INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH AND KNOWLEDGE
ISSN-2213-1356 www.ijirk.com

Review of Taiwan's Green Energy and Carbon-Reducing Measures and Recommendations for Its Energy Transition

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Abstract
Since the beginning of the industrial age, humans have deforested land, reclaimed land for commercial gain, and damaged the environment. Human activity has strongly affected the climate, leading to global warming, threatened the ecological balance, and created problems such as extinction and food and energy crises. Controlling global warming and reducing CO2 emissions are key concerns worldwide. To achieve the European Union's goal of climate neutrality by 2050 and the midterm goal of a 55% reduction in greenhouse gas emissions by 2030, the European Commission announced a major reform of the European Union Emissions Trading System. Following suit, Taiwan has implemented measures to reduce carbon emissions and create a nuclear-free homeland by 2025. This study introduced several projects to save energy and reduce carbon emissions, namely Jatropha curcas biodiesel, a license plate accessory to purify the air, and a tube-through-pipe system to transport drinking water to indoor spaces. This study also described green-energy, carbon-reducing solutions based on Taiwan's geographical and industrial advantages and reviewed its contributions to protecting the environment.

Keywords: *Climate change, renewable energy, energy policy, green energy*

Introduction

The effects of human activity on the climate have intensified over time, with global warming being a crucial problem. Natural disasters, such as the Australian bushfires, floods in East Asia, forest fires in Indonesia, oil spills caused by melting Arctic permafrost, Amazon rainforest wildfires, floods in China, and California wildfires, have become commonplace. The US National Weather Service analyzed the California wildfires by using weather data from the 1970s until the present day. They revealed that the hot dry season in California is at least two and a half months longer than that in the 1970s and that heat and dryness facilitate the development of wildfires. Climate change not only leads to global warming but also decreases the predictability of weather because of excessive CO2 levels, which increase the likelihood of unexpected weather disasters occurring.

Human activity affects the environment and climate. For example, irrigation changes local humidity to various degrees. Scientific research has suggested that human activity has caused the global temperature to increase over time, and it has advocated for minimizing activity that can affect the climate and for reducing the damage it causes to the environment. More than 97% of climate scientists have stated that global warming exists and that human activity may be the main cause. The most dangerous result of human activity is the emissions of CO2 and fly ash during fossil fuel combustion and cement production. Dangerous activities include improper land use, animal husbandry, agricultural activity, and deforestation.1 According to the Fifth Assessment Report released by the United Nations Intergovernmental Panel on Climate Change in 2013, human activity is a primary cause of climate change. Greenhouse gases such as CO2, CH4, and N2O that result from human activity are the contributors to global warming and climate change.[2]

Climate change and global warming have become a concern worldwide. Various factors, such as solar radiation, changes in the earth's orbit, orogeny, and greenhouse gas emissions, contribute to climate change. Extreme weather events resulting from global warming have caused ecological imbalances, unprecedented threats to human life, and economic loss. This has created a burden for governments worldwide, and controlling global warming and reducing CO2 emissions have thus become key concerns for human survival. To achieve the European Union's goal of climate neutrality by 2050 and the midterm goal of a 55% reduction in greenhouse gas emissions by 2030, the European Commission announced a major reform of the European Union Emissions Trading System. The reform involves strengthened control over several industries, including the shipping industry, the energy industry, the steel making and processing industry, the mineral industry (including the cement, glass, and porcelain sectors), and the pulp and paper industry.[1]

The Taiwan government must pay attention to and cooperate with the Taiwanese government and people when it comes to formulating energy transition policies and coordinating carbon emissions to meet the overall ESG considerations. How to maintain a stable power supply system, which is beneficial to the operation of enterprises and maintains economic development, is an important topic of the Taiwan government's energy conservation policy.

One doctoral environmental research team from Taiwan's Nanhua University has made several contributions, including (1) growing *Jatropha curcas* to generate bioenergy and reduce CO2 emissions, (2) developing a system in which traffic barriers are used to purify CO2 and cultivate crops economically, and (3) developing a tube-through-pipe system that transports drinking water disinfected using solar power to indoor spaces (a system that uses solar energy UV-C light to produce sterile water. The sterile water produced must be filtered by activated carbon to be of sufficient quality for drinking.). The Taiwanese government granted them patents for contributions (2) and (3).

