Research Article

The Correlation Between the Development of Renewable Energy, Non-Renewable Energy, and Economic Growth in Taiwan

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ABSTRACT

This paper aims to explore the correlation between the development of renewable energy and economic growth in Taiwan along with the correlation between the development of non-renewable energy and economic growth. I analyzed Taiwan's current energy situation and understand the energy problems that Taiwan faces, and discussed policies that impact Taiwan's economy, energy production, and consumption. I found that Taiwan could achieve stronger GDP growth through increased employment, investments, consumer spending, and technological advancements of renewable energy production rather than non-renewable energy production. I found a correlation of 0.902 between Taiwan's GDP and renewable energy production, as opposed to a correlation of -0.0655 between non-renewable energy production and Taiwan's GDP. This high correlation between the production of renewable energy and GDP growth in Taiwan confirms that the nation should increase its investment in renewable energy production rather than non-renewable energy production. By comprehending the current situations and current policies, this paper attempts to provide an explanation of Taiwan's energy issues, assist future energy policymakers, bring awareness to Taiwan's energy development, promote sustainability goals, and provide a general background of Taiwan's energy development. This paper also aims to provide well-rounded research to help investors make informed decisions about renewable energy.

Keywords: ENERGY: PHYSICAL; Solar; Wind; Economic Growth; Renewable Energy; Energy Security

INTRODUCTION

Due to the lack of natural resources such as natural gas and fossil fuel, Taiwan historically imports most of its energy, leading to severe energy security problem (1). As Taiwan's demand for energy rises, so does its dependency on outside energy sources, worsening its energy security concerns. Taiwan currently imports 96.6% of its energy by relying heavily on imported materials to produce energy. Most of the country's crude oil comes from a politically volatile region of the world (Figure 1). Saudi Arabia accounts for 33 percent of oil imports, Kuwait for 21 percent, the United Arab Emirates 9 percent, Oman 7 percent, and Iraq 2 percent (2).

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Taiwan's growing energy demand has also led to multiple power outages in the last few years, with blackouts becoming increasingly common, as shown in Table 1. Through a combination of aging infrastructure, high cost, and risk in source material, energy imports Taiwan's energy grid is continuously at risk. This is not just a national concern, given Taiwan's role as a global leader in microchip manufacturing.

Renewable energy can be a potential solution to both Taiwan's energy security issues and its rising demand for energy. The addition of renewable energy can improve Taiwan in 3 different sectors: energy, environment, and economy (3Es). Taiwan's policymakers do seem to recognize this and have encouraged the development of renewable energy. Renewable energy could help supply Taiwan's rising energy demand without necessarily exacerbating the energy security issues the country already faces. Figure 2 shows Taiwan policymakers' goals with regards renewable energy. Ultimately, Taiwan can downplay its reliance on fossil energy, lower carbon emissions, benefit the environment, diversify its energy sources, increase energy efficiency, and increase economic growth.

In the 20th century, discoveries such as global warming in 1938 and The Ozone Hole in 1985 have placed a global spotlight on climate change. As nations fully realize the threat of climate change, they pieced together the Intergovernmental Panel on Climate Change in 1988 to provide policymakers with the current state of knowledge about climate change (6). One of the most important steps in battling climate change was the Kyoto Protocol. The Kyoto Protocol in 1997 aimed to reduce human-made

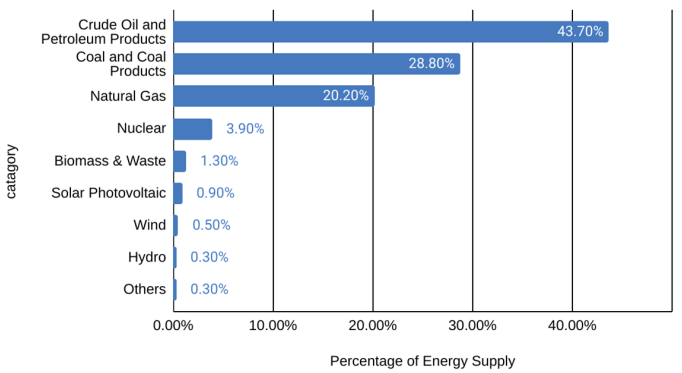

Figure 1. Energy supply of Taiwan in 2023 (3). This bar chart provides a breakdown of the sources of Taiwan's energy supply in 2023, emphasizing the high reliance on imported fossil fuels and imported coal, also highlighting the meager contribution of renewable energy to Taiwan's energy supply.

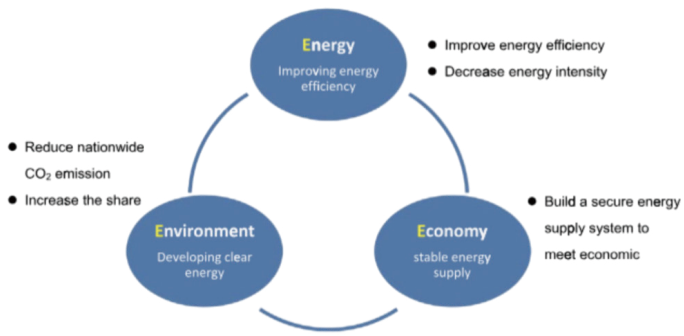

Figure 2. Framework of Taiwan's renewable energy policies (5). This diagram illustrates Taiwan's strategy for renewable energy development, emphasizing the goals of reducing dependence on fossil fuels, lowering carbon emissions, improving energy security, increasing energy efficiency, and supporting economic growth

