# Solar Farm or Salt Wetland? Applying a Contingent Valuation Method to Determine Willingness to Pay for Cigu's Salt Pans*

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"Green conflict" means the conflict between renewable energy development and preservation of natural resources. Cigu, a rural district in the southwest of Taiwan, faces a green conflict between ground-mounted solar power plants installations and wetlands. This research is an attempt to address how people evaluate the unused salt pans and how much they are willing to

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pay to preserve unused salt pans. The contingent valuation method (CVM) is used to elicit the willingness to pay (WTP) for unused salt pans. The results showed that average WTP of Cigu's respondents was higher than that of the respondents in Tainan City. The result indicates the existence of active local advocates. Age, education, and location were the three factors that had significant impacts on WTP in the Tobit regression. Determining how to balance renewable energy development and natural resource preservation is one of the main tasks a government needs to accomplish during the energy transition.

**Keywords:** energy transition, renewable energy, green conflict, wetlands, solar power

# I. Introduction

Sustainability and energy transition have become priorities forTaiwan's future development. Due to industrialization, air and water pollution have been getting worse in Taiwan. In addition, the rising demand for electricity and shift away from using nuclear power have made environmental issues even more complicated.

Normally, energy transition goes with sustainability. Energy transition refers to developing renewable energy to replace "brown" energy, such as coal and oil. In reality, renewable energy development has created a new kind of conflict which is called "green conflict." Green conflict refers to the rapid expansion of renewable energy which sometimes causes damage to the natural environment or to human beings. The shrinkage of wetlands from solar panel installations or the noise resulting from wind power mills are examples of green conflicts. Past literature has shown that wind energy production has threatened the living environment of bats in both Germany (Voigt, Straka and Fritze, 2019) and in the U.S. (Burch, Loraamm and Gliedt, 2020).

There were many salt pans on Taiwan's west coast before 2001, the year when the salt pans were decommissioned because of changes in the salt-making industry (Taiwan's Wetland, 2017). In 2021, Taipower, a state-owned power company, launched the largest land-based solar power plant with a capacity of up to 150MW on the 214 hectares of "abandoned" salt pans in Jiangjun and Cigu Districts of

Tainan, both located in southwest Taiwan. The government aims for solar photovoltaic (PV) installation to reach 20 GW in 2025. In order to meet the national goal, the Ministry of Economic Affairs (MOEA) has searched every possible area to set up solar power plants, including the roofs of private buildings or public facilities, unused salt pans, fish farms, and reservoirs, etc. As a result, the expansion of ground-mounted solar panels has collided with local environment protection initiatives. Green conflicts are occurring while Taiwan's central government is promoting the island's energy transition.

Cigu is a rural district of about 23,000 residents in Tainan, Taiwan. After the termination of salt production, aquaculture has become the main industry in the district. Tourism is gaining momentum too, as its rich natural resources and ecosystems attract many tourists. The most famous tourist attractions in Cigu are lagoons and an ecological conservation area for black-faced spoonbills. However, because of the long hours of sunlight and open space, Cigu was chosen as one of the leading areas for developing solar power.

The government plans to set up two kinds of ground-mounted PV systems: 1) the agrivoltaic development plans, and 2) the PV systems on salt pans. The agrivoltaic development plans involve private firms and private lands, while the salt pans are state-owned. It is easier to build PV systems on salt fields because of the sole ownership of lands. Many controversies occurred when the solar power construction plans were introduced to the local residents. The agrivoltaic development plans have been pending due to the concerns about job losses of

fishermen as well as environmental issues. Although 214 hectares of unused salt pans have been utilized for solar power plants by Taipower, the debate of further use of the unused salt pans in the area is still going on among government, local residents, scholars, experts, and non-profit organizations.

With the exit of the salt industry, the unused salt pans appeared to have no monetary value. Nevertheless, the unused salt pans have turned into wetlands that provide many invaluable functions for wildlife and human beings. The wetlands in Cigu are habitats and food sources for birds and natural sponges. They also prevent tidal flooding. Additionally, the unused salt pans' historic and cultural context and beautiful scenery attract many tourists. They come to see the black-faced spoonbills and endangered migratory birds, that visit Cigu every year because of these wetlands.

Most of Cigu's unused salt pans belong to Taiwan's state-owned industries, such as Taiwan Sugar Corporation and Taipower Corporation. Consequently, it is easy for the government to utilize the state-owned lands to install solar power panels. However, unused salt land in Cigu creates positive externalities for the public but cannot reveal their true value under a market mechanism. Economists use the Contingent Valuation Method (CVM) to determine nonexistent markets and prices for the externalities of public assets constituted by natural resources. The CVM establishes a hypothetical market so that environmental resource users can demonstrate their willingness to pay (WTP) based on changes in the quantity and quality of environmental

resources (Travassos, Leite and Costa, 2018).

What would be the future of Cigu's unused salt pans? Green conflict seems to be inevitable in the region. This research is aimed toward understanding how residents evaluate the unused salt pans to answer the following research questions: How do they recognize the values of the unused salt pans, and what is their WTP? What are factors affecting their WTP? This paper is organized as follows: After the introduction, the next section provides a literature review of energy transition, green conflict, and CVM; the third section explains the research design; the fourth section provides the results, and fifth section provides the conclusions and discussions. Finally, the last section specified the contributions and limitations.

# II. Literature Review

## (1) Taiwan's Energy Transition

As an island with limited energy resources, Taiwan's dependency on imported fossil fuel energy is as high as 98% (Bureau of Energy, 2020). In 2015, thermal power comprised the largest share (50.74%) of the total electricity production: coal 22.98%, oil 4.47%, liquefied natural gas 23.29%, independent power producers 16.72%, cogeneration 15.24%, nuclear power 14.13%, Taipower Company hydro power 2.87%, and wind power and solar PV 0.29%. Due to concerns related to high energy dependency, air pollution, and safety issues of

nuclear power, the Taiwanese government passed the "Greenhouse Gas Reduction and Management Act" and started an energy transition initiative. The goal of Taiwan's energy transition is to generate 20% of its electricity through renewable energy by 2025 (Lu, 2016).