The purpose of this paper is to hope that the government to implement the aforementioned policies and ensure Taiwan's contributions to protecting the environment receive global recognition as being equal to those of several Western countries. Regarding the issue of Taiwan's energy transition, we suggest that the government can refer to

the research results of the environmental protection research team of the University of South China to save energy with a low-cost model. In addition, we use the literature analysis method to discuss the core issues of Taiwan's energy transition and propose effective solutions, in order to help Taiwan move towards the goal of carbon neutrality.

Methods

We analyze the challenges that Taiwan may mucker in the future from the implementation of foreign festivals and Taiwan's energy-saving strategies.

Case Study: The European Union's Promotion of Green Energy

Green energy takes numerous forms, the most common being wind power, hydropower, solar power, bioenergy, geothermal power, and tidal power. Sweden has long promoted solar power generation, and its government provides subsidies to residential communities to install solar panels and purchases the excess power residents generate, which provides additional income to the residents. In addition, the government implemented policies to encourage businesses to develop renewable energy generation systems and allocated 10 billion SEK to promoting green energy in its 2021 budget, with approximately 1 billion SEK for the green transition. The government also considers the opinions of scholars and businesspeople when developing its green policies and engages with businesses and communities by demonstrating the benefits of saving energy and reducing carbon emissions in the sharing economy. Sweden is also the world's first country to implement a carbon tax.

Portugal's advantageous location has enabled it to generate various forms of renewable energy, including solar power, wind power, and hydropower. In 2016, it accomplished an unprecedented feat by supplying power continuously for 107 hours by using renewable energy; this was a record-long period for the European Union. The Portuguese government also passed the National Energy and Climate Plan and has since held several public consultation meetings and interdepartmental technical workshops to achieve carbon neutrality by 2050.

Bhutan has an area of 38,394 km^2, 70% of which is covered by forests, and it is the only country to have constitutional protections for its forests. Located in the Himalayan mountain range, Bhutan generates electricity mainly through hydropower from melted snow of the mountains. Their power supply is so stable that it sells power to nearby countries. The government imposed a legal cap on the number of foreign travelers in the country to prevent damage to the environment.[3]

In 2011, reactor meltdowns occurred in Fukushima, Japan, after coastal nuclear power plants were destroyed by an earthquake and tsunami, constituting the most severe nuclear accident since the Chernobyl disaster in 1986. After this incident, the German government acknowledged the danger of nuclear accidents and accelerated its phase-out of nuclear power.[4] The German government enacted the Renewable Energy Act in 2000, which established funds to purchase and encourage businesses to invest in equipment for green energy. Germany, the first major industrialized country to implement an energy transition, has a goal to increase the proportion of renewable energy from 65% to 80% and to phase out coal power completely by 2030. To meet the demand for electricity, Germany also plans to generate 680–750 TWh of renewable energy annually by 2030, with the ultimate goal being carbon neutrality.[5]

The Germany's Renewable Energy Act (EEG) 2021—the latest version—introduced various measures, such as a reward mechanism for local communities, reductions in or exemptions from EEG surcharges for photovoltaic energy, and plans for market integration and to improve the power grid. These measures are expected to increase the applicability of land-based wind and solar power and to accelerate the development of green hydrogen, a smart

power grid, and wind power. The EEG 2021 also indicates Germany's goal of reaching carbon neutrality by 2050. The Climate Change Act, which is being amended, advances the deadline to 2045 and sets targets for energy saving, green energy, and hydrogen energy. The installed capacity of Germany's offshore wind power facilities reached 7.7 GW in 2020, the third highest worldwide. With its government's plans to increase this capacity to 40 GW by 2040, the strong demand for wind power, and its advanced wind power technology, Germany has secured an advantageous position in the global market.[6]

According to data released by Fraunhofer ISE—the largest solar power research institute in Europe—in 2021, clean energy accounted for 46% of Germany's net public power, and 0.7 TWh more photovoltaic power was generated than in 2020. However, the proportion of clean energy decreased because 16.1 TWh less wind power was generated in 2021 than in 2020. Despite this decrease, wind power remained the largest source of public power in 2021 at 113.5 TWh.

