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Exploring the Mechanism of the Impact of the US Withdrawal from the Paris Agreement on China's Photovoltaic Industry: Based on the Analysis of Comparative Cases of China-Saudi Arabia and China-Brazil Photovoltaic Cooperation

Hanqing Zhou[1]*

[1]School of International Relations and Diplomacy, Beijing Foreign Studies University, Beijing, China
* Corresponding author: hqzhou@bfsu.edu.cn

Abstract:

In the current global climate governance system, the US has shifted from long-term commitment to climate cooperation to suddenly withdrawing from the Paris Agreement. The US withdrawal from the climate cooperation mechanism will be bound to have a negative impact on the global new energy industry system. However, most scholars have not paid sufficient attention to this impact, and instead believe that the US withdrawal will only directly present significant opportunities for the future development of China's new energy industry. Therefore, the impact of the US withdrawal from the agreement remains under-explained. Additionally, the author will propose a new theory through comparative case analysis: the "risk-opportunity" transformation mechanism. In this theory, China's photovoltaic(PV) industry, which holds a crucial global energy strategic position, is selected as the affected entity to explain the impact mechanism of the US withdrawal from the agreement on China's energy industry. Research findings indicate that the US withdrawal from the agreement has clearly led to some significant global risks that have greatly impacted Global South Countries(GSCs). Through a comparative case study of China-Brazil and China-Saudi Arabia photovoltaic cooperation, the diplomatic measures China can adopt within the aforementioned impact mechanism can be explored, providing references for China's practices of continuously transforming risks into opportunities.

Keywords: photovoltaic industry; Global South Countries; climate finance; photovoltaic cooperation; "risk to opportunity" transformation mechanism.

1. Introduction

The impacts that the withdrawal of America from the Paris Agreement has had on the China's energy industry have become a issue of general concern in China's energy industry development process. With the continuous improvement of global climate governance mechanisms, there is growing cooperation among most countries involved in climate governance as well as greater emphasis placed on the cooperation in the field of energy and technology. America has been no exception since 2009. However, after the presidential transition in 2017, America chose to withdraw from this global climate governance cooperation mechanism, inevitably exerting considerable influence on the global energy industry chain, especially China's PV industry, which occupies an important strategic position in it.

This article delves into such a question: Faced with the uncertainty in global climate governance caused by the US withdrawal from the Paris Agreement, how can China transform risks into opportunities through diplomatic and investment cooperation with various GSCs (whether aligned or not with US climate policy) on PV projects? Research on this question is conducive to understanding the actual role of China's PV industry in the transformation mechanism and creating greater development space for its domestic PV industry.

2. Literature Review

Most existing studies are highly optimistic about China's PV industry, believing that the US withdrawal from the Paris Agreement will have no substantial negative impact on China's PV industry and may even bring many positive benefits. In the context of escalating trade protectionism, although the trade barriers the US seeks to exert after its withdrawal from the agreement will diminish the global carbon reduction capacity, they will help China reduce carbon emissions from its PV products instead [1]. Moreover, the US renewable energy law allows its states flexibility, letting each choose its own path based on local conditions to shift toward clean energy, so many states choose to collaborate with China by utilizing China's rapidly expanding renewable energy capacity and the US's expertise in PV innovation [2]. On the other hand, research on Sino-European PV cooperation in response to the risk of US withdrawal has been relatively in-depth. In terms of conditions, China has now dominated the global PV industry, supplying approximately 80% of the world's solar panel polysilicon, about 97% of solar wafers, and nearly 85% of PV cells, though entering the market in the 1990s [3]. This reflects China's market scale advantage. However, Europe has advantages in PV basic research and high-end manufacturing equipment. Through cooperation, both parties can jointly develop a new generation of PV technology, improve battery efficiency and reduce production costs, which can help China tackle the challenges posed by US withdrawal to its PV industry.

