



PINGTUNG COUNTY

BREAKING NEW GROUND: RECLAIMING NON-ARABLE LAND FOR ENERGY FROM SOLAR PHOTOVOLTAICS



Pingtung County, Chinese Taipei: Facts and figures

Population

0.81 million (2021)

Total area

2776 km² (2021)

Municipal Budget

26.8 million (2021)

GHG inventory available since

2005

Figure 1. Geographical map of the island of Taiwan

Since Typhoon Morakotin in 2009, the Pingtung County Government has been working to boost green power development and improve the sustainability of land use in the county. Pingtung is the only county in Chinese Taipei committed to becoming 100% renewable. Its goal is for citizens to use 100% green-powered electricity as the first step in the energy transition. Currently, setting up solar photovoltaics (PV) zones in subsidence areas is a key strategy to ensure sustainable land use while achieving its green energy target.

Introduction

Pingtung County is located in the southernmost tip of Chinese Taipei. It covers an area of 2,276 km², with a length of 112 km (National Statistics, 2021). With such a long and narrow territory separated by the Mountain Da-Wu, the county landscape features mountains and hillsides to the East and a plain to the West, which is where the population and developments are concentrated. There are 33 towns and cities in Pingtung County, with a total population of around 810,000 (Pingtung County Government, 2021a). Pingtung has a tropical climate, with average annual temperatures hovering around 25°C.

Agriculture is the primary economic activity in Pingtung County, supporting the livelihoods of 380,000 people, with its annual production being the second highest in Chinese Taipei. These activities include agriculture, forestry, fishery, and animal husbandry. Since its main activities are traditional industries, the county's greenhouse gas (GHG) emissions in 2019 were about 6.09 tons of CO₂e per capita, which is far lower than the Chinese Taipei average of about 12 tons of CO₂e per capita (Environmental Protection Administration Executive Yuan, 2019). Even though the county has relatively low GHG emissions, to achieve the targets under the Sustainable Development Goal (SDGs), Pingtung aims to develop renewable energy and improve its resilience in response to climate change.

Located south of the Tropic of Cancer, Pingtung is naturally endowed with a high solar potential, which sets the foundation for its sustainable solar energy development. There is sunshine for over 300 days per

year, with an average of up to 4.7 hours/day, which is much higher than the global average (Global Solar Atlas, 2021). As a result, photovoltaic plants and solar thermal systems perform well in the area.

Pingtung demonstrates its determination to facilitate transformative changes and share this frontline potential worldwide by shifting to the sustainable use of renewable resources. Through its strong commitment to renewable power, Pingtung has been developing visionary pathways to a clean energy transition. The Pingtung government started its energy transition with solar and biogas projects. The county has taken the lead in promoting renewable energy in Chinese Taipei and has selected suitable locations to set up solar PV facilities with the vision to achieve 100% renewable energy for livelihood use.

Further, to achieve community-wide 100% renewable energy use by 2022, Pingtung County joined the 100% Renewables Cities and Regions Network. As a result, Pingtung County set up a "Green Energy Promotion Office," the first such office in Chinese Taipei, in 2016 to integrate all the different sectors into one unit and be the main window between stakeholders and the government promoting solar PV projects on non-arable land. This constitutes the first short-term goal to make citizens use 100% renewable energy for their livelihood.

Throughout the Severe Subsidence Area (SSA), Gaoshu Photovoltaic Demonstration, and Multi-function Land Use projects,

sustainable land use was promoted while achieving Pingtung's renewable energy target. Around 3,800 ha of 13,000 ha were selected as non-arable land for installing solar PV power plants. Some of this land was the site of previous illegal mining, other sites support solar PV installations without modifying the original use of the land (e.g. on water bodies). As of today, renewable

energy sources in Pingtung County generate 140,000 GWh of electricity a year and can support the needs of 75 percent of the county's households. By the end of 2022, the installed capacity would go from 777 MW to 1 GW, satisfying the target of livelihood use powered by 100% renewable energy (Taipei Times, 2022; Pan, Lu, & Yen, 2022).