Gas-fired plants were often pushed out of the market, due to the sharp rise in natural gas prices and had a share of 10.4%. While solar PV and wind – Germany's two main providers of renewable electricity – complement each other when seen on a monthly basis over one year, the Fraunhofer ISE noted that there will be more solar PV capacity necessary to provide a balanced supply. The renewables share in gross power production in 2021 was 40.9%.4

Taiwan's Energy Strategy

Taiwan started promoting photovoltaic power in 2000 and enacted the Renewable Energy Development Act in 2009. The government has advocated for a nuclear-free homeland, a goal it hopes to achieve by 2025. The government also implemented the 2-year Photovoltaic Power Generation Program, the Renewable Energy Development Act, and the Green Roof Program to encourage the private sector to invest in solar power.[7]

To promote large-scale photovoltaic power, the government also set a 500-MW capacity target for 2025; with this capacity, 650 million kW of photovoltaic power will be generated annually[8]. At the end of January 2020, the total installed photovoltaic capacity was 284,000 kW, and 28.23 million kW of power was generated in total.[9]

At the end of 2020, the total installed capacity for renewable energy generation was 9,482 MW, which accounted for 16.4% of the total power generation capacity of Taiwan. A total of 15,313 GWh of renewable energy was generated, accounting for 5.5% of total power in Taiwan. Taiwan has invested in six types of renewable power: hydropower (run-of-the-river hydropower), photovoltaic power, wind power, geothermal power, bioenergy power, and waste-to-energy power.[10] The Taiwanese government also set goals such as making 20% of all energy renewable by 2025, quickly completing construction of a third liquefied natural gas (LNG) receiving terminal, which requires additional LNG offloading and storage equipment, and replacing old equipment with ultrasupercritical, high-efficiency generator sets in coal-fired power stations.[11]

The Taiwanese government prioritizes land-based wind farms over offshore wind farms. Taipower selected an area off the coast of Lugang in Changhua to implement phase two of the Offshore Wind Generation Project after the Bureau of Energy allocated 300 MW of installed capacity to the project in 2018, and it constructed an offshore wind farm with a total installed capacity of 294.5 MW. The wind farm is expected to be complete and have on-grid connection by 2025, to generate more than 1 billion kW of power annually, and to reduce annual CO2 emissions by approximately 403,611 tons. The wind farm can help Taiwan achieve its goals of making 20% of its energy renewable, reducing greenhouse gas emissions, creating low–carbon energy infrastructure, and accelerating development. The wind farm requires a large amount of human and financial and resources but can accelerate the development of Taiwan's wind power industry, create job opportunities, and stimulate the local economy.[12]

Taiwan's location on the Ring of Fire affords it potential geothermal power. According to an evaluation of the green energy grid by Taipower, Taiwan can potentially generate 33.6 GW of geothermal power, 12.4 times that generated by the Lungmen Nuclear Power Plant. Geothermal resources in Taiwan are widely distributed across 27 geothermal areas, which can potentially generate 989 MW of energy.13 "Geothermal Power Generation in the World 2015–2020 Update Report" detailed the installed capacity of countries situated near the Ring of Fire in 2020; that of Japan was 550 MW, that of the Philippines was 1,918 MW, and that of Indonesia was 2,289 MW.[14] However, that of Taiwan was only 0.3 MW; this capacity remained unchanged until Cingshuei Geothermal Power Plant reopened at the end of 2021, which increased the capacity to 4.2 MW.[13]

Bill Gates noted in his personal blog "Gates Notes" that geothermal energy is abundant and stored in the form of heat on the earth's surface. The amount of available geothermal energy is several times larger than energy from coal, fossil fuel, and natural gas combined. Geothermal energy is the only form of renewable energy that can be generated nonstop and the most efficient form of green energy; its power generation efficiency of up to 76% is higher than the 20%–40% of solar and wind power.