Actually, the impact of the US withdrawal actually follows a "risk-opportunity" conversion pathway. That is, the US withdrawal does not merely have no effect on China's PV industry or bring benefits to it, but it has caused significant negative impacts. However, China can convert these negative impacts into opportunities for its PV industry through effective diplomatic practices. Therefore, relevant research should first thoroughly explore the specific negative impacts of the US withdrawal, but existing literature has paid little attention to the long-term risks and challenges posed by the US withdrawal, resulting in incomplete explanations of the "risk-opportunity" transformation mechanism. Additionally, there is limited research on China's cooperation with GSCs in the PV sector to address risks, particularly how China can coordinate policy differences among different GSCs and establish effective cooperation mechanisms to achieve the "risk-opportunity" transformation. Existing research has highlighted the necessity for China to establish PV cooperation with GSCs through the Belt and Road Initiative(BRI): Many GSCs participating in the BRI face significant challenges in transitioning to clean energy: First, these countries have relatively low overall levels of development. Among BRI countries, the per capita income of most nations remains below the global average [4]. Second, these countries still primarily rely on traditional energy sources such as coal and oil [4]. Although renewable energy accounted for 38% of global electricity generation in 2021, 86 BRI countries remain below this level [4]. Third, these countries lack sufficient funds, technology, and specialized talent to drive energy transition [4]. However, existing research has paid less attention to challenges such as policy interest discrepancies that may arise during the actual cooperation process.

Based on an analysis of the risks arising from the US withdrawal, this essay focuses on how China's climate cooperation practices with GSCs have transformed various external risks into development opportunities for the China's PV industry. This attempt aims to address the explanatory shortcomings of the "risk-opportunity" transformation mechanism, thereby contributing to the sustained and steady development of China's PV industry in the future.

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3. "Risk-Opportunity" Transformation in Global Climate Governance

Robert O. Keohane pointed out that international institutions can facilitate cooperation among decentralized state actors, enabling effective collaboration even in the absence of a single hegemon [5]. The international cooperation in the PV industry can be achieved through international agreements, technical standards and cooperation mechanisms, which makes emerging powers realize the importance of international institutions.

Based on neo-liberal institutionalism theory, the theory can be further extended: when a dominant power withdraws from global public affairs such as global climate governance, the institutional gaps it leaves behind will trigger opportunities for "substitute supply" in the international system. Emerging powers can fill the vacuum in public goods supply through institutional means such as technology transfer, financial support, tool innovation, and the establishment of bilateral or multilateral cooperation mechanisms, thereby reshaping governance rules and power structures in this process. As such, the "imbalance crisis" in the international order tends to become a strategic window for emerging powers to achieve crucial industrial development and governance upgrades by prudently considering the PV cooperation practices with GSCs within the South-South cooperation mechanism.

Additionally, the essence of risk lies in the mismatch between the existing path dependence and external environmental changes. The key to breaking the deadlock consists in proactively reconfiguring the dimensions of comparative advantage alignment, conforming to the comparative advantage theory proposed by David Ricardo, which aims to maximize the overall benefit by trading each other's relative advantages [6]. When traditional geopolitical alliances weaken or competition intensifies, industrial entities must pursue new growth through spatial repositioning and cooperation model innovation. For example, China's PV industry has shifted from relying on European and American markets to focusing on the Global South. This shift essentially combines China's production capacity advantages (low costs, large-scale production) with the resource endowments of GSCs (high solar radiation, low infrastructure costs), constructing a "technology-resource-demand" complementary value chain. Furthermore, China engages with different countries in the PV sector, with the ultimate goal of achieving PV cooperation and forming a broader PV supply chain, thus reducing external uncertainties. Simultaneously, increased connections within the Global South system contribute to internal structural stability, which can generate more cooperation opportunities.

Accordingly, this paper proposes a "risk-opportunity" transformation mechanism: Although the US withdrawal from the Paris Agreement has exacerbated the fragmentation of global climate governance, China has converted external risks into opportunities for the globalization and upgrading of its PV industry through three channels: confidence building, financial support, and regional cooperation.The mechanism can be seen in figure 1.

