held hostage by politics or ideology. Rather, countries should put aside their differences and work together to address the climate crisis. At the same time, the US-China climate cooperation points out the direction for global climate governance. As global leaders in addressing climate change, China and the United States possess significant resources, including funds, technology, and talent, which they can utilise to address climate governance challenges. In terms of goals and directions, China and the United States have agreed to promote energy transformation, support tripling the global installed capacity of renewable energy by 2030, and accelerate the replacement of coal, oil, and gas power generation. In terms of specific areas of action, the two sides will promote the development of key technologies in the areas of energy efficiency, carbon capture, utilisation and sequestration, methane and other non-carbon dioxide greenhouse gas emissions, circular economy, and resource efficiency. The outcomes of the "the Sunnylands Statement" are reflected in the UAE Consensus, which

demonstrates the joint efforts of the two countries in addressing the global climate crisis and helping to realise the goals of the Paris Agreement.

5. Conclusion

This paper presents a comparative analysis of PV industry development policies in China and the US against the backdrop of COP28, which has set the global response to the climate change crisis on a new course. COP28 emphasises the goals of the Paris Agreement, and the PV industry is crucial in this regard as it has the potential to make a significant contribution to achieving net-zero emissions. The US approach includes financial incentives, regulatory frameworks, and financial subsidies designed to support the development of the domestic PV market. In addition, the Biden administration places significant emphasis on fostering renewable energy supply-demand synergies and technological innovation, with the IRA focusing on the US government's concerns about the PV industry despite the fact that it exhibits clear trade protectionism. In contrast, China, as a global leader in the PV industry, has undergone a shift in its policies from a government-oriented approach to a market-oriented one. This shift has been reflected in the country's five-year plans, which have increasingly emphasised the importance of market and technological advancement elements. The paper concludes by discussing the potential for US-China collaboration in the PV industry. It is argued that such collaboration is critical to global climate governance and the achievement of the Paris Agreement goals, as evidenced by joint initiatives such as the recent commitments made at COP28. Such collaboration is not only crucial for the PV industry but also an important contribution by both countries to help solve the global climate problem, albeit limited by geopolitical perceptual perspectives.

References

[1] Gao Lin. Global Climate Governance Mechanisms and Prospects under the Framework of the Paris Agreement. International Business Research, 2022, 43 (06): 54-62. DOI: 10.13680/j.cnki.ibr.2022.06.002.

[2] Pauw, W. Pieter, and Richard JT Klein. Beyond ambition: increasing the transparency, coherence and implementability of Nationally Determined Contributions. Making Climate Action More Effective. Routledge, 2021: 1-10.

[3] Fan Xing, Li Lu, Gao Xiang, et al. The analysis of COP28 Global Stocktake outcome and global climate governance prospects. Advances in Climate Change Research, 2024, 20 (2): 253.

[4] International Energy Agency (2023), "OECD: Net capacity of renewables (Edition 2023)", IEA Renewables Information Statistics(database), https://doi.org/10.1787/32734471-en (accessed on 23 April 2024).

[5] International Energy Agency. (2023). Tracking Clean Energy Progress 2023, Retrieved from: https://www.iea.org/reports/tracking-clean-energy-progress-2023.

[6] Solar Energy Industries Association. (2024). Solar industry research & data. Retrieved from https://www.seia.org/solar-industry-research-data.

[7] Solar Energy Industries Association. (2024). Solar Market Insight Report 2023 Year in Review. Retrieved from: https://www.seia.org/research-resources/solar-market-insight-report-2023-year-review.

[8] Solar Energy Industries Association. (n.d.). Catalyzing American solar manufacturing. Retrieved from https://www.seia.org/research-resources/catalyzing-american-solar-manufacturing.

[9] Biden-Harris Administration Releases Inflation Reduction Act Guidebook for Tribes. White House Press Releases Fact Sheets and Briefings/FIND, 2023.

[10] International Renewable Energy Agency. (2023). Renewable capacity statistics 2023. Retrieved from https://www.irena.org/Publications/2023/Mar/Renewable-capacity-statistics-2023.

[11] Bo Bai, Xiong Siqin, Ma Xiaoming, Liao Xiawei. Assessment of floating solar photovoltaic potential in China. Renewable Energy, 2024, 220: 119572.

[12] Zhang Huiming, Wu Kai, Qiu Yueming, Chan Gabriel, Wang Shouyang, Zhou Dequn, Ren Xianqiang. Solar photovoltaic interventions have reduced rural poverty in China. Nature communications, 2020, 11 (1).

[13] International Energy Agency. Renewable energy market update. Organization for Economic Cooperation and Development (OECD) Publishing, 2023.

[14] Documentation of the National Energy Administration. Notice of the Comprehensive Department of the National Energy Administration on Matters Related to the Preparation of the ‘14th Five-Year Plan’ for Renewable Energy

Development. Yu Chongde Editor-in-chief, China Electric Power Yearbook, China Electric Power Press, 2021, 740-742, Yearbook. DOI: 10.42942/y.cnki.yzgdl.2023.000794.

[15] China Photovoltaic Industry Association. (2024). China Photovoltaic Industry Annual Report 2022-2023. http://www.chinapv.org.cn/annual_report/1285.html.

[16] Congressional Research Service, US Solar Photovoltaic Manufacturing, 2022.

[17] Yuan Chaoqing & Zhu Yuxin. A study on the evolution of China's photovoltaic industry policy based on dynamic hotspots. Science and Technology Management Research, 2020, 2020 (14): 43-53.

[18] Document of the National Development and Reform Commission. National Development and Reform Commission Ministry of Finance National Energy Administration. Notice on the Explanation of Matters Related to Photovoltaic Power Generation in 2018. Yu Chongde Editor-in-chief, China Electric Power Yearbook, China Electric Power Press, 2019, 616, Yearbook. DOI: 10.42942/y.cnki.yzgdl.2021.000701.

[19] Huang Bin, Zhao Wei, Liao Lida, et al. Analysis on regional difference of the whole PV industry chain from the perspective of policy. Southern energy construction, 2024, 11 (2): 179-188. Doi: 10.16516/j.ceec.2024.2.18

[20] Cui Hongyu. Institutional overcoming of the development dilemma of photovoltaic industry in the post-subsidy era. Law and Economy, 2020 (2): 2. DOI: CNKI: SUN: FZJJ.0.2020-02-026.

[21] Boqiang Lin & Yufang Chen. Impact of the feed-in tariff policy on renewable innovation: Evidence from wind power industry and photovoltaic power industry in China. The Energy Journal, 2023, 44 (2) doi: https://doi.org/10.5547/01956574.44.2.blin.

[22] Outline of the Fourteenth Five-Year Plan for the National Economic and Social Development of the People's Republic of China and the Visionary Goals for 2035. Ethics Research, 2021 (02): 2.

[23] Renewable Energy Development Plan for the 14th Five-Year Plan. Energy conservation and environmental protection, 2022 (06): 6. Xinxuan Cheng & Manjiang Fan.

[24] Cheng Xinxuan, Fan Manjiang. The impact of the US Inflation reduction act on the restructuring of the Asia-Pacific energy industry Chain and China’s response strategies. China Economic Journal, 2024: 1-23.

[25] Fan Xing, Li Lu, Gao Xiang, Chen Zhihua. The analysis of COP28 Global Stocktake outcome and global climate governance prospects. Climate Change Research, 2024, 20 (2): 253-260.