With its long hours of sunlight and being adjacent to the fast wind tunnel-like Taiwan Strait, Taiwan has made solar and wind power the highest priority for renewable energy development. Taiwan has two advantages in the development of solar energy. First, Taiwan has a strong semiconductor industry, which helps utilize semiconductors in the production of solar cells. Second, Taiwan has four large solar cell manufacturers (Gintech, Motech, E-Ton Solar, and Neo Solar Power) as well as a modular package company (Photonic Energy Semiconductor Co. Ltd.). Together they make a complete supply chain for the PV industry in Taiwan. On the other hand, Taiwan has two disadvantages in finding lands to install ground-mounted solar power facilities: First, the population density of Taiwan is the second highest in the world. Second, two-thirds of the island is mountainous. Despite the scarcity of land, the Tsai administration (elected in 2016 and 2020) decided to promote a "Nuclear-free Homeland" policy. Table 1 lists the objectives of the installed capacity of different energy sources (Lu, 2016).

Table 1 The Production Goals for Different Renewable Energy Sources in Taiwan (MW)

| Year<br>Energy sources | 2015 | 2020 | 2025 |
|---|---|---|---|
| Solar PV | 842 | 8,776 | 20,000 |
| Wind power (on shore) | 647 | 1,200 | 1,200 |
| Wind power (off shore) | 0 | 520 | 3,000 |
| Geothermal | 0 | 150 | 200 |
| Biomass | 741 | 768 | 813 |
| Hydropower | 2,089 | 2,100 | 2,150 |
| RE in total | 4,319 | 13,514 | 27,363 |

Source: Lu (2016: 412).

The distribution of the 20 GW goal in solar PV was 3 GW from the rooftop PV systems and 17 GW from the ground-mounted PV systems initially. However, because of the success of the "Million Rooftop PVs project" and increasing green conflicts related to ground-mounted solar power plants, the government adjusted the goal of the two kinds of solar PV systems to 6 GW and 14 GW in 2020 (Bureau of Energy, 2020). Regardless of the distribution between rooftop and ground-mounted types, in order to meet the goal of large-scale solar system installation, the MOEA has attempted to review the inventory of every possible land or space that can be used for installing solar PV systems. Eight possible types of lands/spaces

were listed for this purpose (Bureau of Energy, 2017):

1. Rooftops of public infrastructures (e.g. rooftop of public high schools)
2. Rooftops on factories
3. Rooftops on agricultural facilities
4. Other rooftops (e.g. individual houses)
5. Unused salt land
6. Ground water restriction areas
7. Water areas (e.g., Water bank)
8. Closed garbage landfill areas

The installation progress of rooftop PV systems has been going quite well. In addition to installing PV systems on the rooftops of agricultural, manufacturing, and public facilities, the MOEA has initiated solar projects in industrial parks that are under its administrative jurisdiction. The MOEA is projecting that by the end of 2021, local industrial parks will be accommodating 1 GW of PV systems (EnergyTrend, 2021). Unlike the rapid growth of rooftop PV systems, ground-mounted PV systems have faced challenges because of "green conflicts".

## (2) Green Conflicts and the Value of Unused Salt Pans

With the increasing number of countries worldwide adopting some form of renewable energy policy, there is some under-appreciated interplay between renewable energy generation and biodiversity conservation (Gasparatos et al., 2017). Warren, Lumsden, O'Dowd and

Birnie (2005) coined the term “Green on Green” conflict and called it a “new kind of environmental controversy.” A “Green on Green” conflict refers to the conflict between reduction in emissions of greenhouse gases from energy development and consumption, and the prevention of environmental impacts associated with renewable energy development (Burch et al., 2020).

Turney and Fthenakis (2011) argued that the environmental impacts from installing and operating large-scale solar power plants are much preferred to the traditional means of power generation, but their study pointed out several environmental impacts that required further investigation: habitat fragmentation, land transformation, soil erosion, surface water runoff, and groundwater recharge. However, some studies confirmed that renewable technologies have major negative impacts on biodiversity by disrupting ecosystem processes and thus can potentially take a toll on the provision of ecosystem services. Development of a solar energy infrastructure could take up significant amounts of land, modifying and fragmenting habitats in the process. Also, using dust suppressants and herbicides to maintain the cleared land in order to give panels access to the sun possibly alters key chemical properties of adjoining waterways (Gasparatos et al., 2017). Hence, although renewable energy has the advantage of reducing emissions and pollutants, the environmental impacts it may cause have become main concerns when constructing large-scale solar PV systems.

Based on Taipower’s report, the MOEA announced that there are 4,700 acres of unused salt pan suitable for solar power development.

The area of the first stage of development located in Tainan was 582 acres. Two hundred and fourteen out of 582 acres were already built ground-mounted solar PV plants for which the grid connections were completed on September 14, 2020. Taipower invested as much as 350 million USD in this solar PV plant, which was ranked the 46$^{th}$ largest in the world (Chuang, 2021). While Taipower stated that important bird habitats have been excluded from the selection of land for development, local newspapers and environmental protection organizations have raised doubts in the installation of massive ground-mounted solar plants on unused salt pans (Huang and Lin, 2020).

The main argument against large-scale solar PV plants in these areas is that unused salt pans do have value, which is divided into use and non-use values. There are two types of use value: direct and indirect value. Table 2 lists the four categories of ecosystem services in the unused salt pans (Kuo and Wang, 2018). Each wetland ecosystem service can be mapped to a direct or indirect value (Li and Gao, 2016). For indirect value, the existence and option value is mentioned in the previous literature (e.g. Li and Gao, 2016; Ojea and Loureiro, 2010). The existence value means the existence of a resource regardless its use, while the option value is the value that people place on having the option to use or enjoy the resource in the future (Ojea and Loureiro, 2010). This study investigates how people evaluate both the use and non-use values of Cigu's unused salt pans.