Table 1. Recent blackouts in Taiwan (4)

Date	Issues	Result
May 2021 blackout	malfunction at a high voltage substation in Kaohsiung caused four generators in the Hsinta Power Plant to go offline	rotating power outages for millions of households across the country
March 2022 blackout	Equipment malfunction	12 hours power outage across Taiwan
Summer 2022 frequent blackouts	Taiwan experienced frequent electricity outages during the summer of 2022	Exposing the vulnerability of the power supply in Asia's most important chip-making hub

This table summarizes key blackouts in Taiwan in the past few years and outlines its impact, highlighting the fact that above-average electricity usage during peak hours overburdened equipment and caused malfunctions and widespread blackouts.

carbon dioxide emissions and greenhouse gases in the atmosphere to reduce global warming. Since then, 191 countries around the world have backed this agreement. Although greenhouse gas output has increased since 1977, this protocol remains a significant symbol as the first step to combat global warming (7). Due to geo-political issues, Taiwan is not a part of the United Nations and thus cannot join the United Nations Framework Convention on Climate Change. However, Taiwan is still committed to the goals mentioned in the Kyoto Protocol, following global trends.

Another important step in addressing climate change was the Paris Agreement of 2016, which included significant boundaries such as limiting temperature increases to less than 2°C and achieving zero net greenhouse gas emissions by 2050 (8). The Paris Agreement's effectiveness lies in its range of participants, flexibility (9), and global support (10). Taiwan cannot sign the Paris agreement due to political reasons, but it continues to proactively follow and address climate change problems.

Taiwan has been promoting renewable energy since the late 1900s. In the 1980s, Taiwan started the 150-kW wind turbine prototype development program, although that ended in the 1990s. Later in the 2000s, the nation formed the Issuance of the Regulations Governing Subsidies for the Establishment of Wind Power Generation Demonstration Systems in 2000, Issuance of the Taipower renewable energy purchase scheme of 2003, and issued multiple programs regarding offshore wind power generation and green energy industry development (11).

However, it was not until the 2010s that Taiwan started to focus more heavily on developing renewable energy as a viable alternative to fossil fuels. As Figure 3 shows, Taiwan's renewable energy investment has been slowly rising. Despite a slight dip in 2019, investments skyrocketed and more than doubled in 2020. In the last decade Taiwan has made considerable progress towards increasing renewable energy production.

Currently, Taiwan's goal is to achieve net zero greenhouse gas emissions by 2050, alongside other countries such as Japan, Canada, Argentina, the United States, and most European Union members. In recent years, the nation's policymakers have introduced a sizable number of acts and policies, such as the Climate Change Response Act of 2023 and the Renewable Energy Development Act of 2023, seen in Table 2, allowing Taiwan's renewable energy development to grow stronger. 6% of Taiwan's energy supply in 2021 came from renewable energy, showing significant improvement since 2014, when only 3.8% of its energy supply came from renewable energy (12).

When you consider the 3000 hours (about 4 months) of sunshine per year or the abundant wind power on the West Coast and many islands, Taiwan's geolocation is prime for developing renewable energy. In January 2002, the Executive Yuan of Taiwan adopted the "Renewable Energy Development Plan," marking the start of renewable energy expansion. According to the target goals in Table 3, which is created in 2016, I can see that Taiwan has planned out a growing amount of renewable energy development. Solar power and wind power are the most prominent of all renewable energy sources, taking up around 71.5% of all renewable energy production in Taiwan.

Solar

The first renewable energy Taiwan developed was solar energy. Since the 1980s, the government has encouraged heat collecting from solar water heaters and photovoltaic demonstration systems. As the world's second-largest solar PV producer, Taiwan has immense potential for developing solar energy. Figure 4 shows an upward-sloping curve, despite a decline in 2019 (due to COVID-19), and a notable increase in 2021. Between 2018 to 2021, 26.67 billion NTD was invested into solar power in Taiwan (23). Taiwan plans to invest another 89 billion NTD in the development of ground-mounted solar systems alone (23), and the construction cost per GW for solar energy is estimated at $1.4 billion, with unfinished projects valued at approximately $19.9 billion (24). According to the government, solar power development is expected to generate nearly NT$1 trillion (US$31.7 billion) in total

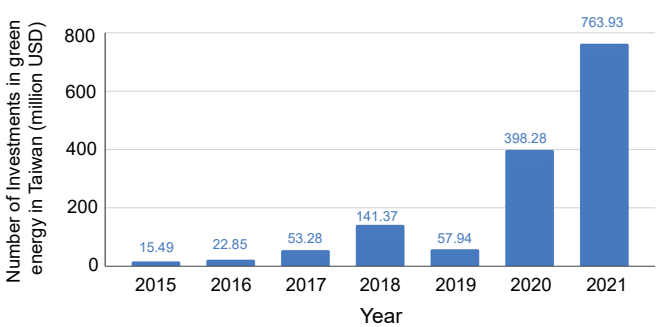

Figure 3. Number of Investments in Green Energy in Taiwan per year (13). This graph tracked the annual investments made in Taiwan's green energy sector from 2015 to 2021, showing an upward trend in investments with small declines in 2019, with a notable increase during the peak of the COVID-19 pandemic.

investments and create 20,000 job opportunities (25). To encourage more progress, the government provided subsidies covering 40% of construction costs and 100% of design costs for residential solar panel installations until 2020 (26).