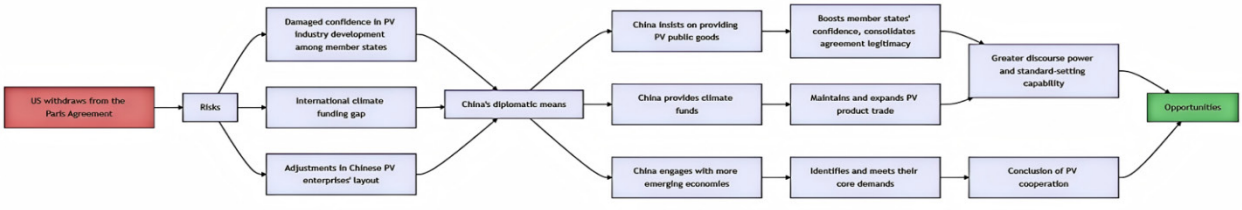

Fig. 1 The "risk-opportunity" transformation mechanism (Picture credit: Original)

4. Results

The negative impacts of the US withdrawal from the agreement on China's PV industry can be illustrated from the following two perspectives, while discussing how, confronted with different risks, China has succeeded in transforming them into opportunities.

4.1 Declining Trust in Global South Photovoltaics(PV) and China's ConfidenceBuilding

From the perspective of political psychology, since the US stands as the long-term leader of climate cooperation, its withdrawal may weaken the willingness of other members of the agreement to develop new energy sources, triggering a bandwagon effect and leading to a slowdown in the growth of demand for PV products in markets of GSCs, like Turkey would be less inclined to ratify the agreement due to the US's departure [7]. If the global new energy process stagnates, China's PV enterprises will face the risk of shrinking overseas orders, especially those relying on international markets.

Accordingly, China has utilized South-South cooperation

mechanisms to provide institutional safeguards for its PV industry. By November 2023, China has signed 48 memorandums of understanding on climate cooperation with 40 GSCs [8]. In terms of regional cooperation, China and Africa have announced the "African Light Belt" project, where China will take advantage of its PV industry to provide electricity for lighting in impoverished areas of Africa [8]. This will allow the majority of countries that are members of the agreement to see a truly trustworthy force at a time when they are most confused and at a loss how to respond to the plight — imitating America's withdrawing from the agreement will not better guarantee the energy development of their own countries, but engagement in cooperation with China will bring a lot of tangible benefits, which will restore their confidence in participating in cooperation on climate governance and will promote the construction of China's discourse and standard-setting capacity in climate governance.

4.2 Climate Finance Shortfall and the Further Opening of China's PV Market

In addition to the conceptual level of willingness to develop new energy sources, it is also important to return to the reality of economic and material power, which is paid the most attention to by all the countries. The withdrawal of America, which used to be the main provider of global climate finance, has put even greater pressure on the global climate finance mechanism [9]. The curtailment of funding has significantly reduced the scale of multilateral and bilateral funding, while the issue of funding allocation imbalance remains prominent: emerging markets and developing economies, representing over half the worldwide population (excluding China), only got less than 15% of global clean energy investment [9,10]. This has made it difficult for less developed GSCs to obtain adequate climate finance. For example, the energy transition in Africa and Latin America may be delayed due to lack of funds, affecting China's PV equipment exports, which is seen as a risk.

China is providing financial support to bridge the gap. Since 2015, China has continued to deliver on its pledge of a 20 billion yuan ($3.1 billion) fund to support climate projects in developing countries, as part of its South-South cooperation efforts [11]. In turn, data shows that in 2024, imports of Chinese PV modules by GSCs will account for 47% of the total [12]. All above can suggest that China has effectively exploited the funding gap to continuously expand its PV market.

5. Case Study

In the "Action Plan for the Innovation and Development of the Smart Photovoltaic Industry (2021-2025)", the Chinese government proactively encourages domestic enterprises to cooperate with international enterprises possessing their own advantages in terms of technology and talent, support enterprises in developing smart PV power station projects overseas, and contribute to the promotion of advanced smart PV models [13].

