
The Impact of Green Transformational Leadership on Green Innovation: A Comparative Analysis of China and the United States in Reducing Carbon Emissions

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Abstract:

The study aims to illustrate the role of green transformational leadership in enhancing green innovation by addressing the theoretical frameworks of both concepts. It focuses on the experiences of China and the United States in reducing carbon dioxide emissions through the presentation and analysis of statistics.

The study concluded that despite the continuous efforts of both countries to reduce carbon dioxide emissions and promote green innovation in response to climate change and economic growth, they still top the list of the highest energy-consuming countries causing emissions.

Keywords: Green Transformational Leadership; Green Innovation; Carbon Dioxide Emissions.

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1. Introduction:

Today's world is characterized by dynamic changes amidst uncertainty, especially with rapid economic growth and sudden climate change. It has become imperative for countries to adopt modern leadership that differs from traditional leadership to maintain continuity and survival and gain a competitive advantage over their competitors. Therefore, countries must focus on green transformational leadership for better change.

Green transformational leadership plays an important role through positive radical change, environmental awareness, and responsibility. It has become imperative for countries to achieve a sustainable balance between economic growth and reduced consumption of sustainable energy by presenting a plan to achieve sustainable development goals on a global environmental level. This involves highlighting green innovation with clean, modern, and affordable energy, and promoting green growth while considering the impacts of climate change. It is essential to adapt to these changes enhance the use of renewable energy and improve its efficiency amidst the rapid and dynamic ongoing economic growth.

Through the above, we try to address the following problem:

Does green transformational leadership affect green innovation?

1.1. Importance of the study:

The importance of our study stems from the importance of the topic that addresses the importance of green transformational leadership as a modern approach that contributes to economic progress achieves economic development, and highlights the importance of green innovation in achieving cleanliness.

1.2. Study objectives:

- Identifying the basic concepts of green transformational leadership and green innovation
- Previous research on green transformational leadership to achieve green innovation
- Comparing China and the United States to reduce carbon emissions.

1.3. Methodology followed:

In our study, we adopted the descriptive analytical approach by reviewing the various theoretical concepts related to green transformational leadership and its dimensions and green innovation and its dimensions, and presenting statistics from both the United States and China and their efforts to reduce emissions.

2. Green Transformational Leadership and Green Innovation Theoretical Framework:

2.1. Concept and Definition of Transformational Leadership:

Before transformational leadership emerged as a leadership theory, scientists and researchers developed several theories in the fields of management and psychology to identify the best leadership theories that impact organizations and individuals. Among these theories is (the Great Man Theory) which suggests that leaders are born, not made, and that leadership is characterized by inherited traits and personal attributes. Although there is

a relationship between leadership and certain personal traits, there was no consensus among these studies on the most important traits that distinguish leaders from others.(Shadan sabah ahmed, 2023, p. 123)

Bass (1990) "indicates that superior leadership performance - transformational leadership - is achieved when leaders can ensure a shift in followers' interests, create awareness and acceptance of the group's mission, and inspire these followers to look beyond their personal interests for the benefit and welfare of the group. It also involves helping them to challenge and surpass their own interests for the sake of higher goals. Additionally, it enables followers to work together, trust each other, and enhances their intrinsic motivation, thereby delivering results that exceed expectations"(Saleh Abdul-Ridha Rashid, 2018, p. 456)

Transformational leadership is defined as "a type of leadership characterized by charisma and a strong presence, as well as a highly influential personality. It primarily focuses on creating change and transforming the organization and its employees to a better state. It relies on a combination of personal charisma, the ability to inspire others, and the enthusiasm to drive them towards achieving performance levels that exceed the ordinary"(Ahmed bin Saeed bin Nasser Al Hadhrami, 2022, p. 77)

2.2. Green Transformational Leadership:

Green transformational leadership is an emerging model that integrates the principles of transformational leadership with a focus on environmental responsibility and sustainability(Aniek Rumijati, 2024),Green transformational leadership encourages subordinates to accomplish environmental aims and objectives(ibrahim, 2022, p. 64), Chen and Chang (2013) also define as "Leadership that motivates subordinates to achieve environmental objectives and pushes them beyond anticipated environmental performance standards (Huawei Tiana, 2023, p. 04), Green transformational leadership and human resource management can greatly help organizations create environmentally friendly service behaviors. With a culture that encourages environmentally friendly behavior,more resources are allocated, and they can alter the organization's thinking process toward environmental preservation(Mangenda Tshiaba Sidney, 2022, p. 11) , The importance of transformational leaders lies particularly in enhancing green performance(Ziying Mo, 2024, p. 03), By enabling green transformational leadership to create a green organizational climate that ensures companies' commitment to operational initiatives within the environment (Viachaslau Filimonau, 2024, p. 141).