Wind

Wind power is one of the best energy sources to replace fossil energy because it is one of the cleanest and fastest-growing renewable energy sources in the sector. The development of offshore wind power is expected to generate NT$1 trillion in total investments and create 20,000 job opportunities (28). Additionally, feed-in tariffs will help companies install offshore wind farms by covering up to 50% of the installation costs of offshore turbines (29). As seen in Figure 5, from 2018 to 2021, Taiwan spent a total of 37.64 billion NTD in offshore wind turbine investments (30). Although it is the fastest growing renewable energy, there are some drawbacks: turbines are loud, unappealing aesthetically, and wind is

Table 2. Recent government policies to incentivize renewable energy development

Year	Renewable Policy	Purpose
2012	Million Rooftop Solar Program	1) To establish an office to consolidate resources, provide professional help for installation issues, provide full solutions to problems faced by domestic operators, and to speed up the process of mass installation of solar panels. 2) To simplify the process of solar panel installation; lower eligibility criteria for non-bidders; connect joint efforts of both the local governments and townships; and promote the idea of a solar panel community to local communities (14).
2012	Thousand Wind Turbines Program	To improve development and utilization of wind energy and reach the 5.6 GW goal for offshore wind by 2025. Become a self-sufficient industry and help Taiwan transition to green (15).
2019	Offshore Wind Feed-in tariffs	To provide a fixed feed-in tariff pricing for 10 or 20 years to incentivize renewable energy development (16).
2022	Energy Storage Subsidy Program	The program is aimed at increased investments in renewable energy storage technology. This program also announced ambitious plans such as achieving 5,500 MW of energy storage capacity by 2030 (17).
2023	Climate Change Response Act	Main Goal- Achieve GHG emission net zero by 2050 - through program, guidelines, and annual reports, the Climate Change Response Act can maximize its efficiency In the long term, it will focus on education and awareness of global warming and development of green buildings partnerships, R&D, carbon sinks and green transitioning, Taiwan could easily achieve net zero (18).
2023	Renewable Energy Development Act	Main Goal- Encourage use of renewable energy and promote energy diversification By establishing a development fund, wholesale purchasing, and subsidies and rewards for renewable energy, the Renewable energy development Act's objectives are easier met. To make this act effective over time, it requires public buildings to install renewable energy equipment, provides longer leases for renewable energy land use, and management plans in coastal renewable energy facilities (19).
2024	renewable energy auctions	Taiwan will offer 3 GW of offshore wind projects in its next auction in March 2024. The maximum wind farm capacity for this auction is set at 900 MW. This move is part of Taiwan's ongoing efforts to boost its renewable energy sector and reduce its dependence on fossil fuels (20).

This table lists the Taiwanese government's renewable energy policies from 2012 to 2024 alongside their intended goals, specific methods, and outcomes.

not a stable energy source - the lack of strong winds could result in a total lack of energy (31).

The goal of this research is to explore the correlation between both the 2 kinds of energy sources (renewable and non-renewable) and GDP in Taiwan. Specifically, it aims to analyze Taiwan's current energy situation, the energy challenges it faces, and the policies influencing energy production and consumption. The study seeks to demonstrate that increased investment in renewable energy can lead to stronger GDP growth by fostering employment, consumer spending, increasing productivity, increased investments, and technological advancements.

METHODS

To examine and compare the relationship between renewable energy production and GDP with non-renewable energy production and GDP, I collected quarterly data on Taiwan's GDP, renewable energy production, and non-renewable energy production from 2010 to 2023, sourced from The National Income and Economic Growth Statistics Database and The Ministry of Digital Affairs. Our analytical focus is on identifying the correlation between Taiwan's GDP and renewable energy production, identifying Taiwan's GDP and non-renewable

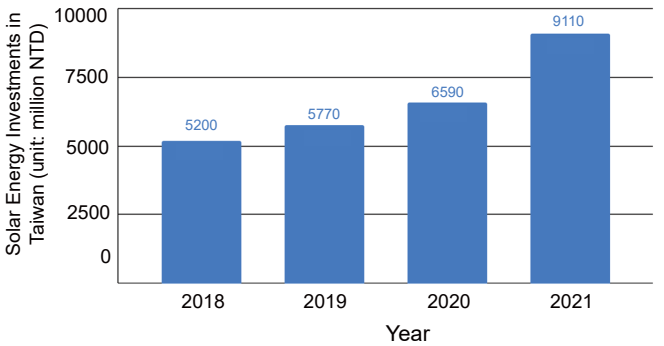

Figure 4. Solar Energy Investments in Taiwan per year (unit: million NTD) (27). This graph shows Taiwan's annual solar energy investments from 2018 to 2021, showing a gradual and consistent growing number of investments, reflecting the commitment to achieve Taiwan's planned goals.

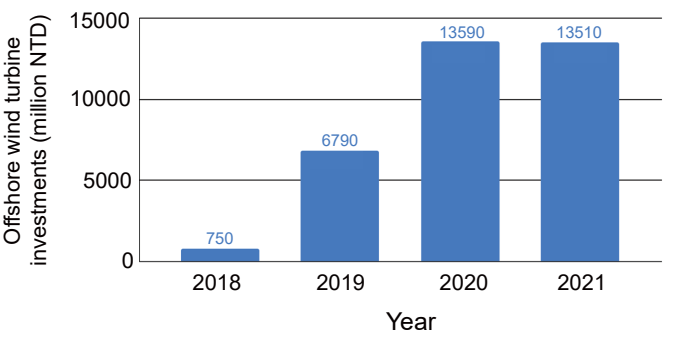

Figure 5. Offshore Wind Turbine Investments in Taiwan per year (unit: million NTD) (32). This graph shows Taiwan's annual Offshore wind turbine energy investments from 2018 to 2021, showing a sudden rapid growth in 2019 and a stalemate in investment numbers in 2021.

