Session 3.5: Performance Review of Green Buildings (1)

Strategic Study on the Benefit Evaluation of Solar Photovoltaic Promotion Policy in Kaohsiung

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ABSTRACT

Kaohsiung City's urban landscape is adorned by its majestic mountain, streaming river, wavy ocean, and abundant sunshine. To further complement the city's vibrant atmosphere, the Kaohsiung City Government initiated a project to adjust its industrial structure to promote Kaohsiung as a green eco-city. The goal of the project is to provide a greener, safer, and most importantly, a more sustainable environment for Kaohsiung's citizens so as to create a truly happy and prosperous living environment.

To reach these goals, the Kaohsiung City Government took action with a series of policies to increase solar energy production. Firstly, it established an operating network by forming an inter-departmental task force to promote photovoltaic (PV) systems in the public and private sectors. It also linked professional organizations with local communities, and set up a dedicated hotline for consultation and inquiries. Secondly, it strengthened its photovoltaic infrastructure through formal statutes and regulations. This includes the announcement of a series of official solar photovoltaic policies, the promulgation of a floor area ratio incentive, and the enforcement of mandatory policies to increase photovoltaic implementation. Thirdly, it designated target sites to serve as examples of the project. This includes installing photovoltaic systems on public rooftops, building photovoltaic demonstration zones, transforming illegal structures into solar power providers, and assisting the fishing and agricultural sectors in building photovoltaic systems.

In total, Kaohsiung's 557 cases in 2015 oversaw an instalment capacity increase of 28,491 kW (or 28.491 MW), generated 37 million kWh of power annually, decreased carbon emissions by 23.3 thousand tons, and created a PV industry with a net worth of NTD 2,841.1 million. This study looks at the evidence of achievements the city has made promoting scientifically meaningful architectural aesthetics in its innovative green buildings and energy technology, as well as the success it has seen pushing the policies through a bottom-up structure. In conclusion, it can be said that, using a model based on a project developed by our institute, the Kaohsiung City Government has successfully made the renewable energy become an integral part of Kaohsiung's lifestyle, creating a threefold win for the government, the institute, and the people of Kaohsiung.

Keywords: solar photovoltaic, policy, suit locally, the city of green daylight, low carbon

1. INTRODUCTION

Despite having transformed itself from a wholly industrial city into a thriving metropolis, Kaohsiung City was still marked by its over-concentrated population, lack of green spaces, and excess of artificial heat sources. Kaohsiung is also much hotter compared to its neighbourhood areas, and its temperatures may well continue to rise while its humidity simultaneously lowers as Kaohsiung's population, commercial activities, and density in land use all continue to grow, leading the city to become what is commonly known as the urban heat island. As a result, increasing the city's green spaces has become a priority in its efforts to lower the rising temperatures.

Over the years, Kaohsiung City has gone through extensive measures to become its own city. Not only has it upgraded its hardware and software to create a healthy, sustainable, ecological, and cultural environment, it has also established itself as a diverse and sophisticated municipality, and rolled out innovative policies such as the Green Building Self-Governance Ordinance and the Regulations Governing the Establishment of Rooftop Solar Photovoltaic Systems so as to achieve its five core values of "ecology, economy, liveability, creativity, and

internationality." Its strategies, which have been widely recognized, also include inserting an aesthetic sense of technology into the city's photovoltaic systems, promoting innovative green buildings and renewable energy technology, and using a bottom-up incentive to encourage owners of illegal structures to spontaneously come forward. Evidence of the city's efforts can be identified throughout the city as the government continues to build a greener, healthier, and more sustainable city.

2. OBJECTIVES

Working in coordination with Kaohsiung's climate, the Kaohsiung City Government set the goal to generate 150 MW worth of solar photovoltaic power within four years. It set up an interdepartmental task force to collectively promote the photovoltaic systems within the following five categories: general constructions, public buildings, schools, factories, and fishing and agricultural facilities.

The Kaohsiung City Government set the four-year goal as a mean to fulfil its global responsibilities against greenhouse effect as well as to take care of its citizens in the long run by implementing its core values of bringing "ecology, economy, liveability, creativity, safety, and internationality" into their daily lives.