Non-arable land for solar energy harvesting

Pingtung's unique approach relies on the use of non-arable land for siting solar energy projects. Agriculture in Pingtung still relies heavily on traditional methods. These poor agricultural practices have led to subsidence in the soil stratum due to the over-extraction of groundwater for irrigation and fishing over decades, especially in the coastal areas that have now been classified as "severe stratum subsidence areas".

During Typhoon Morakot in 2009, towns and villages in the subsidence area along coastal sides of Pingtung were the first to take the brunt. Heavy storms and landslides nearly destroyed fish farms and plantations, and villages suffered from power outages. Although the flood was fought fast, the soil was salinized by seawater and lost its properties, making it unsuitable for farming.

Initially, in order to help residents restore their land and livelihoods, the Pingtung County Government initiated a project named "Aqua Solar Farm" that integrated PV investors and landowners to install PV power plants on non-arable lands. The Green Energy Promotion Office set the goal to replace the traditional power supply with renewable energy for the demand of 286,000 households in the county (about 156,000 GWh annually) (Pan, Lu, & Yen, 2022).

The solar energy potential in Pingtung is not only limited to subsidence areas but also includes illegal abandoned mining sites and

underutilized land such as embankment areas. In the same vein of reconstructing destroyed areas and the restoration of land (groundwater conservation), the Pingtung County Government promoted its two strategies, the "Severe Subsidence Area Project" and "Multi-function Land Use", while satisfying the need for electricity.

Photovoltaic systems in subsidence areas

The "Severe Subsidence Area Project" was launched in August 2019 to promote the installation of solar systems on non-arable land. The project builds solar photovoltaic facilities in subsidence areas that are no longer suitable for cultivation or fisheries. As such, it allows landowners to earn an income from leasing out their land for energy generation while giving the land time to recover from salinization. Naturally, it also supports the county's sustainable energy transition and its achievement of its renewable energy target.

In 2005, four townships—Donggang, Linbian, Jiadong, and Fangliao—were identified as Severe Subsidence Areas (SSA) by the national Water Resource Agency after farmers over-pumped groundwater for aquaculture, making the land unsuitable for agricultural activities (**Figure 2**). These areas were designated as special districts to install photovoltaic power plants (PV zones) (Pingtung County Government, 2021b). Through the Aqua Solar

Farm and the SSA Projects, Pingtung County Government aimed to assist the residents in establishing an alternative source of income through renewable energy generation, creating a win-win scenario for solar energy businesses and local communities.

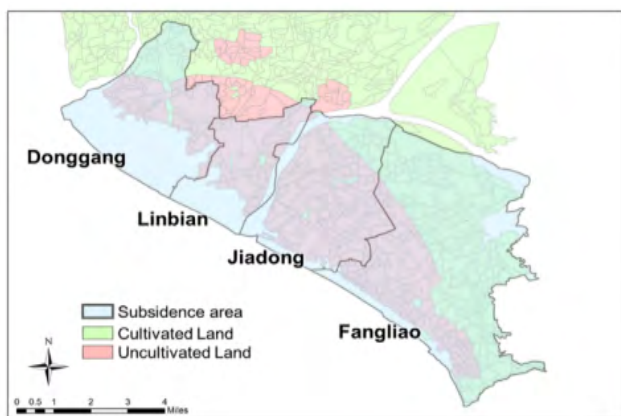


Figure 2. Map results for non-arable farmland. Source: (Pan, Lu, & Yen, 2022)

Of the suitable nonagricultural lands in the selected coastal townships, a total of 3,800 ha were designated to implement the SSA Project

(Pingtung County Government, 2021b). According to the government energy utility Taipower, this area had up to a 1 GW grid connection potential. Therefore, four Ultra High Voltage (UHV) booster stations were constructed with a total capacity of 140 MW officially generating electricity, supporting overloading risks avoidance in the transmission operation system (Pan, Lu, & Yen, 2022). Located at the center and spreading out 3 kilometers, the different installed PV sites are distributed close to the booster stations and away from a highly populated area as shown in **Figure 3** (Pan, Lu, & Yen, 2022). The highest booster station is elevated to guarantee the protection of the system against floods.