Table 3. Renewable Energy Development goals in the near future (21)

	2015		2020		2025	
	Storage capacity (MW)	**Energy generation (100 Gwh)**	**Storage capacity (MW)**	**Energy generation (100 Gwh)**	**Storage capacity (MW)**	**Energy generation (100 Gwh)**
Solar	842	11	8776	110	20000	250
On-shore wind	647	16	1200	29	1200	29
Off-shore wind	0	0	520	19	3000	111
Geo-thermal	0	0	150	10	200	13
biomass	741	54	768	56	813	59
hydropower	2089	46	2100	47	2150	48

This table presents Taiwan's renewable energy targets for solar, wind, geothermal, biomass, and hydropower for 2015, 2020, and 2025, both for projected storage capacities and energy generation.

energy production, and whether renewable energy or non-renewable energy positively impacts Taiwan's GDP.

Descriptive Statistics

According to the data (shown in Table 4), the mean of Taiwan's GDP is 4,503,737 NTD, while the mean of renewable energy production is 3,500MW and the mean of renewable energy production is 39410MW. The standard deviation of non-renewable energy production and renewable energy production were 3590 and 1,392 in 2010~2023, showing a higher variability of non-renewable energy compared to renewable energy. Additionally, the range of renewable energy production when compared to non-renewable energy production, which is 12431 and 5615 respectively, shows how much renewable energy has been growing compared to non-renewable energy production. These statistics offer a foundation for understanding Taiwan's economy, renewable energy production, and non-renewable energy production over the past decade.

RESULTS

Using Pearson's correlation coefficient, I found an extremely high correlation of 0.9024360293 between the renewable energy production and Taiwan's GDP. 0.902 is extremely close to 1, which is a perfect correlation, showing how positively renewable energy production and GDP are positively correlated. Figure 6 graphically shows Taiwan's GDP and renewable energy production rise and fall similarly, indicating a strong relationship between both variables. As Taiwan develops renewable energy, Taiwan's GDP will also grow simultaneously. These results show that producing renewable energy is positively correlated with Taiwan's GDP. On the other hand, there is a negative correlation of -0.06553573915 between non-renewable energy production and GDP. -0.0655 is extremely close to 0, which represents no correlation. Additionally –0.0655 implies an inverse correlation, as I can see in Figure 7, further proving why the Taiwan government should increase its investment in renewable energy rather than non-renewable energy.

DISCUSSION

How has developing renewable energy benefited Taiwan economically?

This section explores why producing renewable energy has a higher correlation to GDP than producing non-renewable energy to fully understand how Taiwan can benefit from continuing and expanding renewable

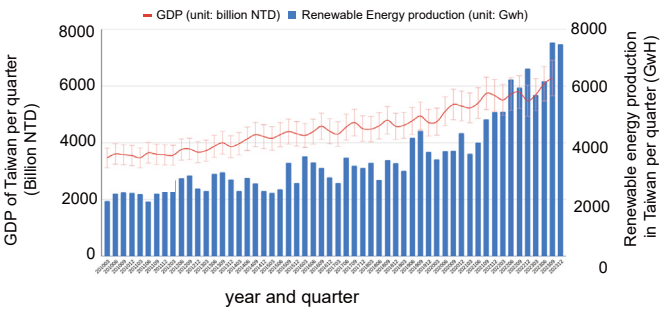

Figure 6. Renewable energy production in Taiwan and GDP of Taiwan per quarter since 2010 (35, 36). This graph combines the GDP and renewable energy production of Taiwan to show the trends in Taiwan's renewable energy production and GDP over time and its correlation with error bars. This shows the high correlation between renewable energy production and GDP of Taiwan, with the rises and falls matching each other.

Table 4. Descriptive statistics of Taiwan's GDP, renewable energy production, and non-renewable energy production (33, 34)

	Renewable Energy production	Non-Renewable energy production	GDP
Mean	3500.831043	39410.65472	4503737.071
Median	3113.120341	39174.82834	4400004.5
Mode	N/A	N/A	N/A
Range	5615.717465	12431.21818	2871992
Standard Deviation	1392.475339	3590.329784	764705.3073
Sample Size	56	56	56

This table provides key statistics, including the mean, median, mode, range, and standard deviation, for Taiwan's GDP and renewable energy production from 2010 to 2023, offering a foundation for further correlation analysis.

energy development. First, it is essential to understand the entire process of how the government catalyzes renewable energy development in Taiwan. The government directly pays factories and businesses to produce more or integrate more renewable energy, which will cause the domestic production of renewable energy-related products to increase and cause economic growth (39). As domestic production increases, factories and businesses must hire more workers to handle the increase in production. These new workers will have salaries and will purchase goods and services, which would benefit other businesses and, in turn, will also cause economic growth. Although this type of government intervention could generate similar economic results if focused on non-renewable energy, such an investment would also come with an increased reliance on risky sources and worsen Taiwan's already problematic energy dependence crisis. Instead, by incentivizing renewable energy production, not only is there an immediate boost to economic growth, but the longer-term impact will also be a lower percentage of Taiwan's energy comes from imported sources. Figure 8 shows the different routes that can benefit Taiwan when developing renewable energy.