5.1 Case analysis 1: China–Brazil PV Cooperation: Leveraging Shared NewEnergy Goals Amid US Policy Divergence

5.1.1 Brazil's energy structure and energy policy

For a long time, hydropower has held a dominant position in Brazil's energy structure, but in recent years, global climate anomalies have led to frequent extreme weather events, with problems such as high temperatures, droughts, heavy rains, typhoons, and forest fires becoming increasingly serious. Brazil has also been severely affected, with prolonged drought causing water levels in the Amazon region to drop sharply, leading to insufficient hydropower generation and triggering a power shortage crisis. In response, the Brazilian government is actively promoting the development of solar PV power to reduce its over-reliance on hydropower [14]. Moreover, the solar PV industry is the renewable energy source growing at the fastest pace in Brazil. However, this emerging industry also has to face some barriers, such as lack of support of other industries and relatively weak PV infrastructure [15]. Therefore, to encourage the development of the PV industry, Brazil is intended to achieve an installed power generation capacity of 236 million kilowatts by 2030, significantly increasing distributed solar power capacity and reducing traditional fossil fuel power generation capacity [16]. It is also worth mentioning that Brazil eliminated import tariffs on various PV components in 2020, while prior to this, most imported PV devices were subject to a 12% tariff [13].Brazil has long maintained strategic autonomy in climate diplomacy and does not blindly follow US policy adjustments, aiming to achieve industrial development through equal cooperation, rather than pressuring other developing countries through trade protectionism. However, Brazil's recognition of the Paris Agreement declined after the US withdrew from the agreement. In 2020, Brazil announced that it would re-examine its Nationally Determined Contributions(NDCs) commitments, citing insufficient international funding as a factor that could affect its ability to fulfill its commitments, which is seen as a risk.

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5.1.2 RiskOpportunity Conversion in China–Brazil PV Partnerships

China and Brazil are highly aligned in terms of energy transition and improving the utilization rate of new energy sources, with policy coordination laying the foundation for PV trade. In the first quarter of 2022, China's PV module exports reached about $10.6 billion, achieving a year-on-year increase of 122.9%. Exports to Brazil amounted to $1.33 billion, making up 12.6% of the total, which indicates that the Brazilian PV market is highly dependent on Chinese components [13]. It can be seen from this that maintaining and developing PV trade with Brazil is one of the effective means for China's PV industry to transform risks into opportunities.

As an important investment destination for China in Latin America, Brazil has attracted Chinese enterprises such as BYD to invest in and build PV power generation projects. In the future, both sides should deepen cooperation throughout the entire industrial chain, with a focus on promoting the integrated development of power station investment, construction and operation. This cooperation model can create a large number of jobs in the post-pandemic era, help Brazil achieve a green economic recovery, and continuously promote PV trade with China through economic strength [13].

Through PV cooperation with Brazil, China has secured further export of national PV standards and a much better international brand reputation in the PV market. For China, this represents a good transformation from risk to opportunity.

Equally important, China has recognized that the Brazilian government requires project financing to comply with environmental and social responsibility standards. This will also help China raise awareness of environment in future PV project collaboration, explore practical approaches to balancing environmental protection and technological innovation, and better fulfill its responsibilities as a major player in global climate governance.

5.2 Case analysis 2: China–Saudi Arabia PV Partnership: Aligning Shared Energy Policies for Mutual Development

5.2.1 Saudi Arabia's energy structure and energy policy

After withdrawing from the agreement, the US returned to its traditional fossil fuel industry, which is consistent with Saudi Arabia's policy of placing great emphasis on its domestic oil market. Since the oil industry is the economic pillar of Saudi Arabia, it has also long adopted a strategy of "systematic obstructionism" in UN climate negotiations, delaying or downplaying its emissions reduction commitments in order to protect the interests of its oil industry.

5.2.2 Risk management and postcooperation opportunities in China–Saudi Arabia PV collaboration

The US anti-dumping and anti-subsidy investigations in Southeast Asia have forced Chinese PV companies to shift their focus to the emerging market in the Middle East. However, the relocation of Chinese PV companies does not mean there are no obstacles: China must cooperate with Saudi Arabia in the development of PV industries without affecting Saudi Arabia's traditional oil interests. Moreover, localization requirements in the Middle East market (such as Saudi Arabia's "localization rate" policy) and geopolitical risks may bring new challenges.

However, it is encouraging that Saudi Arabia's Vision 2030 and China's development strategy complement each other in many areas, particularly in renewable energy. Saudi Arabia has abundant solar energy resources, but they are still underdeveloped. China, meanwhile, is striving to become a global advocate in renewable energy, which provides an opportunity for cooperation between the two countries [17].