In 2020, the company Ysolar began the installation of a 99 MW solar PV power station in Jiadong after two years of negotiation with more than 1,000 landowners to obtain 242.5 hectares of land (Liao, 2020). Obtaining approval from farm owners was the largest challenge facing solar energy development. According to Liao (2020), the company offered a 20-year lease and NTD 400,000

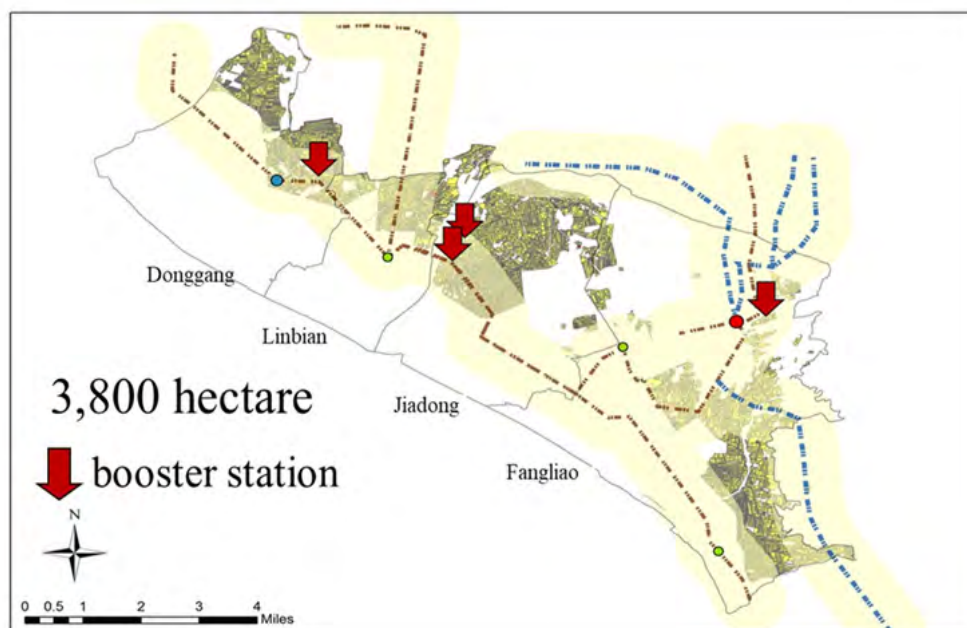


Figure 3. Potential sites for SSA project. Source: (Pan, Lu, & Yen, 2022)

(approx. USD 13,300) for every 0.96992 hectares of land for the right to use the land for solar PV energy generation.

A ‘zero-budget’ promoting model was used as a unique strategy to promote renewable energy in the SSA project, as the project started with no financial support (**Figure 4**). The Green Promotion Office plays the role of an integrator in this model. The mission was to attract PV investors to engage in the project through incentives—reduction in fees, streamlined administrative processes—and ensure the rights of landholders through an administrative contract. Obtaining approval from farm owners is usually the largest challenge facing solar energy development. The project established a communication platform between a few qualified and competent PV manufacturers and landowners, while ensuring the rights and obligations of both stakeholders through the administrative contracts. This enabled landowners and PV manufacturers to pursue their private interests while also cooperating with the promotion of Pingtung’s green energy policy while pursuing comprehensive social interests (Pan, Lu, & Yen, 2022). Furthermore, an administrative contract was created to require the investors to return 2 percent of profit earned due to the feed-in tariff policy to the Green Energy Fund. Furthermore, the Office set up a trust fund for each landholder to ensure their rights for 20 years.

The SSA project not only set up PV plants but also provided the extra advantage of restoring the environment. Due to the SSA project, land that used to be a crop farm or a fish farm was replaced by solar panels, which reduced the amount of groundwater pumped for farming. Of the total 140 hectares on which the SSA project was carried out, 110 hectares was non-arable land, with about 30 hectares being former fish farms. The total reduction in groundwater extraction is estimated to be 3.93 million tons over 20 years (Pan, Lu, & Yen, 2022).