Increased investments

One of the most significant ways renewable energy developments changed Taiwan's economy is the substantial increase in investments. As investment is a critical component in GDP, the goal of becoming net zero drives heavy financial investments and results in economic growth. While it is possible for Taiwanese nationals to invest capital in foreign energy sources such as oil, investment in the direct production of energy comes with much more stability and a higher potential for long term growth. From 2015 to 2021, Taiwan has benefited from 1480.86 million USD of green energy investments. There was an increase of 778.4 million USD in investments between 2015 and 2021 (40). To dive deeper into renewable energy investments, Figure 9 shows the number of cases for renewable energy investments and the size of the investments in units of million USD. This shows that the government is pushing heavily for the transition to renewable energy and the plan is succeeding. Another critical point is in Figure 10, which shows that renewable energy investment is now a

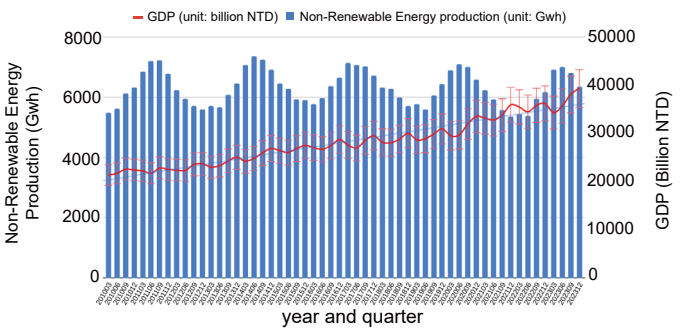

Figure 7. Non-renewable energy production in Taiwan and GDP of Taiwan per quarter since 2010 (37 38). This graph combines the GDP and non-renewable energy production of Taiwan to show the trends in Taiwan's non-renewable energy production and GDP over time and its correlation with error bars. This graph shows the extremely low and inverse correlation between non-renewable energy production and GDP of Taiwan.

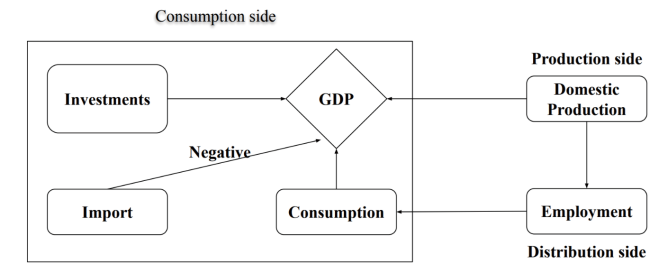

Figure 8. Different methods of developing renewable energy can benefit Taiwan. This conceptual diagram outlines various pathways through which developing renewable energy can benefit Taiwan, ranging from consumption, production, and distribution.

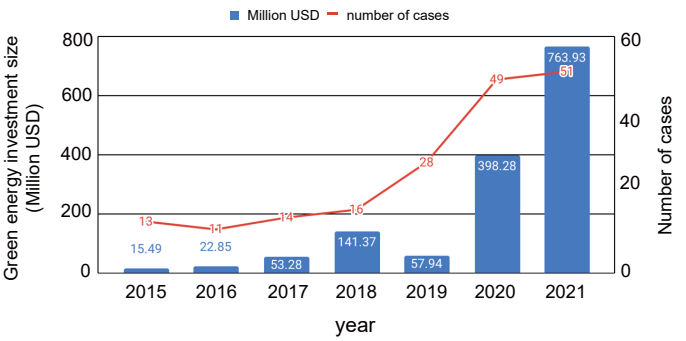

Figure 9. Number of green energy investments and investment size from 2015 to 2021 (41). This bar graph combines the number of cases of green energy investments and the investment size of green energy investments from 2015 to 2021, indicating significant growth in 2020 and 2021.

portion of Taiwan's GDP. Through more acts and policies, the effects of renewable energy investments could become more remarkable than before.

Big tech giants in Taiwan are also focusing on renewable energy. For example, TSMC currently uses 20% renewable energy to make their products and plans to be 100% reliant by 2040 (43). Another example is Apple and Google, which started to source green energy from Taiwan's local green energy farms. Both examples signify the movement towards green energy in Taiwan (44). These businesses' moves demonstrate how renewable energy transitions are not simply good for the environment but are great business decisions as well.

Additionally, investing in brand new renewable energy can also allow Taiwan to fix a rising problem—Old and outdated infrastructure. Taiwan's aging energy infrastructure causes constant repairing, maintaining, and even replacing. Through investing in renewable energy, Taiwan is investing in its own future, creating less burden on its energy production farms/factories and increasing the efficiency of its energy generation.

Employment

Developing renewable energy requires increasing production size. To increase production, renewable energy-developing industries must hire more workers. When hiring new workers, they not only increase the employment rate but also increase Taiwan's GDP. When an individual is hired, their employer pays them monthly salaries. When receiving their monthly salaries, the employee could spend their money purchasing goods and services. By consuming, their spending becomes other businesses' earnings, creating a positive ripple effect across the entire economy. According to Emilia Herman, a Postdoctoral researcher from the Academy of Economic Studies in Bucharest, she found a low but positive coefficient between economic growth and employment in EU countries. Job creation causes an increase in consumer spending because people have more money in their pockets, and it causes economic growth (45). Figures 11 and 12 show us how much employment has increased in both the solar and offshore wind turbine sectors contributed by the development of renewable energy. This data shows how developing renewable energy could grow