Therefore, China has respected the importance of Saudi Arabia's current oil revenues in its national economic development by maintaining the existing scale of oil trade and responded to Saudi Arabia's localization demands of by promoting financial cooperation such as investment, which is the way to interact with such countries and then transform the risk. From 2005 to 2019, Chinese companies secured construction contracts in Saudi Arabia worth more than $35 billion, according to the China Global Investment Tracker [17].

On the one hand, with financial support from China, the Saudi government further encourages local production of PV components and equipment to reduce dependence on imports. ACWA Power has partnered with the Silk Road Fund to build the Mohammed bin Rashid Solar Park, Dubai's largest solar power plant [17]. The two sides also plan to jointly promote the development of renewable energy projects in the Middle East and other developing countries [17]. Another attempt at financial cooperation is that Saudi Arabia's sovereign wealth fund, called the Public Investment Fund (PIF), signed an agreement with China's National Energy Administration in 2019 to focus on collaborating in the development of Saudi Arabia's PV and other renewable energy technologies, underscoring its commitment to tackling key global challenges like energy efficiency enhancement processes [17,18]. This cooperation will help Saudi Arabia establish a complete PV manufacturing system and provide Chinese PV companies

with long-term development opportunities in the Middle East market. On the other hand, there is still room for growth in joint investment between Saudi Arabia and China [19]. During the HLJC meeting in 2017, the two sides signed a memorandum of understanding to establish a $20 billion China-Saudi Arabia joint investment fund [19]. In the future, this fund will mainly invest in projects related to China's BRI and Saudi Arabia's Vision 2030 [19]. This capital cooperation model lays the solid foundation for Saudi Arabia's energy transition and the stable funding sources of Chinese PV companies. The two aspects have helped China's PV industry transform risks into opportunities.

6. Comparative Discussion

A comparative analysis of the two cases above reveals that the risk stems from insufficient climate funding and concerns over the country's realistic economic development. It can be found that when the consistency between the climate policies of GSCs and the US is low, China can capitalize on the situation by striving to negotiate with emerging economies within the Global South for the coordination of climate policies, which may initially require China to offer tangible supportive conditions such as ample climate resources and reliable climate funding sources. However, when this consistency is high, China should grasp the methods for resolving potential geopolitical risks, respecting the overall development interests of these GSCs, and catering to their needs of PV development and energy transition, so that China can include more Arab countries in the BRI to enhance the recognition of Chinese PV standards.

Both of the strategies can well demonstrate China's sincerity in pursuing PV cooperation, and that China aspires to earn the trust and recognition from these nations. This can effectively shape the influence of the domestic PV industry and serve as a precautionary measure, enabling China to expand its PV industry cooperation network during the development process in order to make more GSCs accept Chinese PV standards, thereby improving the industry's ability to convert risks into opportunities, which will ensure that China possesses stronger international mobilization capabilities once new challenges resulting from the US withdrawal from the agreement arise in the future.

7. Conclusion

Focusing more on analyzing certain practices in Trump's federal policies that are highly related to indirect impacts and China's diplomatic practices and foreign climate policies, this study has found that the impact of the US withdrawal from the Paris Agreement on China's PV industry has a specific causal pathway, and has initially attempted to provide some explanation for it: The institutional shock caused by US withdrawal has weakened confidence in GSCs and resulted in a lack of climate finance, but China accordingly rebuilds confidence through diplomatic means and fills the financing gap, enabling it to maintain its PV market position and enhance its global climate governance discourse power. The mechanism can be seen in figure 1.

Contrary to the traditional, one-sided impression of a "rise in the East and decline in the West" in the comparison of US-China power, the risks posed by the US withdrawal to China should not be underestimated. Therefore, China's PV industry should attach greater importance to the "risk-opportunity" conversion mechanism and take effective diplomatic practices such as coordinating differences in PV development policy demands among different GSCs into full consideration.

Finally, as for the scope of application of this mechanism, this study does not provide a detailed explanation of whether the independent climate policies of US state governments may have micro-level negative effects in the macro-level context of China-US energy competition risks. What's more, the study pays less attention to the influence of China's domestic energy development policies and strategies on the transformation of "risks into opportunities". Future research could further examine the roles of US state governments' climate policies and China's domestic new energy development policies and strategies within this mechanism to gain a deeper understanding of the "risk-opportunity" transformation mechanism.

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