Baseload Capital, a Swedish geothermal development company, selected Hongye Village in Hualien, Taiwan, as a second site to develop geothermal energy technology. Behind Baseload Capital is a group of board directors who advocate for reducing carbon emissions. It includes the Breakthrough Energy Venture, founded by Bill Gates and Jeff Bezos, and Chevron Technology Ventures. The presence of such large-scale investors in Taiwan demonstrates its potential in geothermal power generation.

Baseload Power suggested that policy support from the Taiwanese government is essential to fully utilizing geothermal energy. The company took 2 years to construct an exploratory well in Taiwan because of bureaucratic and legal restrictions. According to Sheng-rong Song,[15] a professor in the Department of Geoscience of National Taiwan University, geothermal energy can be utilized at any time, requires little land, is ecofriendly, and is the optimal form of base load energy. However, Taiwan's Hot Spring Act is a large obstacle to the development and exploration of geothermal capabilities because it limits regional water use. As a result, Taiwan lags behind other countries in geothermal power capabilities.[16] The government should mediate communication between geothermal energy companies and local hot springs to assuage concerns regarding pollution and to help both parties reach an agreement.

The Ministry of Economic Affairs issued a decree on the energy supply and consumption standards that obligate energy suppliers and users to proceed with matters specified in the Energy Administration Act and the required security stockpile in 2016, to save energy. The standards stated that all those with a contract capacity of above 800 kW must implement energy audit systems in accordance with articles 9 and 12 of the Energy Administration Act. As a result, energy consumption from major consumers decreased by 15.7 billion kWh between 2015 and 2020, the average annual amount of energy saved increased from 1% in 2009 to 1.73% in 2014, 2,452 households saved 56,300 kL of oil from 2016 to 2020.[17]

A statement released by the Ministry of Economic Affairs on December 16, 2021, indicated that policies to reduce the use of coal must address both the pollution due to and stability of alternative power supplies. Although renewable energy generation has increased, the amount of renewable energy generated will remain less than that generated by coal. LNG power must be increased and technology dedicated to renewable energy generation, hydrogen energy generation, and long-term carbon capture, utilization, and storage for Taiwan to transition from being low carbon to carbon free.[18]

According to open data released by Taipower, the price of electricity was 2.559 NTD/kWh for residential users and 2.446 NTD/kWh for commercial users in 2020. According to data published by the International Energy Agency, 2021 statistics from Enerdata, and data from countries neighboring Taiwan, the residential price of electricity in Taiwan was the fourth lowest globally, and the commercial price was the sixth lowest for the commercial rate in 2020.[19] With these low electricity prices (Table 1).

Countries that highly depend on others for energy (especially for mineral resources, and natural gas) experience strong pressure from increasing energy prices in the future because of the ongoing worldwide pandemic and political conflict between Russia and Ukraine; this may threaten the affordable environment the Taiwanese government has striven to create.

Table 1: Cost of power generation by source (unit: NTD/kWh)

Source	2021 (self-imposed budget)	2022 (end of January)
Taipower (A)		
Thermal power	1.85	2.29
Oil	5.12	5.69
Coal	1.57	1.92
Gas	1.92	2.40
Nuclear power	1.39	1.33
Pumped storage	2.65	1.79
Conventional hydropower	2.16	1.87
Wind power	2.00	1.38
Solar power	2.89	3.46
Subtotal for the amount generated	1.81	2.15
Power purchased by Taipower (B)		
Cogeneration	-	2.02
Privately-run power plants	-	2.06
Coal	-	2.24
Gas	-	2.77
Renewable energy	-	4.75
Conventional hydropower	-	1.78
Wind power	-	5.17
Photovoltaic power	-	4.88
Geothermal power	-	6.17
Other renewable energy	-	4.58
Subtotal for the amount purchased	-	2.86
Average cost of power generation (A + B)	-	2.33

(Source: Taipower)

Results

More than 90% of Taiwan's energy sources are imported (such as oil, coal mines and natural gas). As the proportion of natural gas power generation increases, the cost of power generation increases, and electricity prices are bound to be adjusted. However, Taiwan has adopted a low electricity price policy for many years. The electricity price for industrial users is still 10% off the livelihood users, and the electricity price has always been low. Large enterprises are not willing to change the current electricity consumption model. In 2018, my country's Executive Yuan passed the draft amendment to the "Renewable Energy Development Regulations", which included 20% of renewable energy power generation into the law, and standardized the green power obligations of large electricity consumers. To use electricity, set up renewable energy with a certain installed capacity. At present, the government still lacks innovative strategies, and it is difficult to inspire large electricity consumers to be willing to invest in the new power development system.