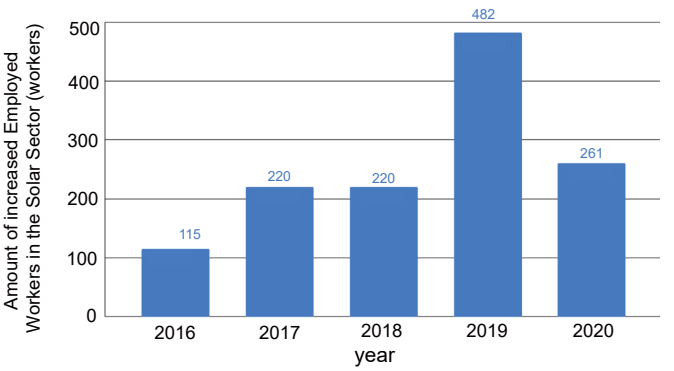

Figure 11. Number of Increased Employed Workers in the Solar Sector (46). This figure presents the rise in employment within Taiwan's solar energy sector, reflecting the benefit of job creation of solar energy development.

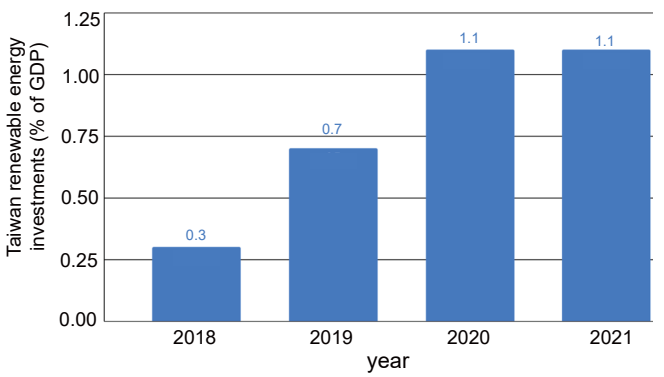

Figure 10. Percentage of GDP Taiwan Renewable Energy Investments count towards per year (42). This graph tracks the portion of Taiwan's GDP attributed to renewable energy investments annually, highlighting the increasing economic significance of these investments.

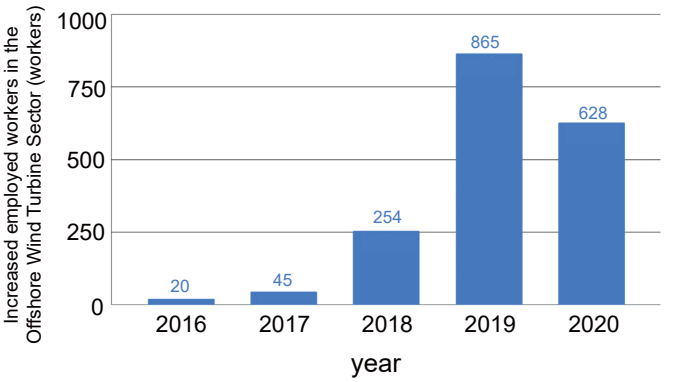

Figure 12. Increased employed workers in the Offshore Wind Turbine Sector (47). This figure presents the rise in employment within Taiwan's Offshore wind turbine energy sector, reflecting the benefit of job creation of wind energy development.

employment, increase consumer spending, and ultimately GDP.

Increased productivity

As energy demand increases, companies hire more workers and purchase equipment to increase productivity. When purchasing equipment from different businesses, they give revenue to other companies, which they could, in turn use to buy equipment for their business or pay their employees, both of which would end up with more money circulating in the economy, causing a ripple effect across the whole economy, bringing economic growth. Unlike increases in consumer or government spending, an increase in investments is more than a one-time boost for the economy. New machinery could be used for decades to come and generate an increased amount of output for a sustainable period, and this will increase profitability and efficiency until the next big project.

Thus, capital investment into the renewable energy industry results in growth across multiple supporting industries. With better technology and increased efficiency, other sectors could copy and use the newest technology in their own production facilities. This increase in productivity is often accompanied by a lower cost and often a lower price for the final good. This shows a productivity increase could benefit multiple industries and sectors simultaneously, increasing economic growth numerous times. This indicates that through the Taiwanese government's acts and development plans, Taiwan's economy will grow significantly through methods such as employment, productivity, technological advancements, and increased long-run production.

An excellent example of a multi-functional renewable energy project is Ørsted's Greater Changhua 1 and 2a Offshore Wind Farms project. Ørsted is a Danish energy producer with multiple global energy projects, including Taiwan (48). In April 2024, they finished production of 2 offshore wind farms on the west coast of Taiwan. These wind farms will contribute 523 billion NTD to Taiwan's economy while also creating 8300 jobs during construction. Through the industrial development fund, the project used 60 million NTD to support 22 companies and 200 people. However, the benefits aren't limited to economics. The new wind farms will reduce 1.75 million tons of carbon dioxide yearly, power 1 million households annually, and teach 750 children about green energy (49). In addition, these benefits do not rely on an outside source of imports and help reduce Taiwan's energy dependence issue. This project exemplifies how by developing renewable energy, Taiwan could not only increase productivity but could also improve and grow each of the 3Es, specifically for Taiwan's economy.

How has renewable energy improved Taiwan's energy situation?

As seen above, developing green energy can benefit Taiwan's economy significantly, but how has renewable energy benefited Taiwan's energy situation? Firstly, there is a decreased reliance on energy importation. As seen in Figure 13, Taiwan is lowering the amount of energy imports. Although the amount of change is minimal right now, recent policies are boosting investment in the sector which will provide more effective change over time and result in lower amounts of energy importation.

