



# The Miracle of Green Energy

Taoyuan, Taiwan



©Taoyuan City Government

## The Gate of Taiwan: Taoyuan City

Surrounded by mountains and the ocean, the city of Taoyuan, has a distinctive nature and cultural environment. Thanks to the geographical location, Taoyuan is also known as the gate of Taiwan and the axis of Asia. The city was upgraded to a first-level administrative district in 2014 and is now the sixth and the youngest municipality of Taiwan. The 32 industrial zones within the city contribute substantially to the country's output value each year, making it the No.1 production center and economic window of Taiwan. With its efforts to continuously expand its development and recruit business in recent years, Taoyuan has succeeded in attracting a number of global enterprises, such as Apple, Cisco, Google and Microsoft, to invest in the region. Nevertheless, this has also resulted in relatively higher energy consumption in Taoyuan compared with other regions in the country. Taking electricity as an example, the municipality's electric energy consumption is about 13.6% of the country's total, forcing the city to consider solutions for energy sustainability.

### City Profile



Area: 1,140 km<sup>2</sup> (440 sq mi)  
Population: 2,245,059

### Linking SDGs



© sdg knowledge platform

## The challenge of industrial GHG emissions

According to Key World Energy Statistics 2016 compiled by the International Energy Agency (IEA), Taiwan's total CO<sub>2</sub> emissions from energy use accounts for 0.77% of the world (ranked 21st), while Taoyuan City has the second highest GHG emissions of Taiwan's six municipalities. The reason is the use of industrial energy. In order to promote balanced economic development and energy sustainability, in addition to encouraging low-carbon industries, Taoyuan has expanded its development of renewable energy since 2014. Besides, incorporating the national objectives of energy transformation, the city now aims to develop non-polluting wind energy, hydraulic energy and solar energy in order to reach the target of deriving energy from 20% renewables, 30% coal and 50% gas by 2025.

## Promoting green energy in Taoyuan City

Among the municipalities in the north of Taiwan, Taoyuan has the most potential to develop green energy. The city has proactively promoted the development of renewable energy and established the “Green Energy Promotion Office” to integrate the City’s green energy policies and development. According to the energy policy ranking published by Energy Transformation Promotion Alliance in 2018, Taoyuan City received the Greatest Progress Award, with the 4th nation-wide ranking for its performance excellence and 1st ranking for installed renewable energy capacity in northern Taiwan.

The key strategies for Green Energy implementation are listed below:

### 1. An optimal use of space – development of solar energy:

- a. In 2015, the city launched the “Leasing and Installation of Roof Photovoltaic Systems in Public Housing” program to install solar energy devices in buildings owned by the city with an expectation that such public services will enhance people’s understanding of photovoltaic systems. In the meantime, the City’s Department of Economic Development also started to launch the Photovoltaic System Installation Subsidy Program for Private Housing.
- b. In 2017, the city held a number of educational and promotional activities and matching seminars, which are designed to target different demographics. The purpose is to bring renewable energy education to younger age groups to enhance students’ awareness of it and to encourage people, companies and industries to install renewable energy generation facilities to increase the city’s green energy proportion.
- c. In 2017, Taoyuan developed the characteristic photovoltaic ponds now found in the region and, through the “Low-carbon City Self-governance Ordinance”, requested large electricity users to source a specific ratio of their consumption from renewable energy (10%).



The Green Energy Promotion Office was established on 6th February 2018

d. In 2018, the city continued to promote the “Generate Your Electricity” green energy policy among the enterprises in the Taoyuan Environmental Science and Technology Park. With efforts from different stakeholders, the roof photovoltaic systems were successfully installed.

**2. Taoyuan's Advantages – wind energy:**

In 2015, the city launched the “Leasing and Installation of Roof Photovoltaic Systems in Public Housing” program to install solar energy devices in buildings owned by the city with an expectation that such public services will enhance people’s understanding of photovoltaic systems. In the meantime, the City’s Department of Economic Development also started to launch the Photovoltaic System Installation Subsidy Program for Private Housing.