According to the Bureau of Energy of the Ministry of Economic Affairs, increasing LNG power through policy can ensure the stability of low-carbon, low–air pollution power supplies. Increasing LNG power is a critical component of Taiwan's strategy to achieve net-zero emissions by 2050. Cooperation between civil society and businesses as well as effective policies are crucial for the Taiwanese government to complete the energy transition and reach carbon neutrality. We found Taiwan's geography, sunshine hours, strong winds, water, geothermal resources, and offshore wind farms afford it advantages in developing its green energy capabilities. However, Taiwain's wind farms currently development still too low; and Taiwain's geothermal power development lags behind the progress of geothermal development in neighboring countries, due to legal problems. In addition, the energy transition decision-making direction announced by the Taiwan government at the end of 2021 still focuses on increasing natural gas imports. Except for the hope of following up to achieve the carbon neutrality goal in 2050, there are no clear plans and measures. However, increasing the proportion of natural gas in energy is not a long-term solution. Costs must also be increased. The low electricity price strategy cannot be balanced in management, and it will become Taiwanese residents often forget the value of the earth's resources and become wasteful.

If Taiwan's energy transition wants to achieve its goals as soon as possible, the Taiwan government must to resolve the issue of low electricity prices and develop towards sustainable management.

Discussion and Recommendations

This study proposed several projects to save energy and reduce carbon emissions to provide Taiwan's government reference.

Jatropha Curcas Biodiesel

Taiwan's geographical and climatic conditions are suitable for *Jatropha curcas*, from which biodiesel can be made. *Jatropha curcas* trees absorb CO_2 and thus mitigate global warming. To refining Jatropha Biodiesel can replace petroleum diesel, thereby resolving energy shortages and affording Taiwan autonomy over its energy supply.This study since 2008 to 2011, it shows that the germination rate is 80.5%, the survival rate of seedling transplantation is 94%, the proportion of fruiting plants in the current year is 21%, and each plant bears 3-19 capsules. In the third year, the yield of seeds per hectare was 3,024 kg, and the oil content of the seeds was 35.1%. Taiwan has numerous wastelands and slopelands suitable for *Jatropha curcas* cultivation. By incorporating *Jatropha curcas* into its afforestation subsidization program, the government can also improve the economic conditions of local and indigenous communities.[20] This strategy would coincide with Taiwan's efforts to localize the energy industry. Social stability requires the survival of all, including those without marketable skills and older adults.

Capitalizing on an Existing Patent (Application Number: 107205685)

Purifying air contaminants from vehicles is more effective upon emission than after; this requires air purifiers on vehicles. The Taiwanese government should install solar-powered cyclonic vacuums and wet scrubbers on traffic barriers to collect pollutants immediately upon emission and purify them. This system directly transforms CO_2 into a carbon source that benefits plant growth, which is particularly valuable for Taiwan considering its lack of natural resources. The system does not require external energy, and because it is installed on the outside of motor vehicles, it purifies pollutants immediately upon emission. Despite its small size, the system is highly flexibly and dense and reduces pollutant emissions in a low-cost and effective manner.

The system is attached to license plates and consists of a main body and a filter. The main body is hollow and has an inlet and outlet for air. A mudguard near the inlet prevents dirt and sand from entering the filter, a water shield between the mudguard and inlet prevents rainwater from entering the filter. The filter in the main body filters air that enters from the inlet after passing through the mudguard and water shield. The system can be mounted between the body of a vehicle and its license plate by using the two screws attaching the license plate to the vehicle (Figs. 1 and 2).[21]

Tube-Through-Pipe System for Indoor Drinking Water Space (Patent Number: M530190)

In the tube-through-pipe system, a solar-powered ultraviolet light disinfects the water stored in a water tank to drinking standards, and a small tube made from medical-class catheter materials is placed into a water pipe. The system received a patent from the Intellectual Property Office of the Ministry of Economic Affairs. The tube transports drinking water from the tanks on the roofs of residential buildings to their kitchens, thereby eliminating the need to boil water, which saves energy. The small tube is smooth, durable, flat, and antibacterial, and it is passed through the pipe by using a camera on the front and five smaller tubes mounted on it. The five smaller tubes each pump water and push the small tube forward while controlling its movement through the pipe until it reaches the kitchen.[21] This technology can also be used to supply nondrinking water for households, thereby resolving problems caused by lead pipes in old buildings.