2.2.1. Dimensions of Green Transformational Leadership:

- **Green idealized influence:**"leaders act as role models of environmental behavior and empower followers to adopt this kind of conduct. They also develop an environmental vision that inspires followers" (Christine Karmy Gad El Karim Srour, 2020, p. 02)
- **Green intellectual stimulation:**Leaders inspire employees to view environmental issues differently and address them with innovative solutions, while inquiring about and verifying the organization's environmental

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practices. It is worth noting that leaders should not resent or retaliate against employees for their opposing ideas, but rather encourage them to ask questions and provide constructive criticism (Marwa Gamal Abu Raya, 2023).

- **Green individualized consideration:** "leaders who display individualized consideration, build close relationships with employees to strengthen environmental values and show sympathy and compassion for followers' prosperity, They also help them build their potentials and abilities, This behavior provides followers with positive feelings like strength, power, and pride, which may reflect on their performance" (Christine Karmy Gad El Karim Srour, 2020, p. 03), Individual consideration by a transformational leader helps to foster a sense of connection with their followers, which leads to increased mutual interest among them (Bashir M. Algazali, 2022, p. 04).
- **Green inspirational motivation:** Motivational leaders inspire their Employees demonstrate positive leadership behaviors by setting aside individual needs for the greater good, their enthusiasm and optimism motivate their subordinates to conquer external obstacles and interanal barriers, surpassing self-interest for the team's objectives engaging in environmentally beneficial behavior (Jennifer L & Barling, 2012).

There are other dimensions of green transformational leadership, which include:

- **Green self-efficacy:** Green self-efficacy in transformational leadership refers to the extent to which a leader considers themselves an environmentally friendly individual, committed to preserving and defending the environment through their green behaviors (Ouaar, 2021, p. 283)
- **Green mindfulness:** "to define "green mindfulness" as a state of conscious awareness in which individuals are implicitly aware of the context and content of environmental information and knowledge" (Lin, 2014, p. 6606)

2.3. The importance of green transformational leadership:

Numerous and ongoing research has shown that transformational leadership is of great importance in The team enhances organizational performance by fostering an innovative environment (Zainab Younis, 2023, p. 03).

"Green transformational leadership significantly impacts the performance of small and medium-sized enterprises in several ways. It develops employees' attitudes towards green practices, leading to sustainability and improving the financial health of the organization" (Tha'er Majali, 2022, p. 03)

2.4 Green Innovation:

Green innovation views product and process development as environmentally friendly by adopting organizational practices that use more raw materials to consider the environment, and fewer materials in product design, using ecological design Principles aimed at reducing carbon emission and achieving high efficiency in the utilization of natural resources such as water , energy and raw materials (Sanjay Kumar Singh,

2020, p. 03) , The adoption of green innovation (GI) presents organizations with new opportunities to differentiate themselves from their competitors by improving product design and quality, while also achieving cost reductions through energy-saving measures and enhancing resource efficiency(Nadia Aslam Janjua, 2024, p. 05),"The Porter hypothesis suggests that climate risks exacerbate the environmental regulatory pressure on companies, thereby further driving the development of innovative green technologies to enhance environmental performance"(Ren & Li, 2024, p. 03).

2.3.1. The importance of green innovation:

- The importance of green innovation lies in its focus on improving environmental performance, reducing pollution, increasing efficiency in energy use, reducing waste, enhancing resource productivity, and lowering the cost of material production (Alia Ibrahim Hussein, 2018, p. 357).
- Green innovation can be leveraged by supporting customers for companies by contributing to brand recognition, enhancing it, and advocating for the costs of green products (Mohammad A. Ta'Amnha, 2024).

