The Empowered Policy and Actions on Kaohsiung City's Skyline Transformation by Photovoltaic Roofs

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Abstract

Kaohsiung city was a heavy industrial city and the rapid development after 1960s comes from the industrial workers to build the typical row houses in the city center. The building type looks like the semi-modern building with flat rooftop as the rescue deck. However, the climate situation in Kaohsiung is hot and humid with strong sunshine and heavy rain, it cause the damage of the rooftop for the performance reduction effect both in thermal isolation and the waterproof. Therefore the inhabitants of Kaohsiung are always set the illegal metal huts above the flat rooftop.

Kaohsiung City Government takes the advantage of geography to promote photovoltaic policy, which breaks the limitations of central statute to implement six innovative PV law instruments first in Taiwan. The new policies include Kaohsiung City Roof Photovoltaic Equipment Installation Regulations, Kaohsiung City Green Building Self-Governance Regulation, the Photovoltaic Intelligent Building Certificate Regulation, implementation of the Installation of Photovoltaic Power Generation System in Buildings, and PV Facility Promotion Team Establishment Guidelines. These encourage the public to establish photovoltaic and transform rooftops into a base for clean energy and also to improve the quality of urban landscape.

Keywords: Self-Governance Regulation, Skyline Transformation, PV.

1. Introduction

Kaohsiung city is located in a subtropical area and having the climate characteristic of high-temperature and some disasters. In order to solve the problems of leaking

roofs and over heat of top units, the inhabitants often build illegal constructions of metal huts privately. However, the climate situation in Kaohsiung is hot and humid with strong sunshine and heavy rain, it cause the damage of the rooftop for the performance reduction effect both in thermal isolation and the waterproof. Therefore the inhabitant of Kaohsiung or in Taiwan they are always set the illegal iron roof above the flat rooftop. (Figure 1) The city statues cause the damage about the urban landscape and public safety, which demand to develop with a positive guidance.

From the year 2012, the Public Bureau of Kaohsiung City Government started the program of “Kaohsiung City’s Green Building Self-Governance Regulation” to enhance the environmental oriental green building development which can deeply reflect the local issues of urban and rural development. The strategy on promoting the installation of PV-roofs that was directly transformed the skyline patterns from illegal iron roofs to approved PV roofs. Moreover, it shows the content and construction of this empowered policy by this Regulation, the mechanisms of expanding public participation by integrating industry, government and academia.

Fig. 1. the landscape view of illegal metal huts skylines

2. Project based Policy for Demonstration

2.1 Photovoltaic promotion project

Aged buildings account for 97% of all domestic buildings. To avoid the illegal construction of metal huts and to transform rooftops into a base for clean energy, the public is encouraged to establish photovoltaic. The following environmental protection measures are emphasized for promoting rooftop photovoltaic: (Figure 2)

- Transforming illegal constructions and striving for urban beautification, thereby enhancing industries and creating business opportunities.
- Vitalizing landfills as photovoltaic bases.
- Combining agriculture facilities with the self-sufficient electricity concepts of farms.
- Integrating and collectively establishing photovoltaic communities.
- Adopting building-integrated photovoltaic as a diverse environmental protection measure, thereby effectively establishing thermal insulation and

waterproof functions, decreasing CO₂ emissions, and achieving the goals of environmental protection and energy saving and carbon reduction.

The promotion results from 2011 to 2012 show the great successful achievement within 508 cases applied for photovoltaic installation in the installation capacity of 21,968 kWp; annual power generation capacity of 27,815,550 kWh; and carbon reduction amount of 17,810 tons, which is equivalent to the amount of carbon absorption for a 885 hectare forest. (Table 1) In addition, the usable rooftop area increased by 264,464 m². Statistical predictions indicate that Kaohsiung City will establish a minimum of 10MW of photovoltaic power annually; thus, decreasing the consumption of air-conditioning electricity by 22.95 million kWh and saving NT\$57.37 million each year. Furthermore, the temperature for the top floor will decrease by approximately 3°C, saving an additional 30% of air-conditioning electricity.⁽¹⁾

Fig. 2. Transforming illegal constructions and vitalizing landfills and agricultural facilities

Table 1. Comparison between the photovoltaic power carbon reduction in 2011 and that estimated for 2012.