3. POLICIES AND STRATEGIES

With global warming on the rise, the Kaohsiung City Government was ahead of its time when it initiated its photovoltaic project prior to the promulgation of Taiwan's Renewable Energy Development Act. While the city's geological climate rendered it a suitable candidate for solar energy, the reality on the ground was that current building regulations, the conditions of existing structures, and the price of setting up photovoltaic panels had made it hard to promote solar power on a city-wide scale. Having identified these obstacles, the government saw a need to relax existing laws while aggressively pushing, promoting, and subsidizing photovoltaic constructions. It also listed the photovoltaic project among its priority policies for better effect. Therefore, the Kaohsiung municipal government proposed the four year plan and the specific ten action plan. (Table 1)

Creating an Operating Network	Appointing an interdepartmental task force.
	Giving local communities professional assistance
	Setting up a dedicated hotline
Utilizing Policy as Promotional Tools	Formulating statutes and regulations
	Providing floor-to-area ratio incentives
	Making photovoltaic systems mandatory
Push the subject	Installing photovoltaic systems on public rooftops
	Building photovoltaic demonstration zones
	Transforming illegal structures into solar power providers
	Building photovoltaic systems in the fishing and agricultural sectors

Table 1: Kaohsiung government put forward the specific ten action plan

3.1 Creating an operating network

Appointing an interdepartmental task force

The interdepartmental photovoltaic project task force was established with Kaohsiung deputy mayor as convener, deputy director general of the Secretariat as deputy convener, and the Public Works Bureau as chief managerial office. The task force is in charge of supervising the promotion of the photovoltaic project within the five categories of general constructions, public buildings, schools, factories, and fishing and agricultural facilities. The major and assisting offices in charge of the categories (as shown in Figure 1) work together to fulfil the city's innovative vision.

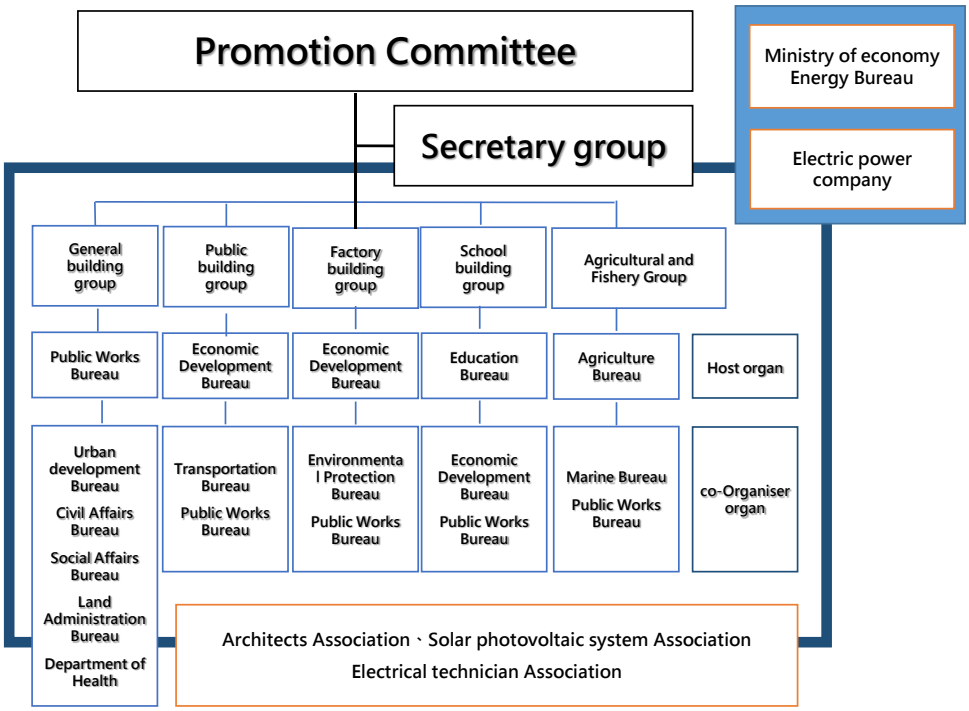

Figure 1: Plans to promote the organization chart

Giving local communities professional assistance

To promote widespread installation of photovoltaic systems across the city, the Kaohsiung City Government sought the assistance of professional associations (Figure 2). This includes the Kaohsiung Architects Association, the Kaohsiung Professional Civil Engineers Association, the Real Estate Development Association of Kaohsiung, the R.O.C. Solar Photovoltaic System Trades Association, the Taiwan Professional Electrical Engineers Association, the Taiwan Photovoltaic Industry Association, the Taiwan Electrical Contractors Association, and the Taiwan Solar Thermal Energy Association. In addition to signing official MOUs with the associations and hosting public briefing sessions to provide more information for the public, the government set up a platform to help pair citizens interested in installing photovoltaic systems with suitable vendors.