2.3.2.Determinants of Green Innovation:

- **Innovation of Green Products:**These are products that use fewer resources in their production and have a minimal impact on the environment. Throughout the product's lifecycle, they reduce waste generation by introducing significantly new or improved products that align with environmental and technological innovation. All these improvements include the basic characteristics or technical specifications of the products. Ideas are applied innovatively through the manufacturing, marketing, and design of new products for environmental improvement. Additionally, the process of modifying and designing the local product demonstrates a reduction in the negative impact on the environment at all stages of the product's lifecycle(Boutarfa souriya, 2020, p. 243).
- **Green Process Innovation:**"Green process innovation refers to the modification of manufacturing processes and systems to produce environmentally friendly products that achieve environmental goals, such as energy conservation, pollution prevention, and recycling of waste adapted to the manufacturing process. It involves using innovative methods to reduce the negative environmental impacts of production processes. This includes activities that reduce emissions or hazardous waste during manufacturing, recycling waste and emissions for reuse, and reducing energy and raw material consumption. Green process innovation is used as a tool to improve environmental management in companies, allowing the industrial production process to achieve a vision of environmental sustainability and potential environmental efficiency (Basir Khalaf Khazal, 2019, p. 139).

3. Previous Studies:

3.1. Study (Sanjay Kumar Singh M. D., 2020):

Titled (Green innovation and environmental performance: The role of green transformational leadership and green human resource management)

This research explores the interactive nature of green human resource management and green transformational leadership in advancing green innovation and environmental sustainability. The researchers used a questionnaire to collect triadic data from 309 small and medium-sized enterprises (SMEs) in the manufacturing sector in the UAE. They employed covariance-based structural equation modeling (SEM) to test the study hypotheses. The results indicated that there is an interactive relationship between green human resource management practices and green transformational leadership, whereby the former enhances the impact of the latter on green innovation, which indirectly affects the company's environmental performance through green innovation. The theoretical study suggested that the performance relationship of human resource management does not rely on a study of the synergistic effects of green transformational leadership and green innovation, with a focus on the mediating role of green innovation in amplifying the impact of transformational leadership on desired outcomes (i.e., additive and interactive) to influence the company's environmental performance. Therefore, leadership plays a crucial role in influencing human resource management practices, which in turn predicts green innovation in the organization.

3.2. Study (Morsi, 2022):

Titled (The Impact of Green Transformational Leadership on Green Innovation: The Mediating Role of Green Organizational Culture)

This study aims to explore the mechanisms through which green transformational leadership directly influences green innovation activities, the indirect impact between them through the mediation of the green organizational culture variable. The researcher used the survey method, employing a set of measures for the study variables. A survey was conducted on a sample of 282 employees from ten hotels in Sharm El-Sheikh, Egypt. In addition to the direct impact of transformational leadership, the study found that green organizational culture plays a crucial role in fostering green innovation, acting as a mediator between leadership and innovation.

3.3. Study (Huawei Tian, 2023):

Titled (Does fintech innovation and green transformational leadership improve green innovation and corporate environmental performance? A hybrid SEM-ANN approach)

This study aimed to utilize Environmental Modernization Fintech perceptions (EMT) and the Ability-Motivation-Opportunity (AMO) Model to illustrate roles in Fintech and Green Alternative Leadership (GTL) in

fostering corporate environmental performance (ENP). Moreover, it explored the mediating role of corporate green innovation between these associations. The researchers employed survey data from 286 managers of small and medium-sized enterprises (SMEs) in Bangladesh, where a two-stage hybrid structural equation modeling-artificial neural network (SEM-ANN) was used to assess the hypotheses. Empirical findings revealed that financial technology adoption is positively associated with SME green innovation and European Neighborhood Policy. Additionally, it was observed that gas-to-liquids significantly impacts the green innovation of organizations and the European Neighborhood Policy. Green innovation was found to enhance the European Neighborhood Policy in manufacturing SMEs. Furthermore, the results indicated that green innovation mediates the relationships between financial technology adoption and the European Neighborhood Policy, and between gas-to-liquids and the European Neighborhood Policy

❖ How does our study differ from previous studies:

Previous studies were conducted in diverse and chronologically ordered environments. The first study, conducted in 2020 in the United Arab Emirates, revealed that green human resource management plays a significant role in shaping the relationships between transformational leadership, green innovation, and environmental performance, as evidenced by structural equation modeling. As for the second study carried out in 2022 in Egypt, the direct impact of green transformational leadership on green innovation, as well as the indirect effect through the mediating role of green organizational culture, has been studied. A survey method was used. The third study, conducted in 2023 in Bangladesh, explored the relationship between innovation in financial technology, the application of green transformational leadership principles, and the achievement of sustainable environmental performance at the organizational level. Furthermore, it explored the mediating role of green innovation between these associations. Structural equation modeling was used. Our study, on the other hand, is distinguished by a comparative analysis between China and the United States to reduce carbon emissions.