Table 2 The Existing Ecosystem Services at Budai Salt Pan Wetland

| Ecosystem services | | Indicators used to support the service | Value type |
|---|---|---|---|
| Provisioning | Food | Seagrass, fish, crab | Direct |
| | Genetic materials | Biomass | Direct |
| Regulating | Climate regulation | Moisture content | Direct |
| | Water purification and waste treatment | Biofilters, hydrophytes and organisms | Direct |
| | Natural hazard regulation | Storage area | Indirect |
| | Pollination | Vegetation and insects | Indirect |
| Cultural | Spiritual and inspirational | Resources for human activities | Non-use |
| | Recreational | Resources for human activities | Direct |
| | Aesthetic | Resources for human activities | Non-use |
| | Educational | Resources for human activities | Direct |
| Supporting | Nutrient cycling | Aerobic and aerobic respiration in the soil | Indirect |

Source: Kuo and Wang (2018); Li and Gao (2016).

It is difficult to assign market prices to these ecosystem services. Ecosystem services have ‘public goods’ characteristics because they create positive externalities in the environment. Goods with positive externalities tend to attract free riders. The green conflict occurred due

to the fact that the solar PV plants lead to high economic returns, and the unused salt pans have no tangible monetary value, making it difficult to determine what is best for society. Economists provide several good methods to reveal the value of the goods and services in the absence of explicit markets. The next section explains how this mechanism works.

## (3) Contingent Valuation Method

Pricing systems work well for private goods that are rival and excludable. However, estimating the benefits generated by public goods has been a major challenge for economists and public policy makers. A person may be willing to make an economic tradeoff to assure that a wilderness area or scenic resource is protected even if no one would actually visit the area or use the resource. The tradeoff is labeled as "existence value" or "passive use value" (Carson, 2012: 27). Existence value is a type of "non-use value" in a wetland's ecosystem (Li and Gao, 2016). Natural resources, public services, cultural heritage sites are all public or quasi-public goods that are considered either non-rival or non-excludable. Insufficient provision is a main problem of public goods. Finding the real value of these public goods would help governments correct market failures. Therefore, economists and policy makers are eager to find solutions and suggestions to solve the underproduction problem of public goods. Among many methods, Mitchell and Carson (1989) argued that the contingent valuation method (CVM) represents the most promising approach developed thus far for determining the public's willingness to pay for public goods.

Freeman III, Herriges and Kling (2014) also stated that it is only possible to provide a comprehensive assessment of the use value and existence value of public goods through surveys.

According to Mendelsohn and Olmstead (2009), there are two broad classes of methods that can be used to assess economic value in the absence of explicit markets: behavioral (revealed preference) and attitudinal (stated preference). The CVM is classified into attitudinal methods. It uses survey questions to elicit people's preferences for public goods by finding out what they would be willing to pay (WTP) in dollar amounts. It circumvents the absence of markets for public goods by presenting consumers with hypothetical markets in which they have the opportunity to buy the goods in question. The CVM first came into use in the early 1960s when economist Robert K. Davis used questionnaires to estimate the benefit of outdoor recreation in a backwoods area in Maine using a bidding approach to reveal the maximum WTP of respondents. (Mitchell and Carson, 1989: 2-3). The estimation of consumers' WTP can be used for improvements in public goods or for measures to halt their deterioration (Bance and Chassy, 2020).

The CVM is applied to studies estimating WTP for preserving natural resources (e.g. Amigues, Boulatoff, Desaigues, Gauthier and Keith, 2002; Davis, 1963; Islam, Ahmad and Islam, 2018; Travassos et al., 2018), solving pollution or congestion problems in cities (Cicchetti and Smith, 1973; Ridker, 1967), climate change measures (Aldy, Kotchen and Leiserowitz, 2012), urban spaces (Brander and Koetse, 2011) or cultural heritage (Kling, Revier and Sable, 2004), citizen advisory committees (Bance and Chassy, 2020), and government

policies such as waste management services (Djayasinga and Virsa, 2019), renewable energy (Lee and Heo, 2016; Xie and Zhao, 2018), and health policies (Jeuland, Lucas, Clemens and Whittington, 2009; Meijer, Brouwer, Koopmanschap, Berg and Exel, 2010). Thus, it is commonly used in evaluating environmental issues.

In addition to estimating WTP for public goods, CVM can provide information about external factors that have influences on WTP. Chu, Zhan, Wang, Hameeda and Wang (2020) stated that using CVM to estimate the value of ecosystem services could also make it possible to discover how value is influenced by social, economic, and multidimensional environmental factors. The influencing factors include household income, gender, age, ethnicity, education level, and environmental knowledge (Chu et al., 2020; Travassos et al., 2018; Djayasinga and Virsa, 2019; Xie and Zhao, 2018).

# III. Research Design

The purpose of this research is to understand of how residents evaluate unused salt pans and to determine the WTP. As stated previously, two kinds of PV systems are planned in Cigu. The agrivoltaic development plans used private lands while the PV systems on salt pans used state-owned properties. The issues related to the agrivoltaic development plans are not covered while the values of unused salt pans are explored in the current study.

Because a "green conflict" between solar PV systems construction and ecosystems in unused salt pans has been occurring in Cigu for

several years, many of Cigu's residents are aware of the debates. In the interviews with residents or in public hearings, the author noticed that people repeated the same statement again and again:

> *"We are not against renewable energy. What we are against is building solar power plants in our township."*[1]

The statement exactly reflects a NIMBY (not in my back yard) attitude. Hence, geographic proximity may affect the attitudes toward solar PV systems and WTP related to unused salt pans. Based on this, two groups of respondents were selected according to the distance between their residence and the new solar PV plant operated in 2021. The first group includes the residents living in the four villages (Xiliao, Dingshan, Yancheng, and Jhongliao villages) surrounding Cigu's new solar PV plant, as shown in Figure 1. The second group comprises citizens living in the other districts in Tainan City. The second group is treated as a comparison group, which might hold different opinions about the value of unused salt pans because they live relatively far away from the solar PV plant. The first group in the study was labeled "Cigu's four villages," and the second group "Tainan City". The relative location and the size of the two groups are shown in Figure 2. The black line in Figure 2 shows the Tainan City area, and the balloon-shaped marker on the map indicates Cigu's four villages.