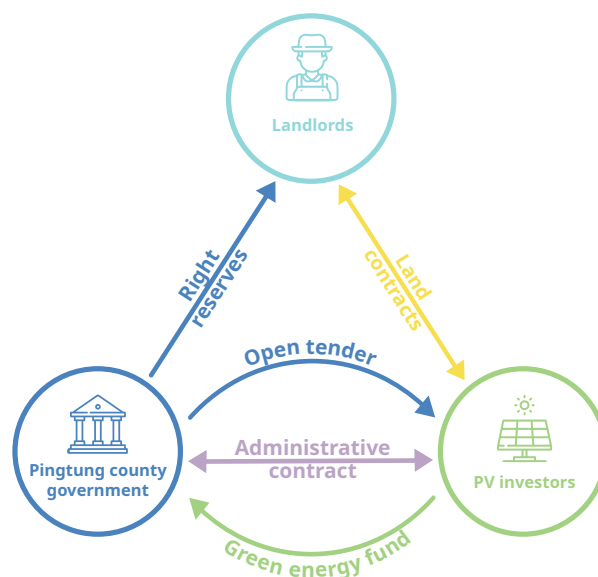


Figure 4. Zero budget promoting model for SSA project. Adapted from: (Pan, Lu, & Yen, 2022)

Reclaiming abandoned mining sites

Similar approaches were tried on other barren and waste lands, such as illegal mining sites. The consequences of illegal gravel mining over two decades ago in Gaoshu Township, the northernmost administrative area of Pingtung County, is evidenced by many large pits on numerous parcels of publicly owned land which compromised the quality of land for agricultural purposes. This was unfortunately made possible by the land’s remote location and lax supervision, resulting in frequent illegal dumping of garbage, debris, and waste, which resulted in serious environmental damage (**Figure 5**). Despite a concerted 5-year effort by the Pingtung County Government and the National Property Administration of the Ministry of Finance (NPA) to backfill the sites with earthworks provided by the Water Resources Agency of Ministry of Economic Affairs (WRA) from dredging operations, the land remained largely unused due to poor soil and lack of irrigation infrastructure for agricultural use.



Figure 5. Illegal mining causing serious environmental damage. Source: (The Central News Agency, 2021)



Figure 6. Gaoshu PV Demonstration Project. ©Pingtung County Government

It was not until 2017 that the county government, in view of its overall development plan, signed a contract with the NPA to enhance the use of the land and jointly created the Gaoshu Photovoltaic Demonstration Project (**Figure 6**), converting agricultural land that was not suitable for farming into sites for renewable energy production. This has rehabilitated the formerly damaged land by gradually transforming them into a clean and low-carbon green energy demonstration area, designated as a special PV zone. The project completed the first phase in April 2017 with an installed capacity of 1.9 MW. It is estimated that the total installation capacity will reach 37 MW, equivalent to providing 12,600

households with electricity and reducing carbon emissions by 24,000 metric tons. The demonstration zone expects a private investment of NTD 1.32 billion (approx. USD 44,000) for the local area, with a total output value of NTD 4.11 billion (approx. USD 137,000) and provide 220 job opportunities. (Pingtung County Government, 2021c).

Through the Gaoshu PV Demonstration Project Zone, 112 state-owned properties are expected to have photovoltaic installations completed by the end of 2021, with a combined total of 40.9 MW capacity connected to the main grid (**Figure 7**) (Energy Trend, 2021; Pingtung County Government, 2021c). It is hoped that