4. Carbon dioxide emissions from air transport:

4.1. In the United States:

Annual data estimates of carbon dioxide emissions from commercial air transport and aircraft (air transport) for the transport of passengers and commercial cargo for the United States were estimated by the Organization for Economic Co-operation and Development (OECD) from 2019 to 2023, as shown in the following table and the attached figure:

Table N°1: CO2 emissions for the United States during air transport for the years 2019 to 2023

- Reference area: United States
- Unit of measure: Tonnes

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- Pollutants: Carbon dioxide
- Emissions: Air emissions accounts: air transport A_B_D_E_F

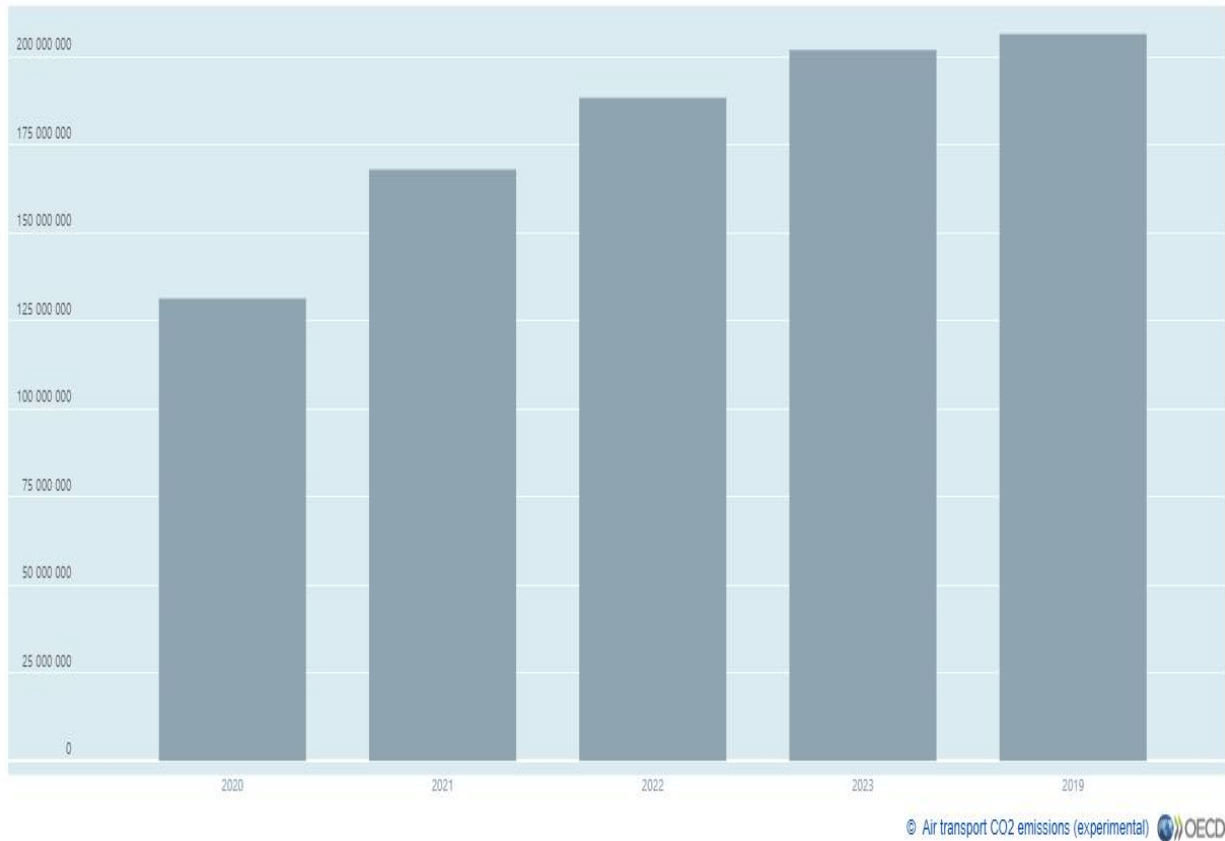
Time period	2019	2020	2021	2022	2023
	206 452 640	131 310 418	167 960 141	188 353 219	201 900 146