In 2017, the city held a number of educational and promotional activities and matching seminars, which are designed to target different demographics. The purpose is to bring renewable energy education to younger age groups to enhance students’ awareness of it and to encourage people, companies and industries to install renewable energy generation facilities to increase the city’s green energy proportion.

In 2017, Taoyuan developed the characteristic photovoltaic ponds now found in the region and, through the “Low-carbon City Self-governance Ordinance”, requested large electricity users to source a specific ratio of their consumption from renewable energy (10%).

In 2018, the city continued to promote the “Generate Your Electricity” green energy policy among the enterprises in the Taoyuan Environmental Science and Technology Park. With efforts from different stakeholders, the roof photovoltaic systems were successfully installed.

**3. An optimal use of resources – hydraulic energy:**

Downstream from the nearby Shihmen Reservoir, the city government plans to establish a 90 MW hydraulic turbine to generate energy with the water from the reservoir. Besides, with respect to the dam established in the phase two plan of the Shihmen Reservoir catchment area, the city will establish a 40 MW hydraulic turbine downstream to generate energy through the elevation gap of the curved river course. In total, the installed capacity of these two turbine generators are expected to reach 130 MW.

**4. Urban evolution – the establishment of a biomass energy center :**

We intend to promote Taoyuan Environmental Science and Technology Park as an example of a resource cycling business park. Taiwan is the Country’s No.1 industrial technology city. Not only have one third out of the country’s top 500 manufacturing enterprises built factories in Taoyuan, but the industrial output value of Taoyuan has been ranked

first nationally for nine consecutive years. Taoyuan now has merely one incineration plant. Challenged by the enormous volume of trash, the City plans to build a three-in-one biomass energy center through the Build-operate-transfer (BOT) approach. The center will feature functions and facilities such as anaerobic digestion, thermal treatment units and solidified landfill. The site, which is about 4.38 ha and is designated for the establishment of environmental protection facilities, will collaborate with the Taoyuan Environmental Science and Technology Park's industrial waste disposal industry to reach the objectives of "self-management of waste", "establishment of a Taoyuan waste cycle supply chain" and a "circular environmental management-oriented and eco-friendly science park with zero waste, low pollution, diverse disposal solutions and sustainability".

The biomass energy center will prioritize acceptance of household trash from residents, waste from the Taoyuan Science and Technology Industrial Park and general industrial waste within Taoyuan County in order to provide local enterprises with a stable waste disposal capacity. The Center is expected to launch official operations in July of 2021. Upon its completion, this Center will become the country's biggest biomass energy plant and will generate about 200 MWh per year (equals to the electricity required by 60,000 families per year).

### Successful cooperation between the local government and the private sector

Organization	Contributions
Taoyuan City Government	The promotion of green energy is firstly based on the solar photovoltaic system, the installation of which has been spearheaded by public buildings to demonstrate the positive intentions behind the program and establish a good investment environment.
Green Energy Equipment Manufacturers	Through a good environment, equipment manufacturers are willing to provide a higher proportion of power generation rebates to improve the willingness of public and private enterprises to cooperate; to sign wind power generation system MOUs with well-known manufacturers, and gradually spread the development of renewable energy.
Enterprise Response	Through the effectiveness of the promotion and legal operations, more enterprises in Taoyuan City are expected to respond to the green energy construction.

### Benefits: The Green Energy Miracle

Since the beginning of the promotions of green energy, the government has not only made a great effort to introduce relevant programs to various target groups, but also launched relevant matching activities among the device suppliers and enterprises. This has attracted a number of big domestic enterprises to build production facilities and offices in the City.