Intelligent Technology, Green-Mark Products, and Home- and Community-Based Power Generation and Storage

Taiwan should further capitalize on its semiconductor and intelligent technology industries by incorporating them into its communications, green energy, and local agriculture industries to reduce energy consumption and improve transportation, thereby improving the economy and increasing Taiwan's international competitiveness. After the burst of the dotcom bubble, the fiber-optic communication industry grew through several mergers. Fifth-generation (5G) technology can be widely applied to artificial intelligence (e.g., for precision medicine, intelligent electric vehicles, the Internet of things, traffic management, scientific investigation, drones, and national security) because of its speed and energy-saving capacity. The use of 5G technology has increased substantially in Taiwan, with some residential properties combining it with optical-fiber broadband internet. With the development of communications technology, cable television will be replaced by wireless television. Removing television cables can improve the appearance of residential communities, help residents save money on their electricity bills, and facilitate the development of artificial intelligence in Taiwan. It will also improve the high-consumption industry model, increase said industry's productivity, create economic benefits, and help cities work toward low-carbon living.

Intelligent electric vehicles have been promoted worldwide. However, the lack of energy storage and charging stations remains a challenge. Energy storage systems must be widely dispersed to prevent disruptions to the power supply and the smart grid, comprising intelligent electric cars and intelligent cities, and to facilitate the development

of intelligent electric technology. Smart grids and power generation and storage devices can improve cloud computing and increase data transparency, which would enable residents, commercial properties, and office buildings to control their electricity consumption, save energy, and reduce carbon emissions. Intelligent homes can enable residents to turn off appliances by using their phone, thereby ensuring energy is not wasted. This can also enable users to identify causes of excessive energy consumption and adjust accordingly. Surplus energy can be sold to the government, which would be mutually beneficial.

Green Buildings and Planting Trees: A Balance Between Humans and Nature

Huangdi Neijing, an ancient medical text from the East, states, "A good doctor prevents diseases, an average doctor acts on potential diseases, and a poor doctor treats diseases." The text highlights the importance of slow and calm living and cultivating moral character. The text also frames the human body as a microcosm calibrated by earth, water, fire, and wind to achieve harmony among the body, mind, and spirit; humans can also achieve this harmony with nature. However, residential properties in the industrial age do not account for the body, mind, and spirit of residents and typically are made of rebar and concrete. For commercial reasons, nearby environments are usually destroyed to build such properties. Humans should cohabitate with nature rather than deforest land or use the sea for commercial gain because these practices can disrupt the ecological balance. Long-term anxiety and fear can also create emotional and familial problems, resulting in an imbalance among the body, mind, and spirit.

In 1999, well-known British architect Norman Foster designed a building with an arched glass roof, the Bundestag. The building is a paragon of green architecture. Berlin Hauptbahnhof, designed by architect Meinhard von Gerkan, is a hub for railway transportation in Berlin, the capital of Germany, the largest elevated station in Europe, and a classic example of green architecture. The rooftop of the station has solar panels that can generate approximately 160,000 kW of power annually. The building's steel and glass are recyclable, and the glass walls offer ample natural lighting, thereby reducing financial and environmental costs (Wikipedia).[22] Taiwan can learn from Germany's energy transition and low-carbon policies.