Year	Total generating capacity (kWp)	Generating capacity (kWh/year)	CO ₂ emission reduction (ton-CO ₂)	Reduction ratio (in comparison with former year)	Equal to Greenery of Kaohsiung Metropolitan Park
2011	6,633	8,616,300	5,400	—	5.0
2012	15,335	19,920,160	12,410	229 %	11.5
Total	21,968	27,815,500	17,810		

2.2 Green roof improvement project

As a response to urban disaster prevention challenges such as sudden torrential rain caused by climate change, and to achieve energy saving and carbon reduction, and enhance the feasibility of transforming urban landscapes, the green roof improvement project was conducted. Test results prove green roofs to be effective in thermal insulation, temperature reduction, and air-conditioner usage decrease. In addition, green roofs have the function of temporarily collecting water and delaying storm water runoffs, thereby mitigating the burden on urban drainage systems. The green roof improvement project was

implemented according to the following points:

- The 3D greenery of urban gardens and community consultation and explanation mechanism.
- Establishing a microclimate weather station for data collection, analysis and application.
- Establishing consultation enquiry, employing plant doctors, and providing technical service
- Establishing organic farming, promoting transformation, and supporting urban eco island hopping.
- Meta-analysis of benefits and R&D; thus, exerting maximum function of green roofs.

Fig. 3. The efficiency evaluation for the green roof of the pilot project

Fig. 4. The benefits of psychological healing, space integration and utilization, and social interactions

The green roof's practical benefits include disaster prevention and flood detention, carbon sequestration and air purification, urban heat island temperature reduction, and energy saving and carbon reduction through air-conditioning usage decrease. (Figure 3) Furthermore, the green roof has added values such as landscapes for leisurely activities, a natural attitude of lifestyle of health and sustainability, space reutilization, urban ecology diversity, and social interaction.

The goal for the green roof improvement project is to establish 35,000 m² of green roof coverage per year. Based on the calculation of a CO₂ fixation of 20 kg/m² for grass coverage, an annual carbon sequestration of 642 tons can be achieved. At the same time, Green roofs can be transformed into organic farms. (Figure 4) This self-sufficient life style and co-operation can improve the distancing between parent and child relationships and other interpersonal relationships that are a common phenomenon in cities.

3. Branded Policy promotion and overall mechanism establishment

The objectives of carbon and disaster reduction are achieved through stipulating Kaohsiung City Green Building Self-Governance Regulation that conforms to the City's needs, promoting an ecological city, constructing a green building environment, creating a healthy life quality, and supporting a green economy. In the proposed plan, photovoltaic construction, the practical construction of "Kaohsiung LOHAS" buildings, local academic research, the establishment of community workshops, and green roof improvement demonstrations are subsidized. Consequently, community construction is activated and a platform is available for collecting the consensus of social groups and community members. This down-to-up participation movement and the matchmaking mechanism have created a site for verifying and demonstrating the previously mentioned innovative laws and regulations.

Table 2. The relationship between strategic planning and innovative regulations in Kaohsiung

<i>Strategic dimension</i>	<i>Innovative laws and regulations</i>	<i>Execution direction</i>
Policy	Kaohsiung City Green Building Self-Governance Regulation	Integrate and regulate various types of buildings in Kaohsiung City in conformity with the green building strategy
	Kaohsiung City Roof Photovoltaic Equipment Installation Regulations	Loosening the installation criteria
Reward	The 2012 Public Works Bureau of Kaohsiung City Government Subsidy Project for the Implementation of the Installation of Photovoltaic Power Generation System in Buildings	Encourage citizens to install roof top photovoltaic power generation systems in buildings
	The 2012 Kaohsiung City Government Subsidy Plan for "Kaohsiung LOHAS" Constructions and R & D	Subsidize constructions, academic research, and the establishment of community workshops
Brand	Kaohsiung City "Kaohsiung LOHAS" Building Accreditation Application Regulation	Branding of the "Kaohsiung LOHAS" label
	Kaohsiung City Photovoltaic Intelligent Building Certificate Regulation	Branding of the "Photovoltaic Intelligent Building" label
Integration	Kaohsiung City Government Photovoltaic Facility Promotion Team Establishment Guidelines	Promote the installation of photovoltaic facilities on buildings in Kaohsiung City and assist citizens in applying for installation
	Public Works Bureau of Kaohsiung City Government Sustainable Green Building Operation Fund Establishment Guidelines	Manage Kaohsiung City's Sustainable Green Building Operation Fund
	Kaohsiung City Government Green Building Technique Review Committee	Review questions regarding provisions for green building strategy regulations
Sustainability	Kaohsiung City Sustainable Green Building Operation Fund Revenues and Expenditures and Utilization Regulation	This fund is established as a response to disaster prevention, low carbon environment, and building development demands to create a sustainable and intelligent healthy green building environment.