Figure 2: Combination of professional groups and community participation in the operation of the photovoltaic project.

Setting up a dedicated hotline

A dedicated service hotline was set up so as to increase the efficiency and efficacy of installation requests. The service hotline not only takes inquiries and applications, but it is also in charge of collecting statistics and data.

3.2 Utilizing policy as promotional tools

Formulating statutes and regulations

The Kaohsiung City Government has since 2012 formulated four architectural laws governing the instalment of photovoltaic systems. The laws were created so as to promote the generation and utilization of the renewable solar energy.

In 2014, the laws were incorporated into a comprehensive project consisting of six laws, a platform pairing individuals with professional instalment vendors, and a subsidization program. Through the formulation, execution, as well as review and revision of these statutes and regulations, Kaohsiung's solar photovoltaic systems, intelligent energy management operations, and green building standards have been significantly improved. As the scale of income from promoting green buildings grows, the city is able to continue expanding solar power instalments and energy-saving buildings.

Providing floor-to-area ratio incentives

Another important promotional policy is the floor-to-area ratio (FAR) incentive. Areas with lower FARs will be granted a 30 percent FAR incentive with the instalment of photovoltaic systems. This allows areas consisting mostly of low-rise buildings become so-called "sunshine communities." Meanwhile, residential areas with an FAR of 180 percent must install a rainwater storage capacity that is at least 0.132 times the measurement of the area, build a green roof, or install photovoltaic panels that generate more than 2 kW power per building.

Making photovoltaic systems mandatory

The Kaohsiung City Government was able to make photovoltaic instalments mandatory in urban areas, open spaces, and the Kaohsiung LOHAS Housing Project by providing construction businesses with incentives during the initial reviewing stages in urban design projects and the licensing review of construction permits.

3.3 Designating exemplary demonstration sites

Installing photovoltaic systems on public rooftops

As action always speaks louder than words, the Kaohsiung City Government took the lead to install solar photovoltaic systems on the roofs of government buildings and public schools using a rental program. In having vendors set up the solar panels, the government is estimated to have saved around NTD 500-700 million in installation and maintenance fees. In addition to giving the city solar energy, the model also creates economic value for the local solar power industry, and at the same time serves as an example of the project's benefits, attracting public attention and recognition. In doing what's best for the environment, Kaohsiung increases its use of renewable energy, helps the solar photovoltaic related industries grow, and ultimately strengthens the city's economic structure and overall competitiveness.

Building photovoltaic demonstration zones

The Kaohsiung City Government has chosen the area surrounding the Pier-2 harbour, the Jhongdou redevelopment zone, and the area of the 2014 Kaohsiung gas explosions as the city's photovoltaic demonstration zones. The goal is to gradually have the installation of photovoltaic systems expand around the zones and ultimately link up to form a photovoltaic power city.

Transforming illegal structures into solar power providers

Kaohsiung City prides itself in its counselling rather than punishing attitude when it comes to illegal structures. It encourages owners of illegal structures to convert their illegal rooftop dwellings into photoelectric facilities (Figure 5). It also provides loans and subsidies as incentives to increase interest as well as lower installation thresholds.

The new structures, on the one hand, help solve the two most common problems seen in illegal rooftop dwellings, i.e. leaking and overheating, and on the other hand, can be legally built with an additional sunroom compartment. While the city is significantly beautified, the power generated can be sold to the Taipower Company for additional income. As a result, the original hot and stuffy city has the opportunity to be transformed into a pleasant and a steady provider of renewable energy.