1. The author attended several public hearings and conducted 20 interviews in Cigu District from May 2019 to May 2020. The statement was drawn from several interviews with local residents on 3 June 2019, 18 September 2019 and 23 September 2019.

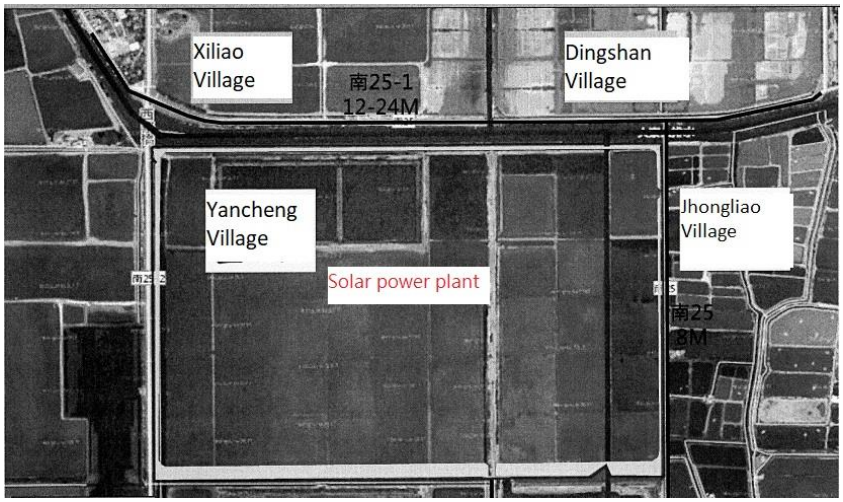


Figure 1 The Four Villages Surrounding Solar Power Plant in Cigu

Source: Taipower (2016).


Figure 2 The Location of the Two Study Groups

Source: Made by Google map

Three research questions are raised based on the two groups of residents in the study:

How do the two groups of residents evaluate the unused salt pans? Are there any differences between the two groups?

1. How do the two groups of residents evaluate the unused salt pans? Are there any differences between the two groups?
2. What is the WTP for unused salt pans? Are there any differences between the two groups?
3. What factors affect the WTP?

A CVM survey was adopted to determine WTP for Cigu's unused salt pans. There are usually three parts in a CVM survey: 1) A detailed description of the good(s)/service/amenity being valued and the hypothetical circumstances under which it is made available to the respondent. 2) Questions that elicit the respondents' WTP for the good(s)/service/amenity being valued. 3) Questions about the respondents' characteristics, their preferences relevant to the good(s)/service/amenity being valued, and their use of the good(s). (Mendelsohn and Olmstead, 2009: 332-333; Mitchell and Carson, 1989: 3).

Considering the suggestions for designing a CVM survey, the author uses a 5-Point Likert Scale to design the first part of the survey questionnaire about the unused salt pan's direct, indirect, and non-use values. The second part of the study asks questions intended to help understand the respondents' attitudes toward installing solar PV systems, specifically, their attitudes toward energy transition, their personal experience with solar PV plants, and the percentage of the

unused salt pans they suggest to be preserved. The third part creates a hypothetical market for unused salt pan preservation to determine respondents' WTP. Brander and Koetse (2011: 2765) summarized several payment vehicles used in the past CVM studies: entry charge, tax, donation to a fund, and other payment vehicles. The payment vehicle which Chuang and Chen (2017) used in studying Taiwan's natural resource protection case was donation to a non-profit organization considering possible protest bids. In the same vein, the hypothetical question in this study assessed respondents' willingness to donate cash to a non-profit organization on an annual basis in order to help preserve unused salt pans.

A sequential bid approach was used to elicit the monetary value the respondents were willing to offer for preserving the unused salt pans.[2] Boyle, Thayer, and Schulze (1985) pointed out that what value to choose for appropriate starting bids as one of the problems for sequential bids. The average donation of Taiwanese people from 2004 to 2016 was 500 NTD [USD 17] a month; therefore, 500 NTD was used as the starting bid (Rightplus, 2019). However, taking into consideration that the respondents may support multiple organizations, this study assumes a 500 NTD bid as an annual donation amount. Respondents could bid 500 NTD or other amounts, as shown in Figure 3. When the respondent chose 500 NTD, he or she could also consider bidding 1000 NTD, then further offer a maximum price if so desired. On the other

2. There are three approaches in CVM: 1) open-ended; 2) sequential bids; 3) closed-ended (Cemeron and James, 1987).

hand, if the respondent did not choose 500 NTD, he or she could consider bidding 250 NTD, and then further offer a minimum amount. Finally, the fourth part comprised questions about respondents' demographic characteristics, including gender, age, occupation, education, family income, and residence.

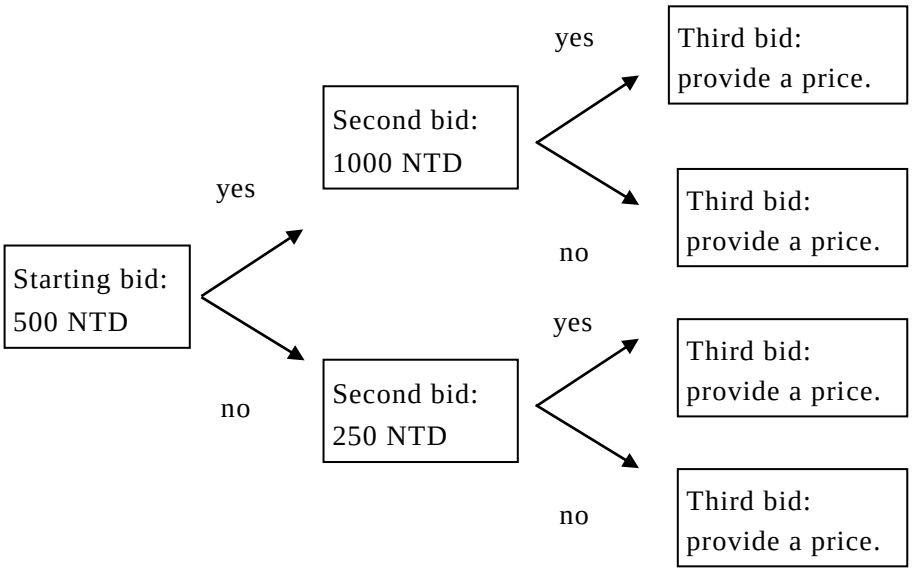


Figure 3 WTP's Bidding prices

Source: The author

The questionnaire was revised two times. The first revision was based on the opinions of a research team with rich field study experiences on the ecosystems in the Budai's and Cigu's unused salt pans. The second revision was based on the suggestions of a scholar whose book discussed public policy analysis methods including CVM.