Another critical benefit is energy consumption. Figure 14 shows that Taiwan's energy consumption has increased significantly. Since 2003, Taiwan's energy has increased almost 50%, demonstrating the need for more energy. Figure 15 shows that although Taiwan's energy consumption growth has decreased recently (mostly due to COVID-19), Taiwan's overall energy consumption is steadily rising. Developing renewable energy not only helps reduce carbon emissions but also allows Taiwan to relieve the pressure on the limited amount of fossil energy generation plants. Through renewable energy development, Taiwan now has a chance to diversify its energy sources, making it less energy dependent and less at-risk of another blackout or any energy security issues.

CONCLUSION

Taiwan's energy situation includes problems such as the lack of energy security, energy diversity and growing energy demand. Following global trends, developing renewable energy provides an answer to these issues and would bring additional benefits as well. Through renewable energy development, Taiwan can improve the 3Es. For the Environment, Taiwan can focus on lowering greenhouse gas emissions, make renewable energy 20% of its entire energy supply by 2025, and help slow global warming. For Energy, Taiwan can not only lower energy importation, improve energy security, and diversify energy sources, but Taiwan can also reduce the burden on limited energy producers which caused blackouts throughout the entire island. Additionally, a stable energy supply would feed the needs of the island's increasing energy demand. For the Economy, developing renewable energy comes with increased capital investments, employment rates, increasing productivity, and technological advancements and consumer spending, which will cause economic

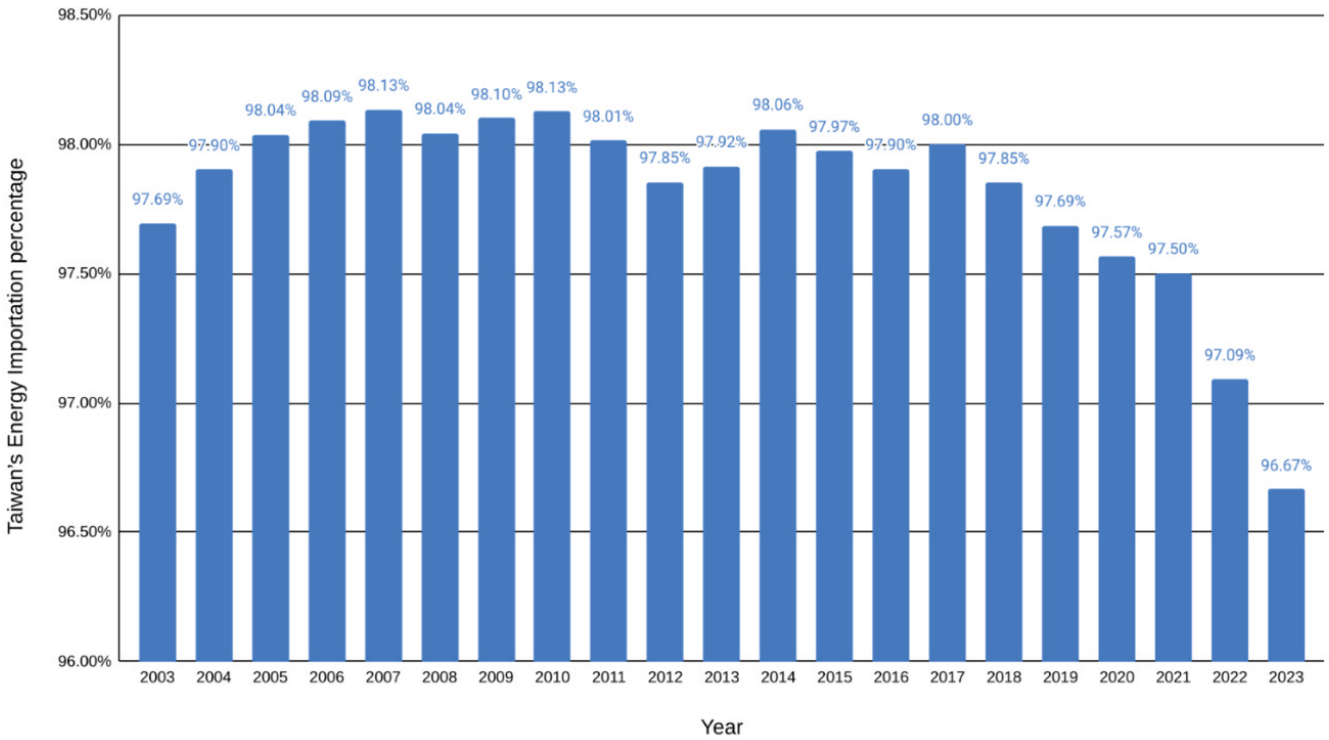

Figure 13. Taiwan's Energy Importation percentage from 2003~2023 (50). This line graph shows the gradual reduction in Taiwan's reliance on imported energy, a key reason of renewable energy development in Taiwan.