Building photovoltaic systems in the fishing and agricultural sectors

Kaohsiung encourages its farmers' associations, traditional wholesales markets, animal protection units, agricultural facilities, and 95 livestock and poultry farms to install solar photovoltaic systems. It is also working with the various agricultural and fishery associations in encouraging the conversion of idle building rooftops into solar panel units.

4. RESULTS

Due to the nature of its development, Kaohsiung City's heavy-industry based economy has come with the price of serious air and environmental pollution. According to statistics, Kaohsiung's annual carbon emissions of 97 million tons make up 25 percent of the nation's total. What's more, each citizen's personal carbon emission is 2.67 times the nation's average. Nonetheless, the city's 2015 statistics show that the 557 photovoltaic application cases successfully created an instalment capacity of 28,491 kW (or 28.491 MW), generated 37 million kWh of power annually, decreased carbon emissions by 2.33 million tons, and created a PV industry with a value output of NTD 2,841.1 million.

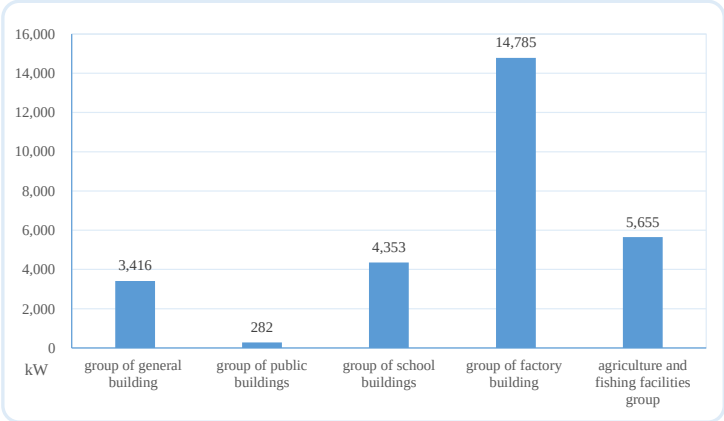

Figure 3: Various groups have been set up photovoltaic capacity

As indicated in Figure 5, factories have the largest photovoltaic power output at 14,785 kWp; fishing and agricultural facilities come in second at 5,655 kWp. It can be said that these traditionally high carbon emission industries are now fulfilling their social responsibilities in reducing greenhouse effect.

Shown in Figure 4, Kaohsiung City, the implementation of the solar photovoltaic policy has a number of specific implementation of the case, According to the situation of different groups, The presentation of the optoelectronic aesthetics of different buildings, Not only create a new state of the city state, Kaohsiung is also the specific contribution to the global energy conservation and carbon reduction.

(a) General constructions

(b) Factories and traffic facilities

(c) Public buildings

(d) Agricultural and fishery facilities

(e.) School buildings

Figure 4: Example of solar photovoltaic systems installed in various types of buildings

5. STAGE CONCLUSION

With the combined use of six laws, one subsidy plan, and one pairing platform, Kaohsiung City's solar photovoltaic project has been deemed a success. According to statistics, the city is estimated to see photovoltaic output of at least 30MW annually. The new regulations have also helped increase the overall number of green buildings in Kaohsiung. Kaohsiung's creative and diverse efforts to create a greener city have set an example of what could be achieved. It's achievements between 2000-2016 (as of May) are as follow:

- The total of 3,027 applications has a joint capacity of 152,615 kW (152.615 MW), generates 180,741 kWh annually, has reduced carbon emissions by 15,366 tons, and has created a NTD 15.26615 billion output value for the photovoltaic industry.
- With the talk of an international carbon tax of NTD 1,940 (EUR 50) per ton of emission likely to become a reality, Kaohsiung City's estimated 30 MW annual photovoltaic output may help lower carbon emissions by 24,276 tons per year. This would amount to saving NTD 47.1 million annually, and a cumulated NTD 924 million in 20 years.
- The cost saved from having to dismantle illegal rooftop structures, including paying personnel fees, dispatching vehicles, and processing construction waste, is estimated at NTD 135 million per year, which adds up to NTD 27 billion in 20 years.
- As the metal roofs of illegal rooftop structures are converted into solar panels, sunshine is absorbed and transformed into electricity, resulting in a drop in the city's scorching temperatures.
- The photovoltaic project's annual value output of NTD 20 billion helps increase employment opportunities.

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