The questionnaire was finalized at the end of November in 2020. A pilot study was carried out on December 24, 2020. Forty responses were collected. The Cronbach's alpha for the pretest was 0.821, which indicated good internal reliability of the questionnaire.

# IV. Empirical Results

This section first presents the descriptive statistics of the samples. The second part provides the evaluation of the unused salt pans. Finally, the results for WTP and the factors impacting it are discussed.

## (1) Two groups of samples: descriptive statistics

The survey for the first group was conducted on January 13 and 14, 2021, and that for the second group on January 30, 2021. The survey method was convenience and in-person surveys, which were handled by six trained interviewers. In Cigu's four villages, the interviewers started the survey in the Community Center, where local residents gathered for events and lessons. The interviewers also walked around villages to knock on doors to collect surveys. For the comparative group, residents in Tainan City, the interviewers conducted surveys on several busy areas near the Tainan Train Station. The interviewers confirmed interviewees' residence in Tainan before starting the survey. Table 3 presents the samples size for the two groups. There were 82 valid samples from Cigu's four villages (Group 1) and 167 valid samples from Tainan City (Group 2).

Table 3 Sample Sizes for the Two Groups

| Study group | Cigu's four villages | Tainan City |
|---|---|---|
| Questionnaires collected | 102 | 198 |
| Valid questionnaires | 82 | 167 |
| Valid rate | 80% | 84% |

Source: The author

Table 4 summarizes the characteristics of the sample. The distribution of gender, education level, income, age, and occupation indicated that the demographics were very different between the respondents from Group 1 and Group 2. In general, the respondents in Cigu were mostly elderly men, with low education and income levels, and working in the primary industry or retired. The sample from Group 1 was consistent with the impression people have of Cigu District. It is hard to run into young people on the street in Cigu District. On the one hand, Cigu district suffers from an exodus of its young people, who desire employment opportunities in higher-end industries; on the other hand, some of Cigu's residents insist on protecting the natural environment and oppose solar PV plants. The respondents from Tainan City were well educated, mostly under 40 years old, and had higher income levels compared to the respondents in Cigu.

Table 4 Sample Statistics

| | Cigu's four villages | | Tainan City | |
|---|---|---|---|---|
| | N | % | N | % |
| Gender | | | | |
| Male | 54 | 65.9 | 76 | 45.5 |
| Female | 28 | 34.1 | 91 | 54.5 |
| Total | 82 | 100.0 | 167 | 100.0 |
| Education | | | | |
| Elementary (and under) | 35 | 42.7 | 7 | 4.2 |
| Junior high school | 17 | 20.7 | 9 | 5.4 |
| Senior high school | 24 | 29.3 | 48 | 28.7 |
| University | 4 | 4.9 | 84 | 50.3 |
| Graduate school | 0 | 0 | 19 | 11.4 |
| Not provided | 2 | 2.4 | | |
| Total | 82 | 100.0 | 167 | 100.0 |
| Annual income (1,000NTD) | | | | |
| 500 and under | 50 | 61.0 | 31 | 18.6 |
| 500 to 750 | 2 | 2.4 | 25 | 15.0 |
| 750 to 1000 | 0 | 0.0 | 19 | 11.4 |
| 1000 to 1250 | 1 | 1.2 | 6 | 3.6 |
| 1250 to 1500 | 1 | 1.2 | 8 | 4.8 |
| 1500 to 1750 | 1 | 1.2 | 1 | 0.6 |
| 1750 and above | 0 | 0.0 | 9 | 5.4 |

| | | | | |
|---|---|---|---|---|
| Don't know | 27 | 32.9 | 64 | 38.3 |
| Not provided | 0 | 0.0 | 4 | 2.4 |
| Total | 82 | 100.0 | 167 | 100.0 |
| Age | | | | |
| 20 and under | 0 | 0.0 | 20 | 12.0 |
| 21 to 30 | 1 | 1.2 | 57 | 34.1 |
| 31 to 40 | 3 | 3.7 | 24 | 14.4 |
| 41 to 50 | 7 | 8.5 | 25 | 15.0 |
| 51 to 60 | 20 | 24.4 | 18 | 10.8 |
| 61 to 70 | 22 | 26.8 | 14 | 8.4 |
| 71 and above | 28 | 34.1 | 8 | 4.8 |
| Not provided | 1 | 1.2 | 1 | 0.6 |
| Total | 82 | 100.0 | 167 | 100.0 |

Source: The author

Note: The survey was supported by Ministry of Science and Technology. The full report can be found at Government Research Bulletin https://www.grb.gov.tw/. The author reported and analyzed the complete survey in her book：Hung (2022).

## (2) Evaluations of Unused Salt Pans

Table 5 compares the evaluation of the two groups' opinions about the unused salt pan. There are two ways of classifying the unused salt pans' value shown in Table 5. The first way uses ecosystem service type to classify value and adds two kinds of value: save for the next generation and existence value. The second way classifies the

ecosystem service values into direct, indirect and no use value, as suggested in Table 2. The average for both groups were 3.64 and 4.19, which indicates that the respondents did appreciate the value of the unused salt pans.