In 2018, the city's total installed capacity for solar energy is about 123.7 MW, which has duovigintupled (x22) since its capacity prior to being upgraded into a municipality. This is about 5.2% of the country's total and first in the north (among cities and counties located in north of Miaoli County). The benefits of each strategy for solar photovoltaic energy generation can be seen from list below:



Installing Roof Photovoltaic Systems in Private Housing



"Promoting Green Energy" financing loans

#### 1. Program of Leasing and Installing Roof Photovoltaic Systems in Public Housings

From 2015 to 2017, the photovoltaic roof system was installed in 126 agencies and schools in Taoyuan, with a total installed capacity of 13.8 MW. In 2018, the phase III tendering project was launched with the objective of establishing photovoltaic systems with a total installed capacity of more than 3MW.

#### 2. Photovoltaic System Installation Subsidy Programs for Private Housings

From 2015 to 2018, the City has subsidized 190 cases at a total cost of NT\$75,000,000 and installed capacity of 17.4 MW. In 2019, the city government further included the energy storage equipment into the subsidy targets, with an aim to encourage factories and big electricity users to install energy storage facilities.

#### 3. Photovoltaic Ponds

To maintain the balance between its ecological landscape, environment and energy generation policy, Taoyuan City Government has conducted an assessment for the establishment of photovoltaic ponds. The result indicates that the energy generation efficiency of photovoltaic pond is 10% higher compared to that of the land devices. Therefore, the city established eight photovoltaic ponds at Taoyuan and demonstrated the technology in the Taoyuan Agriculture Expo. The total installed capacity of these 8 ponds is estimated to 26.9 MW.

#### 4. Land Revitalization of Landfill

Out of all rehabilitated landfills, the city has selected five to establish photovoltaic systems with a total installed capacity of 3MW. These systems are expected to generate 3.15 GWh per year.



Solar photovoltaic system in a landfill.

As Taoyuan's total installed capacity for cumulative renewable energy is about 123.7MW, it is estimated that the city will produce about 1,354,515,000 kWh per year, which is roughly the average annual energy consumption of 372,529 households (about 46% of the City's household total). According to the 2017 statistics, when the national average of CO<sub>2</sub> emissions per kWh of electricity generated reaches 0.554 kg CO<sub>2</sub>e, an installed capacity of 123.7 MW will reduce about 750,401.3 tons of carbon emissions.

If 1 kWh is NT\$2.6253 on average, this will save about NT\$3,556,008,230 (NT\$3,500,000,000) for Taoyuan. Additional economic values can be seen in the following:

1. A series of subsidy programs was launched starting from 2015 to encourage the City's citizens and big electricity users to install photovoltaic systems and energy storage equipment with the expectation of creating a low-carbon city and promote the installation, technology and development of renewable energy related systems.
2. Taoyuan City signed an MOU with wpd (a German wind energy company) on September 12, 2017 with the expectation of creating and developing renewable resources; providing the city's citizens with work opportunities; localizing the offshore wind energy industry; developing the green energy industry and economy of Taoyuan; maintaining the rights and benefits of local fishermen; promoting green energy education; and further enhancing renewable energy promotions and programs with the aid of wpd's abundant experience in the field. Furthermore, on January 28, 2018, the city government attended the MOU exchange ceremony between Century Wind Power and wpd. The city government hopes that the collaboration and cooperation between themselves, system suppliers

and local industries will promote the city’s green energy industry and facilitate the development of renewable energy.

3. The Taoyuan city government cooperated with Chang Hwa Bank, Hua Nan Bank, Bank SinoPac, Mega Bank and Taiwan Business Bank to promote green energy financing loans at a total amount of NT\$115 billion. The city hopes that sufficient and diverse fund sources will assist enterprises, factories and big electricity consumers in installing renewable energy generation facilities. In this way, the city will be able to increase the renewable energy system installation and green energy usage rates, and reach its objectives of energy saving, carbon reduction and sustainable development.