Source:OECD. (s.d.). OECD data explorer. Récupéré sur <https://data-explorer.oecd.org>

Fig N° 1:A bar chart of CO2 emissions for the United States during air transport from 2019 to 2023:

Air transport CO2 emissions (experimental) 

Reference area: United States • Unit of measure: Tonnes • Adjustment: Neither seasonally adjusted nor calendar adjusted • Pollutants: Carbon dioxide • Emissions: Air emissions accounts: air transport A_B_D_E_F
 Combined unit of measure: Emissions, SEEA (residence principle)



Source:OECD. (s.d.). OECD data explorer. Récupéré sur <https://data-explorer.oecd.org>

Table N°1 and Figure N°1 show that U.S. air transport CO2 emissions from 2019 to 2023. Emissions peaked at 206,452,640 tons in 2019. They began to decline in 2020, reaching a low of 131,310,418 tons, due to the impact of the COVID-19 pandemic and subsequent restrictions on air travel. Emissions then gradually increased through 2023, reaching 201,900,146 tons, due to the resumption and return of air travel.

4.1. In China:

Table N°2: CO2 emissions for the china during air transport for the years 2019 to 2023

- Reference area: china
- Unit of measure: Tonnes
- Pollutants: Carbon dioxide
- Emissions: Air emissions accounts: air transport A_B_D_E_F

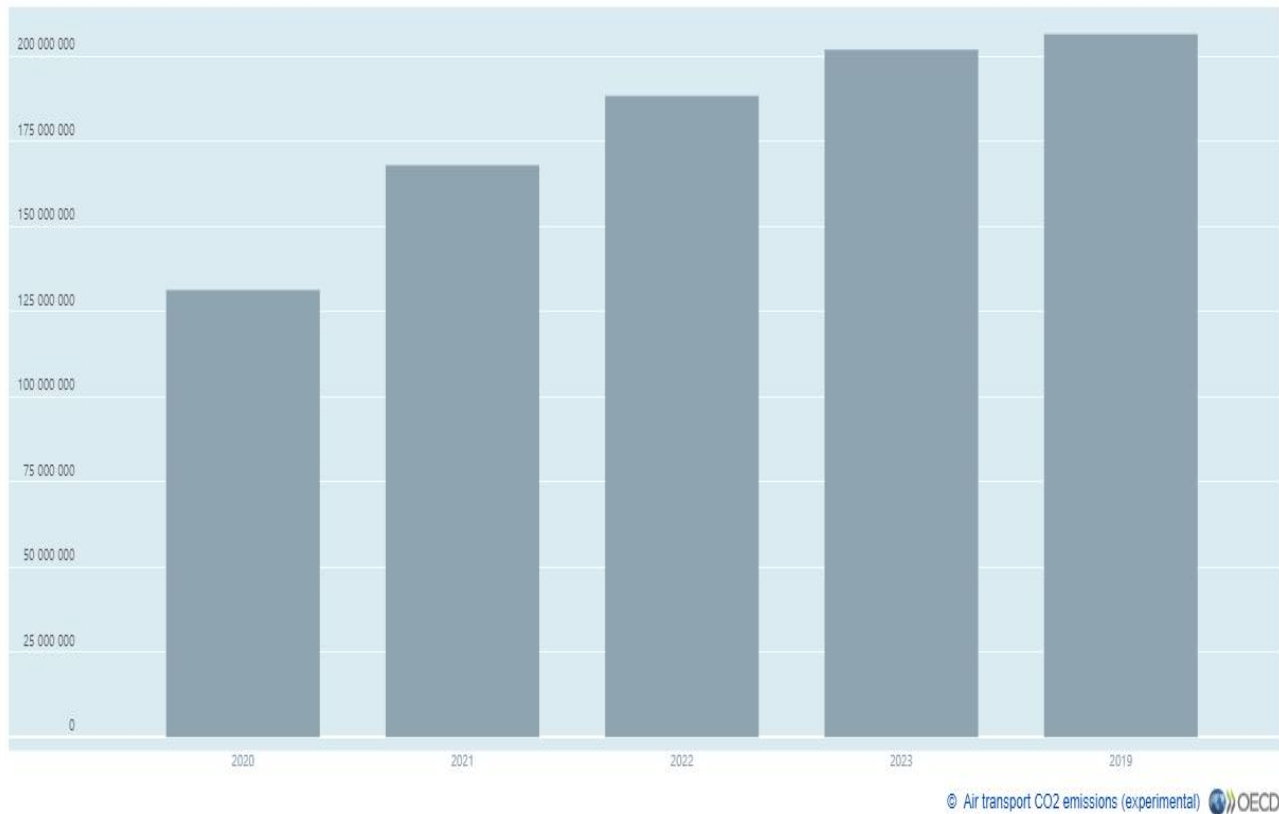
Time period	2019	2020	2021	2022	2023
	109 392 195	70 765 756	72 822 196	45 430 459	91 093 421