The averages of the two groups had statistically significant differences in most evaluations. Group 2 evaluated the unused pans more highly in almost every respect. The two groups had similar evaluation outcomes only in terms of the existence value. The results showed that most of the respondents of Group 1 did not appreciate the value of unused salt pans to any great degree. Cultural value was what the two groups valued the most. The two groups had very different opinions on supporting value. Group 1 only gave the supporting service an average of 2.89 points, but Group 2 gave it an average of 4.59 points. Supporting service is a kind of indirect value that refers to "aerobic soil respiration." It is an important function for nutrient cycling but difficult for people without biology knowledge to understand. Also, leaving unused salt pans for the next generation was an aspect where the two groups had different opinions. It seems that the Group 2 tended to agree more to keeping unused salt pans for the next generation.

The different evaluation results possibly came from the very different demographic factors for the two groups. However, it should be noted that both groups appreciated the cultural and existence values the most. In order to control for demographic factors, regression was used as discussed in the next section.

Table 5 Evaluations of Unused Salt Pans

| Type | Value | Cigu's four villages[a] | Tainan City | t value | *p* value |
|---|---|---|---|---|---|
| 1 | Provisioning | 3.62 | 3.98 | -1.743 | .084 * |
| | Regulating | 3.27 | 3.97 | -3.951 | .000 *** |
| | Cultural | 4.13 | 4.45 | -1.752 | .082 * |
| | Supporting | 2.89 | 4.59 | -7.230 | .000 *** |
| | Next generation | 3.48 | 4.04 | -2.086 | .039 ** |
| | Existence | 4.06 | 4.26 | -.773 | .441 |
| 2 | Direct use value | 3.70 | 4.24 | -3.385 | .001 *** |
| | Indirect use value | 3.27 | 4.06 | -4.280 | .000 *** |
| | No use value | 3.85 | 4.22 | -2.058 | .042 * |
| | Average | 3.64 | 4.19 | -3.366 | .001 *** |

a: 5-Point Likert Scale, Strongly disagree (1 point); Disagree (2 points); Neither agree nor disagree (3 points); Agree (4 points); Strongly agree (5 points)

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

Source: The author

## (3)WTP and its Impact Factors

### (3.1) WTP

The mean WTP value for all respondents was 524 NTD. Table 6 presents the bid amounts for the two groups. Of all the 82 valid

respondents in Group 1, 60.98% of respondents were unwilling to pay for the preservation of unused salt pans. Comparatively, of all the valid respondents in Group 2, only 31.74% of respondents had zero WTP. For those whose WTP were positive, 500 and 1000 NTD were the two most popular bids. Although the initial bid (500 NTD) might have affected the respondents' WTP (Boyle et al., 1985), it still provided a reference point for understanding the absolute value and relative WTP between the two groups.

Although 60% of the respondents from Group 1 were unwilling to pay a positive WTP, the accumulated percentage of respondents who were willing to pay more than 1,000 NTD in Group 1 (3.7%) was almost the same as that in Group 2 (3.6%). In addition, the maximum WTP in the Group 1 was 30,000 NTD, which was six times larger than Group 2's maximum (5,000 NTD). There was a big variance in WTP in Group 1. The average WTP in Group 1 was 667 NTD, while the average WTP in Group 2 was 456 NTD. The higher average WTP from Group 1 was mainly due to some extreme values.

The extreme WTP values reflect the opinions of a few Cigu's residents. When the author was doing field research in Cigu, many local active advocates provided their opinions and insights regarding the history and beauty of Cigu. Landowners, fishermen, and many other local residents voiced their concerns and passions related to preserving their homeland. Although few in number, these advocates are willing to spend both time and money to protect their homeland, hence they do have enormous influences on public policies.

Table 6 Frequency of WTP by Region (NTD)

| WTP(NTD) | Cigu's four villages | | | Tainan City | | |
|---|---|---|---|---|---|---|
| | N | % | Reversed accumulated percentage of positive WTP | N | % | Reversed accumulated percentage of positive WTP |
| 0 | 50 | 60.98 | 100.0 | 53 | 31.74 | 100.0 |
| 100 | 0 | 0.00 | 36.6 | 4 | 2.40 | 67.7 |
| 150 | 1 | 1.22 | 36.6 | 1 | 0.60 | 65.3 |
| 200 | 1 | 1.22 | 35.4 | 10 | 5.99 | 64.7 |
| 250 | 2 | 2.44 | 34.1 | 15 | 8.98 | 58.7 |
| 300 | 0 | 0.00 | 31.7 | 6 | 3.59 | 49.7 |
| 500 | 11 | 13.41 | 31.7 | 37 | 22.16 | 46.1 |
| 600 | 0 | 0.00 | 18.3 | 1 | 0.60 | 24.0 |
| 1,000 | 12 | 14.63 | 18.3 | 33 | 19.76 | 23.4 |
| 1,450 | 0 | 0.00 | 3.7 | 1 | 0.60 | 3.6 |
| 2,000 | 1 | 1.22 | 3.7 | 3 | 1.80 | 3.0 |
| 3,000 | 1 | 1.22 | 2.4 | 1 | 0.60 | 1.2 |
| 5,000 | 0 | 0.00 | 1.2 | 1 | 0.60 | 0.6 |
| 30,000 | 1 | 1.22 | 1.2 | 0 | 0.00 | 0.0 |
| Missing value | 2 | 2.44 | | 1 | 0.60 | |
| Total | 82 | 100.00 | | 167 | 100.00 | |
| Mean | 667 | | | 456 | | |
| Mode | 0 | | | 275 | | |
| Median | 0 | | | 0 | | |

Source: The author

## (3.2) Factors Impacting WTP

Because WTP was truncated at zero, a Tobit regression was used to answer this research question. Table 7 presents the three models, which included three sets of variables. Model 1 contained only demographic variables; Model 2 added three variables, which represented the attitude toward renewable energy (Green Energy), whether the respondent had seen a solar PV plant previously (Seen PV), and the percentage of respondents suggesting preserving the unused salt pans for the next generation. Model 3 added three more variables, which express the respondents' evaluation of the unused salt pans.

The regression results showed that the attitudes and evaluations of respondents had no impacts on their WTP. The three statistically significant variables were age, education and location. Although the pseudo R-squares of the three models were not high, the purpose of this study is not to build a predictive model but find out impact factors on WTP. Because Model 3 was the most complete and had the highest pseudo R-square, the following explanations used Model 3 to elaborate on the results. Holding other factors constant, a year increase in age would result in a decrease of the WTP by 43.65 NTD. By the same token, one level education increase would lead to an increase of the WTP by 544.9 NTD. Lastly, compared to the respondents who live in Cigu's four villages, the respondents in Tainan City has a WTP that is 2,290 NTD lower.