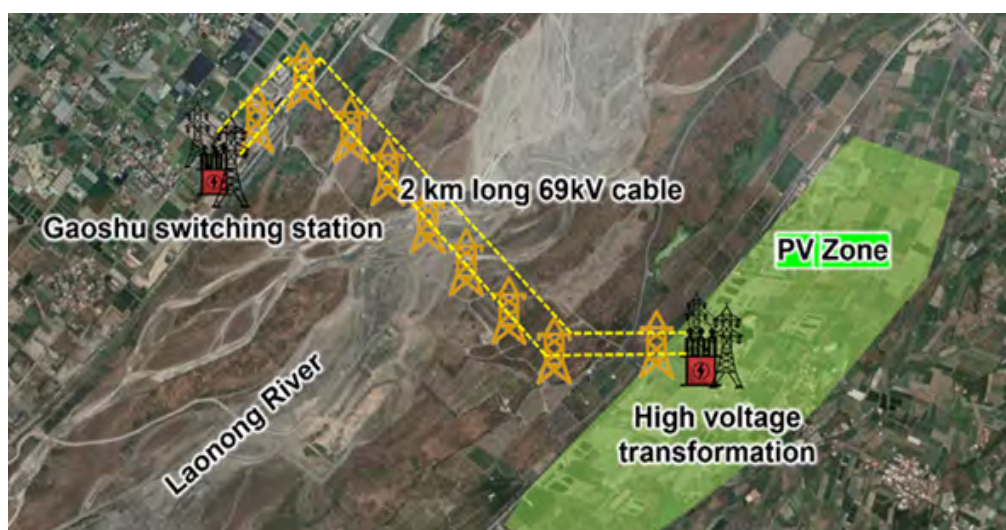


Figure 7. Transmission tower across river for 2km to merge with the main grid. ©Pingtung County Government

around 160 hectares of state-owned and private land in the vicinity will be eventually converted and connected, thus transforming land unsuitable for agriculture into areas of renewable energy production with a cumulative capacity of 200 MW (Energy Trend, 2021; Pingtung County Government, 2021c).

Multi-function land use for PV deployment

In the active search for available unutilized space to increase solar PV capacity in alignment with the its energy targets and policies, Pingtung County developed a Multi-function Land Use project that aims at effectively utilizing available spaces in public facilities (examples are shown in **Figure 8**). This includes floating PV on ponds, PV panels on dikes, landfills and covered courtyards at schools. The project allows for the installation of renewable energy without affecting the functions of the original facilities.

The Pingtung County Government completed the installation of a photovoltaic system along the 2 km dike of the Lili River in 2019, making it the first of its kind in Chinese Taipei. Despite the difficulties involved in power generation via river dikes due to the high safety requirements, the power generation facility has a capacity of 2 MWp and an average daily power generation of 6.5 MWh, which can meet the residential electricity demand of approximately 322 households (Pingtung County Government, 2021d). An expansion of the system is planned for an additional 2.5 MWp, which is expected to generate 8.5 MWh of electricity per day, or enough power to supply electricity to 850 households (Hsinchen & Xie, 2020).

The first floating PV device with an installed capacity of 499 kW was built in Chinese Taipei in 2016 in accordance with the Electricity Act, which established a more complicated application procedure for a PV installed



Figure 8. Methods of combined use of solar PV capacity for various types of land. Source: (Pan, Lu, & Yen, 2022)

capacity plant over 500 kW (Pan, Lu, & Yen, 2022). The success of such floating PV power plants can help increase interest in similar projects worldwide. Some additional benefits of floating devices are that the systems can

co-exist with animals. Birds can find shelter under the panels to build nests (**Figure 9**). PV panels can reduce water evaporation by 70%, and the water cools down the system making it around 10% more efficient.