Source:OECD. (s.d.). OECD data explorer. Récupéré sur <https://data-explorer.oecd.org>

Fig N° 1: A bar chart of CO2 emissions for the china during air transport from 2019 to 2023:

Air transport CO2 emissions (experimental) i

Reference area: United States • Unit of measure: Tonnes • Adjustment: Neither seasonally adjusted nor calendar adjusted • Pollutants: Carbon dioxide • Emissions: Air emissions accounts: air transport_A_B_D_E_F
 Combined unit of measure: Emissions, SEEA (residence principle)



Source:OECD. (s.d.). OECD data explorer. Récupéré sur <https://data-explorer.oecd.org>

The table^{N°2} and figure^{N°2} of China's air transport CO₂ emissions from 2019 to 2023 show that 2019 saw the highest emissions, reaching 109,392,195 tons. Then, they began to decline in 2020 and 2021, reaching the lowest values of 70,765,756 tons and 72,822,196 tons, respectively, due to the suspension of most flights during the COVID-19 pandemic that began in China. Emissions continued to decline, reaching the lowest value in 2022, estimated at 45,430,459 tons, due to the emergence of new variants of the virus. Then, they gradually increased in 2023, reaching 91,093,421 tons, due to the resumption of flights.

5. Challenges Facing the United States and China in Reducing CO2 Emissions:

5.1 Challenges China Faces in Reducing CO2 Emissions:

- The emission rate is relatively high in China. As a measure to reduce carbon emissions, electrifying trucks is particularly important.(Zhongzhen Yang & Yu Lin, 2024, p. 17).
- “Transferring passenger transport demand from the air mode to high-speed railway (HSR) transportation could reduce carbon dioxide emissions. Such carbon dioxide reduction has been confirmed in previous research in China”(Peiming He, 2024, p. 1385)

5.2 Challenges United States Faces in Reducing CO2 Emissions:

- A Bayesian Structural Vector Autoregressive (SVAR) model was employed to analyze the US economy from August 2006 to November 2023. The results revealed a positive correlation between CO2 prices and oil prices. However, coal prices did not have a significant impact on CO2 prices(Khalid Mehmood, 2024, p. 04).
- The urgent need for the United States, as a global economic powerhouse, to adopt stricter environmental policies has become evident. Given the direct correlation between economic growth and increased CO2 emissions, the US, as a leading industrial nation, bears a significant responsibility to take immediate action to reduce emissions and improve global environmental quality(A'yun, 2023, p. 189)

6. Conclusion:

This study evaluated the mutual impact of green transformational leadership and green innovation in achieving the Sustainable Development Goals, with a special focus on the transition to a green economy, especially in light of the alarming upward trend in carbon dioxide emissions in all countries, especially China and the United States. Our study reached the following main findings:

- ✓ The need to adopt green transformational leadership and green innovation as an effective strategic alternative to maintain competitive advantage among countries of the world.
- ✓ Carbon dioxide emissions in both China and the United States increased in 2019 and decreased in 2020 due to the Corona virus pandemic, which led to the suspension of flights, especially air travel.
- ✓ Due to rapid economic growth and environmental changes caused by climate, both the United States and China are working to reduce carbon dioxide emissions using renewable energy instead of increasing energy consumption. They are cooperating through policies and strategies to control coal emissions.

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