Table 7 WTP's Tobit Regression Results

| | Model 1 | | | Model 2 | | | Model 3 | | |
|---|---|---|---|---|---|---|---|---|---|
| **Variables** | Estimate | Std. Error | P value | Estimate | Std. Error | P value | Estimate | Std. Error | P value |
| **Constant** | 1383 | 1304 | 0.288 | 1787.6 | 1922.7 | 0.352 | 701.3 | 2250 | 0.755 |
| **Gender** | -505.5 | 399.7 | 0.205 | -253.0 | 426.5 | 0.553 | -345.3 | 453.3 | 0.446 |
| **Income** | 191 | 149.4 | 0.200 | 233.20 | 156.8 | 0.136 | 219.9 | 159.8 | 0.168 |
| **Age** | -46.48 | 13.66 | 0.000 *** | -48.9 | 14.6 | 0.000 *** | -43.65 | 15.39 | 0.004 ** |
| **Education** | 524.7 | 228.2 | 0.021 * | 487.4 | 241.7 | 0.043 * | 544.9 | 259.5 | 0.035 * |
| **Location_ Tainan** | -1709 | 6547 | 0.009 ** | -1977.3 | 707.1 | 0.005 ** | -2290 | 758.1 | 0.002 ** |
| **Green Energy** | | | | 44.7 | 266.0 | 0.866 | -0.654 | 281.1 | 0.998 |
| **Seen PV** | | | | -669.9 | 450.7 | 0.137 | -670.2 | 461.9 | 0.146 |
| **Keep salt pans** | | | | 100.7 | 171.5 | 0.557 | -32.12 | 187.6 | 0.864 |
| **Direct use value** | | | | | | | 37.48 | 351.7 | 0.915 |
| **Indirect use value** | | | | | | | 227.6 | 300.1 | 0.448 |
| **No use value** | | | | | | | 168.7 | 280.2 | 0.547 |
| **Log (scale)** | 7.898 | 0.061 | < 2e-16 *** | 7.91 | 0.063 | < 2e-16 *** | 7.918 | 6.488 | < 2e-16 *** |
| **N** | 238 | | | 214 | | | 200 | | |
| **Wald-statistics** | 26.52 | | | 24.46 | | | 26.51 | | |
| **Pro>F** | 0.00007 | | | 0.0019 | | | 0.0054 | | |
| **Pseudo $R^2$** | 0.0434 | | | 0.0094 | | | 0.1368 | | |
| **Log-Likelihood** | -1339 | | | -1268 | | | -1208 | | |

Source: The author

# V. Conclusions and Discussions

From the results of the CVM survey presented in the previous section, three conclusions can be drawn as follows:

Firstly, the evaluations and regression results both demonstrated that geographic proximity matters in determining the value of the unused salt pans. Nonetheless, the two results seem to conflict with each other. On the one hand, the respondents in Tainan City rated the value of the unused salt pans higher; on the other hand, the Cigu's four villages has an average WTP that is higher than that of Tainan City's. Cigu's unused salt pans may enchant visitors with the beautiful scenery and cultural heritage, but in general local residents may not appreciate them so much. However, the extreme WTP values in Cigu's four villages indicated that some local residents actively participate in preserving the salt pan wetlands even though Cigu District is suffering from aging population and an exodus of young people. These stakeholders attended meetings and public hearings with local officials, and have even engaged in protests to stop solar PV plants construction. The local advocates are not alone. Because of the growing number of disputes between renewable energy and ecosystem preservation, many national and local non-profit organizations have begun to cooperate with local advocates in order to find possible solutions for green conflicts. Obviously, a few active local stakeholders are going to play a major role in deciding Cigu's solar power future.

Secondly, in addition to the location factor, age and level of education were two factors that affected WTP. Respondents who were younger and had higher levels of education levels were more likely to pay higher amount to preserve unused salt pans. The possible explanation for the significances of age and the level of education might be that the younger people and those with higher education levels have a more positive attitude towards the environmental protection. Meyer (2015) demonstrated that education causes individuals to be more concerned with social welfare and to behave in a more environmentally friendly manner. Giannelloni (1995) obtained similar results finding younger and better educated people have a more positive attitude towards the protection of the environment. The results were consistent with the findings in Xie and Zhao (2018) (age), Travassos et al., (2018) (level of education), Djayasinga and Virsa (2019) (education level). However, income is an important factor mentioned in the previous literature that did not have a significant impact here. In short, personal demographics have impacts on WTP.

But how the respondents evaluated the unused salt pans is not a significant factor empirically. Although the evaluations of unused salt pans were high for both groups, the respondents may not feel that they have a personal responsibility when it comes to preserving the unused salt pans. Due to the absence of a market, people tend to become “free riders” when consuming public goods. This may explain why there is no significant linkage between the evaluations and the WTP.

Finally, the results of the CVM survey showed that extreme values

existed in Cigu's four villages, which partly explained the "green conflict" in the region. With the commitment the Tsai government made to energy transition, unused salt pans have become one of best possible places to install ground-mounted solar PV plants because they are considered "no-use." However, the respondents showed their recognition of the unused salt pans' value, and more than half of the respondents are willing to pay some amount to preserve these wetlands. The largest bid (30,000 NTD) was sixty times of the initial bid (500 NTD). This extreme WTP implies that some of Cigu's residents treasure the unused salt pans a lot. Based on the interviews the author has conducted in the area, there were several major concerns from local residents:[3]

> *"The chemicals used to wash solar panels may pollute the fishpond water that flows through connected water pathways."*
>
> *"Solar panels may cause land pollution after they reached the end of their life in 20 years. Then, what do we do with all this waste and land?"*
>
> *"Salt fields are the best place for migratory birds, especially black-faced spoonbills. Large scale solar PV panels installation may scare birds away and reduce tourist numbers."*
>
> *"Salt pan wetlands play an important role in securing the region from floods."*

3 The author has conducted 20 interviews in Cigu District. The major concerns were cited from interview transcripts, which were summarized in Hung (2019).