### The road ahead

As of December 2018, the City’s cumulative installed capacity for renewable energy devices was 354.4 MW, including 123.7 MW for solar energy; 100.7 MW for wind energy; and 130 MW for other renewable energy (including hydraulic energy). From 2019 to 2021, the city government plans to add another 50 MW in capacity each year for solar energy, for a total of 150 MW. Together with the 175 MW from offshore wind energy and promotion of other renewable energy, the City Government’s goal is to increase the cumulative installed capacity for renewable energy to 675 MW by 2021. The strategies to achieve the goal include:

1. **Continuous promotion of the installation of photovoltaic systems**

For private housings, the city has launched the “Roof PV System in Private Housing” initiative based on the principles of keeping the system no-cost to the citizen and no-subsidy on the part of the government. That is, having photovoltaic suppliers lease systems for installation on the roofs of private housing and install photovoltaic generation systems. It is estimated that an installed capacity of 6 MW will be reached by 2021 under this project.

For the enterprises in the industrial zone, we plan to cooperate with the central government (mainly the Bureau of Energy) to conduct explanatory sessions to encourage and promote the installation of roof photovoltaic systems.

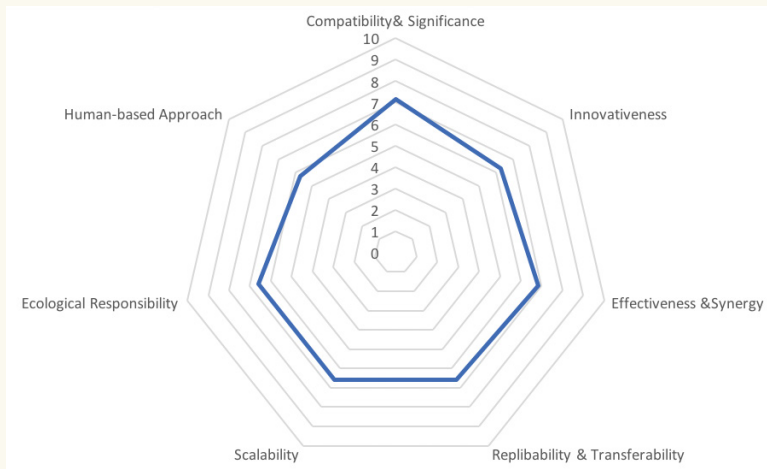
2. **Installation of autonomous energy systems in remote counties for disaster prevention and mitigation**

An evaluation was conducted in 2018 to establish “energy generation, energy storage and energy saving” smart energy systems in remote counties. The purpose is to ease the difficulties people in remote areas may have with accessing help from outside in disaster conditions.

3. **Installation of energy storage systems for renewable energy**

A subsidy totaled NT\$5 million will be granted to assist the City’s big electricity users whose electricity consumption is over 800 kW with installing energy storage systems.

## Evaluation



- The City Government of Taoyuan has provided great support in order to develop renewable energy. It is interesting to note that a detailed discussion was done with regards to the strategies that will be used in order to meet the objectives. Even the process on how to engage the locals was also provided. But the sustainability of the project will be a big challenge and strategies should be discussed more. The project did not mention that it is linked to SDG 11.
- The Promotion Office set up in this case plays an important role to roll out subsequent policies. It can be learned by other cities that want to speed up their sustainable policies.
- Because electricity generation is the largest source of carbon emissions globally, switching from fossil fuels to renewable energy for electricity generation is one of the most efficient methods to cut carbon emissions and pollution. Therefore, green energy is an important factor to solve the problems in many countries. In this project, the government focuses on improving the supply of renewable energy by implementing many programs, not only to meet the demand of energy consumption but also contribute to reduce the CO<sub>2</sub> emission. Thus this project is very critical and necessary. The project also makes the right choice when choosing Taoyuan as a place to implement the program because there are many manufacturers placed in Taoyuan which eliminates a large number of CO<sub>2</sub> emissions. The results obtained in Taoyuan can promote an approach for other cities in Taiwan to adopt renewable energy solutions.