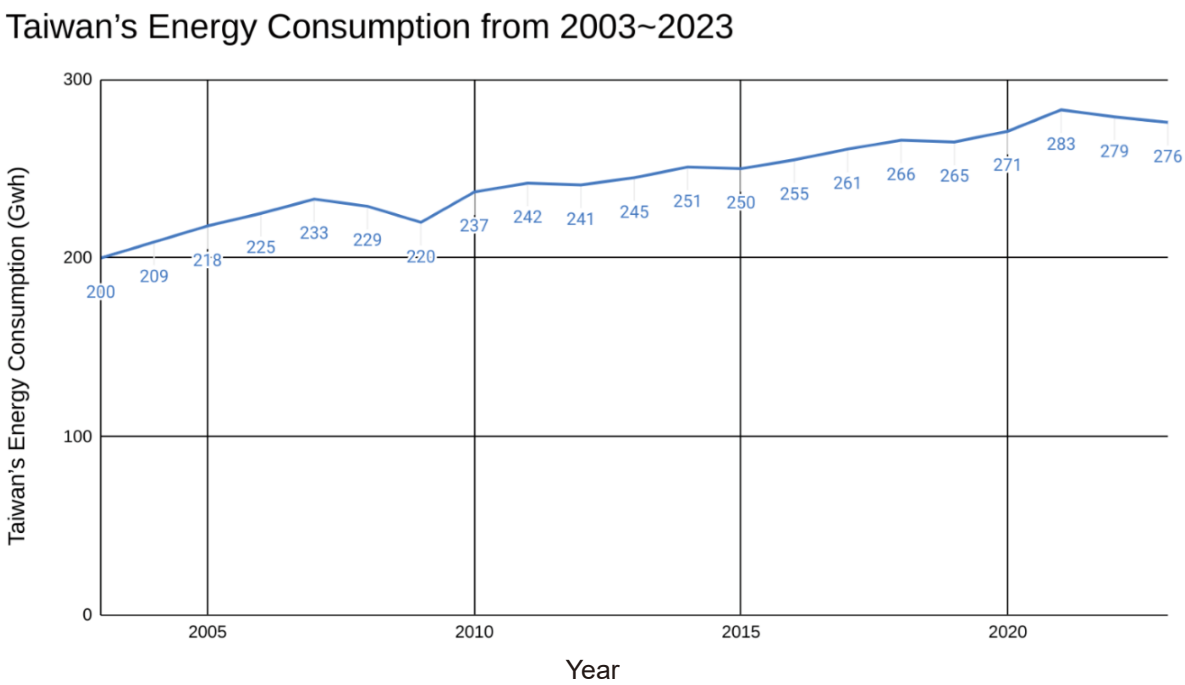

Figure 14. Taiwan's energy consumption from 2003~2023 (51). This graph presents Taiwan's total energy consumption over the past two decades, highlighting the increasing energy demands driven by economic growth and industrial activities.

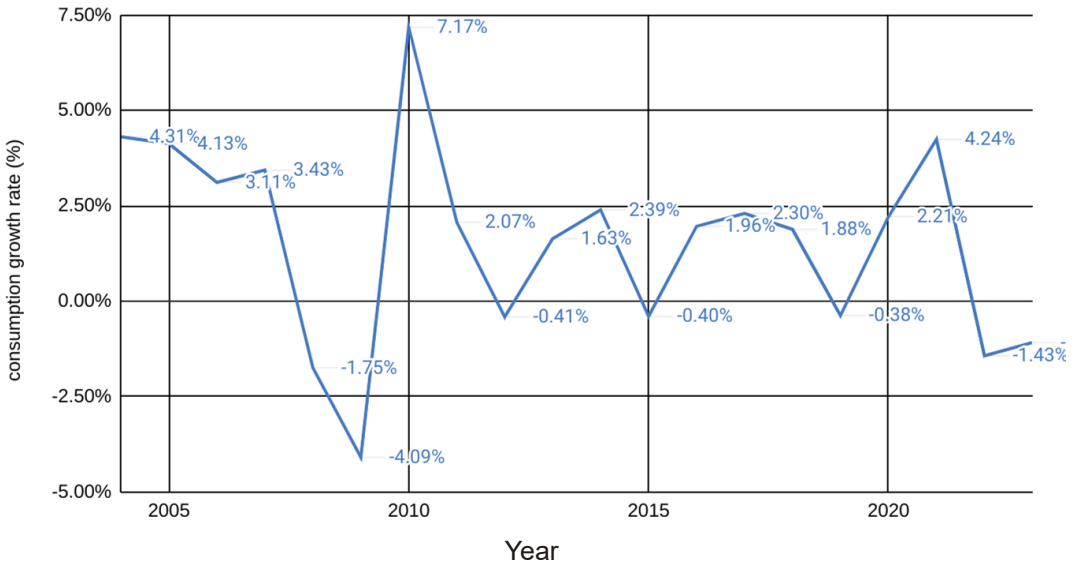

Figure 15. Taiwan's Energy Consumption Growth from 2003~2023 (unit: 100%) (52). This figure tracks the percentage growth in Taiwan's energy consumption year over year in the past 2 decades, showing a steady increase with recent deceleration due to the Covid-19 pandemic.

growth in both the short and long run.

After my analysis, I have found a positive correlation of 0.902 between renewable energy development and GDP. However, I also found a negative correlation of 0.655 between non-renewable energy production and GDP, which further strengthens my stance that as Taiwan develops renewable energy, Taiwan will continue to prosper in economic growth.

Nevertheless, this study might contain potential limitations. First, the correlation is based on the government's official data. Still, if there are inaccurate reports, it could cause a miscalculation of the correlation and potentially skew the results. Secondly, insufficient data might cause an incorrect evaluation of the current state of renewable energy development. Additionally, this paper does not fully acknowledge Taiwan's geo-political issues. Lastly, this paper focuses primarily on solar and wind power, which might limit the scope and total size of renewable energy's effect on Taiwan's GDP.

DECLARATION OF CONFLICT OF INTERESTS

The author declares no conflicts of interest.

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