These concerns contributed to Cigu's green conflict. Thus, determining how to balance energy transitions and natural resource protection is the main task the government needs to focus on. In this study, a CVM survey was used to explicitly show that respondents in general appreciate the value of the unused salt pans and that some of them are willing to pay an amount of money to preserve them. However, the government categorizes the unused salt pans as non-value lands that are good for installing ground-mounted solar PV plants. This conflict will not be resolved unless the government becomes aware of the value of salt pan wetlands and communicates with local leaders to reach a consensus on some portion that will be preserved.

Some possible solutions suggested by local stakeholders are finding other places such as rooftops or parking lots to install solar PV panels, involving local residents in the decision-making process, developing community-based renewable energy projects instead of large-scale projects, and central planning of renewable energy plans. Regrettably these recommendations are not being taken seriously by the government. Just like the debates in ideology between communism and capitalism, or between central planning and the natural order, the energy transition also faces a similar dilemma: centralization or decentralization? Should the government invite local communities to participate in deciding locations and usages of renewable energy development, or should the government simply make all the decisions for the public?

Furthermore, energy transitions should not be limited to

technology transitions, i.e., using green technology instead of brown technology. Energy transitions also need to involve social and political changes. According to MacEwen and Evensen (2021), new energy resources are in fact a political economic issue involving winners and losers, so it is important for policy makers to determine who is benefiting from (and why) and who is being harmed by the system when a new energy source is introduced. Developing renewable energies is never a simple policy implementation but rather a systematic change.

When a government is only concerned about the effectiveness of an energy transition or meeting a deadline, the needs of communities in an energy transition are would never be discussed or satisfied. Expanding large scale solar PV plants does help achieve 20 GW goals sooner, but it also creates massive green conflicts and public dissatisfaction at the same time. Bureaucratic design has been a dominant approach in Taiwan's public policy-making. As North (1990: 100) argued, because of the path dependence in policy-making and short-term high market returns, and the attempt by political or economic entrepreneurs to maximize the margins that appear to be the most profitable (short-run) alternatives (in this case, installing large scale solar PV panels), the positive externalities from salt pan wetlands may be ignored.

For the future usage of salt pans and a successful energy transition, "energy democracy" needs to be considered in the energy transition policy-making process. Energy democracy refers to shifting power toward workers, communities, and the public during an energy

transition. Energy democracy acknowledges the historical and contemporary perspectives and experiences of frontline communities (Fairchild and Weinrub, 2017). From the opinions of Cigu's stakeholders, it is important to understand the needs of the community and respect their heritage. It seems that the lack of communication with locals is one of the reasons for green conflicts. Listening to communities and incorporating their needs to build a decentralized energy supply model may be an option for the Taiwanese government to consider in the future.

# VI. Contributions and Limitations

This study used CVM to elicit WTP of unused salt pans which serve as wetlands. The contributions of this study are: Firstly, the study provided relevant evidences for the discussions on the energy transition policy through survey. Evidence-based policy discussions are more productive than position-defended discussions. The study demonstrated a method to draw out the value of non-market goods. More evidence-based studies will be needed in energy transition debates while massive green conflicts are happening around Taiwan. Secondly, there are two major ground-mounted PV system plans on Taiwan's west coast: the agrivoltaic development plan, and the PV systems on salt pans. The agrivoltaic development plans have caused much controversy as they involve parties with multiple interests. Building PV systems on salt pans attracted less attention because the lands are state-owned and

"unused". This study contributed by discussing the value of unused salt pans and pointed out the externalities they created.

However, several limitations need to be mentioned. The first limitation is that the convenient sampling limits the generalization power of the results. The demographic statistics showed that Cigu's respondents are seniors with low education and income levels, which are consistent with people's impression of Cigu's residents. However, the chi-square tests do not support the significant representativeness of the samples. Accordingly, one should be careful not to generalize the research results but focus on understanding the differences between the two groups of respondents. Galloway (2005) argued that the convenient sampling method assists in obtaining a range of attitudes and opinions and in identifying tentative hypotheses that can be tested more rigorously in further research. The results of this study would become a foundation for future explorations on this topic. The second limitation is that inclusion of extreme values and the lack of reasons for zero bids. The internal research group meeting agreed that inclusion of extreme values presented the reality in Cigu's green conflict case. In addition, finding the reasons for zero bids is one of the debates in CVM (e.g. Halstead, Luloff and Stevens, 1992). The current study does not discuss this issue but hopes some studies will address it in the future.

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# 地面型太陽光電廠或鹽灘濕地的抉擇：以權變評價法分析七股鹽灘濕地的願付價格

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「綠色衝突」指的是因為發展替代能源與自然資源保護的衝突，位於台南西南邊的七股區目前就正面臨設置地面型太陽光電廠與保護鹽灘濕地的綠色衝突。鹽灘濕地無市場評估之經濟價值但具環境外部性，故本研究利用權變評價法(contingent valuation method)對當地居民進行問卷調查，以找出民眾對於鹽灘濕地的「願付價格」(willing to pay)。研究對象為七股本地居民與台南市民眾，抽樣方式為便利抽樣法，由訪員面對面請受訪對象填寫問卷。研究結果顯示，七股當地居民的願付價格高於台南市居民，且有些七股當地居民願意付極高的價格來保護鹽灘濕地。Tobit 迴歸分析的結果顯示，年齡、教育程度與居住地為影響受訪者願付價格的三大要素。在發展替代能源的同時，各地的綠色衝突紛紛出現，願付價格顯示，雖然自然資源未具實際貨幣價值，但民眾仍願為其支付一定程度的金額以換取自然資源的存續。政府在能源轉型的過程中不可忽視綠色衝突的產生，也不應只計算有數字的成本效益，而忽略了民眾對永續發展的期待。

**關鍵詞**：能源轉型、再生能源、綠色衝突、濕地、太陽能發電

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