Taiwan's first zero-carbon building, the Magic School of Green Technologies, was completed in 2011 and is located in National Cheng Kung University. The building was hailed as the world's greenest building along with 44 others by British publisher Routledge in *The World's Greenest Buildings*. According to the book, which Jerry Yudelson and Ulf Meyer coauthored, the annual energy usage intensity of the Magic School of Green Technologies is 40.43 kWh/(m2.yr) (Wikipedia).[23]

The Beitou Branch of Taipei Public Library was listed as one of the 25 most beautiful public libraries in the world on US website Flavorwire.com. It is the first green library in Taiwan and is made mainly of wood. The roof has solar photovoltaic panels and rain collectors that save energy and water. The building is an oasis for reading where humans and nature can coexist peacefully.

Taiwan has several examples of successful green architecture, but the slow development of this field may be due to the public's limited understanding green energy. The government must cooperate with businesses to create more green buildings and reduce carbon emissions.

Using ESG Index to Achieve Energy Saving and Carbon Reduction Goals

For businesses to develop, they require a set of quantitative criteria to evaluate performance. The ESG index provides a basis for consumers to evaluate businesses' performance and image. Businesses should regularly review their stage-wise development models, how their development affects humans and the environment, and their social responsibility. Businesses with proper ESG practices are robust and often receive recognition from external entities, which increases corporate value.

The ESG index (environmental, social, and governance sustainability index) is based on the 2015 United Nations Sustainable Development Goals, which are part of the 2030 Agenda for Sustainable Development and provide a blueprint for sustainability. The ESG index is a key indicator of businesses' sustainability.[24]

In its "Rate the Raters 2020" study, SustainAbility Institute, an international authority on business assessments, conducted in-depth interviews and distributed a questionnaire to 319 experts from 60 countries to understand their perspectives on ESG raters in 2019. The study revealed that investment institutions and experts consider the RobecoSAM Sustainable Development Goal Scores, the Carbon Disclosure Project index, the Sustainalytics index, and the MSCI index to be the most authoritative.[25] Taiwan's efforts to reduce carbon emission can help preserve the earth's resources and ensure businesses uphold the government's plan to implement energy-saving, carbon-reducing, and ESG practices, thereby connecting Taiwanese businesses to the international community and increasing their competitiveness. The public and private sectors may reach a consensus regarding the aforementioned matters and formulate effective measures.

Conclusions

Nature is the cradle of all life. Forests, which cover a large portion of the earth, reduce the atmospheric CO_2 concentration, provide habitats for animals, control hydrological conditions, and anchor soil. They are thus a crucial part of the earth's biosphere. Rapid industrial development has entailed widespread deforestation and challenges in conserving water and soil; living environments are threatened by industrial sewage, air pollution, and the overexploitation of groundwater. Global warming affects not only the climate but also the environment and can lead to the extinction of species and food crises. Unstable supplies of food and water can create economic turmoil and political conflict over resources. Green energy–based practices are not necessarily high cost, and some can be implemented by educating the public and by implementing clear governmental policies. Carbon neutrality can be achieved in part by educating the public about low-carbon architecture, designing air convection systems, storing rainwater, capitalizing on daylight, and growing tropical plants.

The Taiwanese government should avoid overly intervening in the domestic market and adjust electricity prices to balance supply and demand and enable consumers to adjust their behavior accordingly. In addition, Taiwan should prioritize low-carbon forms of energy, such as renewable energy, solar power, and offshore wind power, to ensure the stability of power supplies and the prices thereof. Countries in the initial stages of energy transitions must have sufficient funding and clear policies and provide national subsidies to advance green energy. Governmental management and balancing of electricity prices are also crucial to sustainability.

We hope that Taiwan can match the European Union's progress in green energy and fully utilize the potential of its energy systems. In addition to encouraging private businesses to implement ESG practices, the government should incentivize residents and corporation to save energy. This study introduced several additional methods of achieving a balance between humans and nature, namely creating *Jatropha curcas* biodiesel, capitalizing on an existing patent to create an air purifier, implementing the tube-through-pipe system, utilizing intelligent technology, products with the green mark, and home- and community-based power generation and storage, and promoting the construction of green buildings and tree planting. The Taiwanese government can cooperate with the public to localize energy, implement green energy, and maintain ecological balance while utilizing geothermal energy, increasing renewable power, reaching a consensus regarding green power with private businesses, and establishing regulations and strategies to achieve low-carbon goals.

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