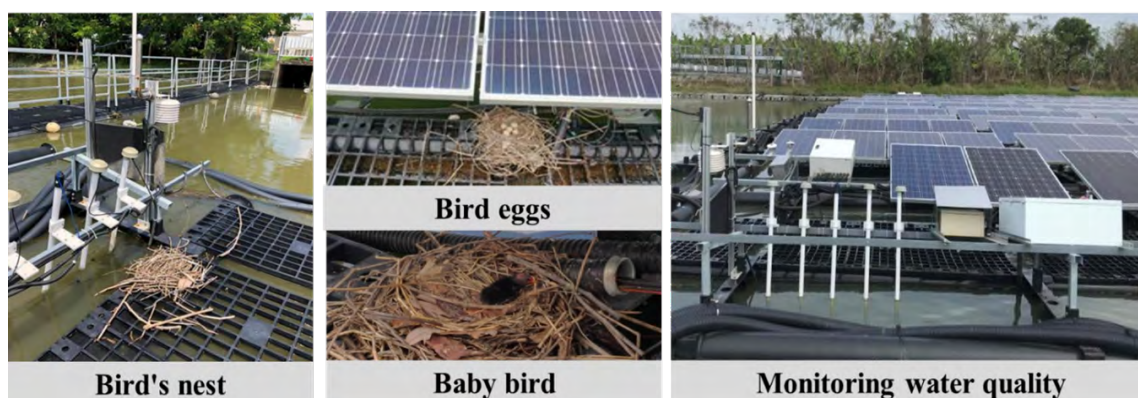


Figure 9. Eco-friendly floating PV device. ©Pingtung County Government

Policies and enabling frameworks that support the PV development

The installed capacity of renewable energy in Pingtung is currently 777 MW (Pan, Lu, & Yen, 2022). The annual renewable energy generation is 128,000 GWh/year, sufficient for the use of 235,000 households (Pan, Lu, & Yen, 2022). Steady progress has been made over the past ten years, especially after 2016 when the first Green Energy Promotion office was established. As of 2021, the installed capacity is almost seven times higher than in 2016 (**Figure 10**).

The implementation of PV projects in Pingtung is supported by some enabling policies and frameworks. The creation of a single-window clearance office was crucial for streamlining engagement between stakeholders and the government.

Collaboration across multiple levels of government was also fruitful. The Gaoshu Photovoltaic Demonstration Project was a

collaboration between the Pingtung County Government and the National Property Administration, while also involved the Water Resources Agency.

Despite the land use designation being mainly for agricultural use in Pingtung, current planning includes prioritizing solar PV installations to support the achievement of the renewable energy target in underutilized areas. Hence, the legal framework includes “Regulations for the Examination of Applications for the Use of Agricultural Land for Agricultural Facilities,” where Article 30 enables the reuse and revitalization of idle land as landowners can “permit” the set-up of photovoltaic installations. Therefore, solar power can be set up without changing the land use registration, meaning that landowners do not have to pay the “change of agricultural land-use” rebates.

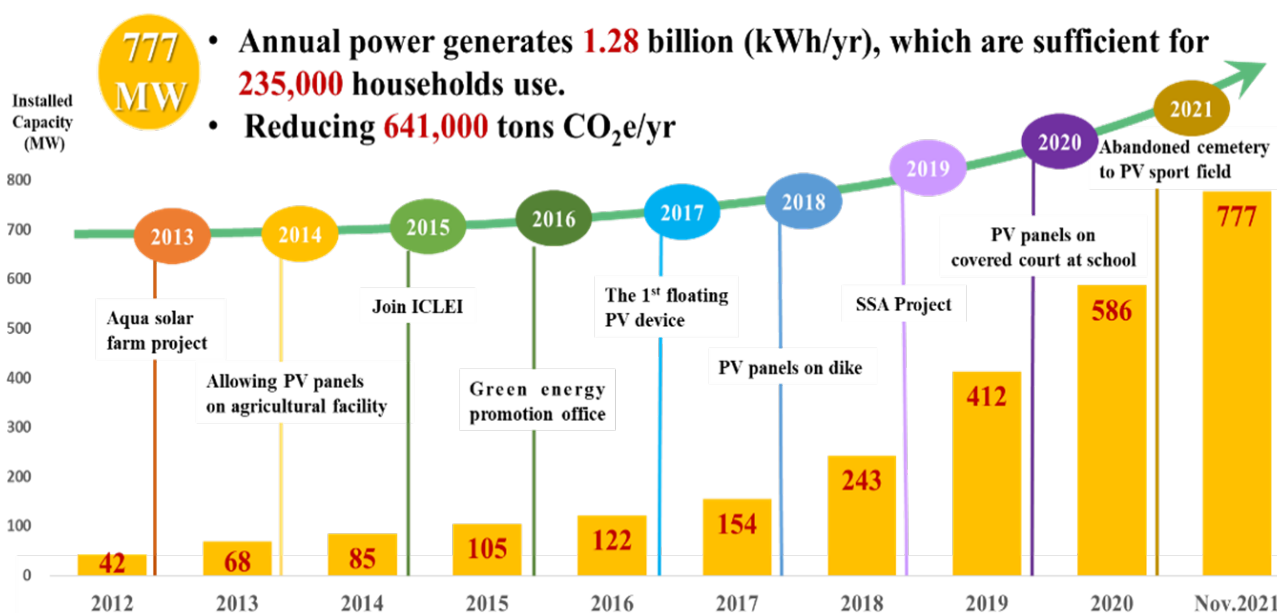


Figure 10. Installed capacity of renewable energy in Pingtung. Source: (Pan, Lu, & Yen, 2022)