The Photovoltaic Intelligent Building Certificate and Kaohsiung LOHAS Building Label were established through branding; thus promoting energy saving and carbon reduction, enhancing disaster prevention industries, and increasing opportunities for building designers. There are more and more private construction companies to join the programs and the roof garden of the high rise buildings in Kaohsiung now become an extra living space for the buyers to share the good quality. At the same time, the company also gets the high reputation than before, because they are now the green developers. Table 2 shows the relationship between strategic planning and innovative regulations in Kaohsiung, the reward and brand effects do really help the policy to step further than before.

4. Push and pull mechanism by professional advising team

In the beginning the new policy was announced in 2011, there were few projects can catch-up the Kaohsiung City Green Building Self-Governance Regulation to do the design. Therefore, the Kaohsiung city government first starts to make the demonstration from public building. The fine art museum was the first one to demonstrate the green roof in large scale, and the new building of Fisherman's Wharf market place was identified as the first pilot project to adopt the PV panels with the electricity business. However, the private sectors also stand wait and see the acceptance of market. After the surveys to the private sector, the professional committee found out some

Before renovation (illegal)

After renovation (legal)

The new community project by private sector

Fig. 5. The pilot projects of PV roof demonstration

Fig. 6. The pilot projects of green roof demonstration (left: Private high rise building, Right: the PV urban farming at the rooftop of Sanming district office)

joint-key points to let the policy to be easy practice. 1. The education program from pilot project using the power of press. 2. To establish the service window helping the administrative process and the conjunctions. 3. To set the professional service team from academic sector to help the citizens get the free professional evaluation. 4. To establish the qualified design groups to help the citizens making the renovation plan. Figure 5 shows the first pilot project served by professional team and arising the interests of PV roof renovation. Figure 6 shows the pilot projects of green roofs.

5. Discussions and future perspectives

The policy started from 2011 and the promotion of the skyline changes attracted some of the inhabitants to start the pilot projects. The strategy has put in the regulation for the new constructions in Kaohsiung, and forced the factory and residence above 5000 m² to install the PVs or green roofs. In the beginning, some of the industries have the complaints about the Kaohsiung city government for this policy. After some benefits from the pilot projects and the feedbacks from the electricity company and encourage processes, the policy now has been accepted in a growing progress. However, as the wholesale price of the electricity from the PVs getting lower and lower, the future step of the policy should focus on the holistic services by the government and the new encouragement by the social awareness with the self-labeling system. The processes of Kaohsiung city government now become the demonstration for the other city in Taiwan, and the courage to challenge

the regulation by the central government also provide the new window for the local self-governance thinking in Taiwan.

Consequently, the employment rate in Kaohsiung City is increased and citizens who reside in other parts of Taiwan exhibit greater opportunities and willingness to return to Kaohsiung for work. We anticipate that Kaohsiung City will become a livable ecological city, and we endeavor to create a healthy living environment that is capable of carbon and disaster reduction. The annual carbon reduction goal is set at 12,360 tons, and the estimated carbon reduction amount after a decade is 123,600 tons. (Figure 7)⁽²⁾

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Fig. 7. The contributions of the action plan in these two years

Green industry	The number of increase in job opportunities per case (year)
Solar power services	approximately 350
Green roof services	approximately 210
Green building services	approximately 1200
Community workshops	248
Academic researchers	53
Total	2061