In 2019, there was an amendment to the Electricity Industry Law. The power generation, transmission and distribution and electricity sales were separated from Taipower, the only energy provider in the country, moving towards liberalization of the electricity industry. According to the Renewable Energy Development Regulations, renewable energy can be traded in the form of green electricity, and every MWh of green electricity sold also means that the buyer will receive a renewable energy certificate (T-REC). Such measures can help entities essentially purchase the associated environmental benefits of renewable electricity, in addition to the electricity itself.

Since Chinese Taipei has a single power grid, Taipower will continue power distribution throughout the whole territory to stabilize the safety of transmission and backup capacity. Taipower will also promote Automatic

Frequency Control (AFC) for energy storage from 2020. By having the characteristics of a fast charge and providing energy to adjust the frequency, the power system can increase efficiency and help maintain the stability of the power supply. For instance, the Gaoshu PV zone can apply for green energy certificates and AFC services in energy transformation. Through the establishment of AFC, the system helps to maintain the stability of the domestic power supply system.

In the future, renewable energy can continue to be combined with local activities. Plantations of agricultural products, such as pineapple, papaya, and taro, as well as some local Hakka cultural settlements, can be planned to become renewable energy and environmental education parks. This can create a win-win scenario for local employment and sustainable development.

Lessons Learned from Pingtung's 100% RE Strategy

A number of lessons learned can be drawn from Pingtung County's experience in how to promote the deployment of renewable energy and working around land use limitations.

Zero Budget Promoting Model

A zero-budget promoting model was one such unique strategy to promote green energy by using economic incentives to attract PV investors, while ensuring the rights of landholders with an administrative contract. These incentives include reducing fees for land use and facilitating administrative process to speed up project development. Furthermore, an administrative contract was created to require the investors to return 2 percent of profit due to the feed-in tariff policy to the Green Energy Fund. A trust fund for each landholder was also set up in order to ensure their rights for 20 years.

Green Energy Policy

By instituting a "Green Energy Policy", the county's land-use plan accommodates diversified and multi-functional development in the local context by prioritizing the use of land not suitable for agriculture or abandoned public land for renewable energy generation. An enabling framework at higher levels of government has also allowed for smoother implementation.

Restoration of idle land

Siting for renewable energy can pose a challenge at times. The Agricultural Land Use Law allows the reuse and reactivation of idle land such as abandoned mining sites for energy generation through solar PV installations. The profit from producing power can generate income for the local government and the National Property Administration, which makes it an attractive approach for the private stakeholders and the government.

Additional income for landowners

Participatory approaches can also help secure livelihoods for farmers who are otherwise vulnerable. Pingtung's approach can help tackle issues caused by land subsidence, declining soil quality and urban migration through renewable energy projects. This provides an alternative source of income for the landowners as they await restoration of their land over 20 or more years.

Single window clearance

The creation of the 'Green Energy Promotion Office' has contributed greatly to streamlining administrative processes and exchanges between stakeholders on issues related to energy and the environment. Such an entity can facilitate access to information for all parties involved, speed up project timelines and in general improve investor confidence and enable access to finance and investment.

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The 100% Renewables Cities and Regions Roadmap project facilitates the energy transition by raising local awareness on renewable energy sources, showcasing how local and national governments can create coordinated enabling frameworks and policies, exploring access to public and private sector finance, and building local renewable energy projects to address electricity, heating and cooling.

The 100% Renewables Cities and Regions Roadmap project is implemented by ICLEI – Local Governments for Sustainability and funded by the International Climate Initiative (IKI), which is implemented by the Federal Ministry for Economic Affairs and Climate Action (BMWK) in close cooperation with the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) and the Federal Foreign Office (AA).



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