

The Preference evaluation of offshore wind power replace of the Nuclear power

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As stated in the amendment of Power Act in 2017/01/11, the ‘2025 Nuclear-free Homeland’ goal in which nuclear power equipment must stop running by 2025 was to be achieved. In order to accomplish the objectives of carbon reduction and ‘nuclear-free homeland’ in compliance with the policy, Taiwan government started implementing a new energy policy focusing on energy transition and development of renewable energy (Atomic Energy Commission, 2018) with a main approach of offshore wind power. According to the assessment conducted by International Engineering Consultants Ltd 4C Offshore, Taiwan’s west coast was one of the world’s most effective offshore wind energy stations (4C Offshore, 2013). For this reason, ‘Offshore Wind Power’ becomes a key project to be actively developed.

In 2018, Bureau of Energy passed the bill ‘Wind Power Initiation’ and launched a four-year project which aimed at a target onshore capacity of 1.2 GW (estimated annual energy output is 2.9 billion kWh) and offshore capacity of 5.5 GW (estimated annual energy output is 19.8 billion kWh). The total generated energy of 6.7 GW (estimated annual energy output is 22.7 billion kWh) is expected to replace the energy gap of the decommissioning of nuclear power plants by 2025 (Bureau of Energy, 2018). Although Art. 95.1 of Power Act ‘2025 Nuclear-free Homeland’ became invalid after the passage of ‘Go Green with Nuclear’ referendum in the 9-in-1 General Election in 2018, Executive Yuan informed that since life extension of current nuclear power plants was not feasible after assessment and nuclear waste problem remained unsolved, the general goal of ‘Nuclear-free Homeland’ would still be kept and the government would continue exploring renewable energy solutions which included offshore wind power and solar energy, etc. (United Daily News, 2019).

However, difficulties are faced while initiating the use of offshore wind power to replace nuclear power: (1) Since offshore wind farms will not be installed until 2020 but The First Nuclear Plant was decommissioned in 2018 and The Second Nuclear Plant

is scheduled to be decommissioned in 2021, the energy gap during this period can only be temporarily filled by thermal power generation, which would increase carbon emissions and PM2.5 in the air and public health would be greatly affected (The Liberty Times, 2017). (2) Deficits in spinning reserve caused by energy gap were magnified and examined after the event '815 Power Blackout across Taiwan'. People were panicked by power shortage and started considering whether or not nuclear power plants should be reactivated (TVBS Poll Center, 2017). (3) After selection and bidding, the average cost of offshore wind energy is estimated to be about \$4.82/kWh, which is higher than current costs. Hence the electricity price is bound to be adjusted and public acceptability should be taken into account. (4) Since the result of referendum showed that the majority of voters made an objection to 'Nuclear-free Homeland', this might bring challenges to energy transition (Taiwan Environmental Information Association (TEIA), 2018).

To sum up, although documents about willingness-to-pay for nuclear risk / climate change surveys (Chen, 2012) or willingness-to-pay for substituting nuclear power with natural gas (Lin, 2016) are available, currently no related research about willingness-to-pay for substituting nuclear power with offshore wind power can be found.

Choice experiment is a type of 'stated preference model' which can be used to calculate use and non-use value (Liu & Lu, 2017). Attributes of goods are identified and respondents are asked to make choices under different scenarios or options (Adamowicz, et. al., 1998). In comparison with other descriptive assessment methods, Choice experiment can not only provide more information but can also estimate average WTP and hidden price or marginal price of different attributes as well (Hoyos, 2010).

As offshore wind power farms have not yet installed in Taiwan, the benefit evaluation of substituting nuclear power with offshore wind power can only be conducted by setting a hypothetical market and questionnaire designed on the basis of Choice Experiment and Contingent valuation method would be adopted. By using the questionnaire survey, the willingness-to-pay for substituting nuclear power with offshore wind power can be evaluated and people's awareness of/attitude to offshore

wind power and risk of nuclear power can be explored. The objectives of the survey are summarized as follows:

1. By using the questionnaire, people in Taiwan are surveyed for their awareness of/attitude to offshore wind power and risk of nuclear power.

2. With the combination of Choice Experiment and Contingent valuation method together with designed questionnaire, the willingness-to-pay for substituting nuclear power with offshore wind power can be evaluated.

This research aims at evaluating Taiwanese people's willingness-to-pay for substituting nuclear power with offshore wind power. The empirical study uses the Choice Experiment, which is related to Conjoint Analysis, to design a hypothetical model consisting of three groups of attributes to test the possible effect that offshore wind power may bring about when any one of the current nuclear power plants is substituted. In the meantime, Random Utility Model is applied to estimate the tested sample's relative valuation degree of nuclear power plant decommissioning, benefit of terminating nuclear power, and increase of electricity price. Moreover, Contingent Valuation Method (CVM) is used to evaluate people's willingness-to-pay (WTP) for substituting nuclear power with offshore wind power and to investigate the factors that influence this willingness-to-pay.

The region chosen by this research for questionnaire survey is Hsinchu area where Hsinchu Science Industrial Park is located. In recent years, the production value of Hsinchu Science Industrial Park is more than one trillion NTD, the number of approved firms set in it is more than 520 and employees working in the park are more than 150,000 people (Hsinchu Science Industrial Park Administration, 2019). This is why it becomes a pivotal area for the country's economic development. As we know, the development of high-tech industry rely heavily on energy supply—for example, the industrial power used in Hsinchu Science Industrial Park from 2012 to 2019 goes to 55,908,737,802 kWh. And Hsinchu City has the highest share of large consumers of energy (> 800 kW) according to Taipower's statistic data. Therefore the issue of power and energy is strongly connected to the development of Hsinchu area.

On the other hand, since Hsinchu area is far from New Taipei City where The First and The Second Nuclear Plants are located and also distant from Pingtung County where The Third Nuclear Plant is located, it is not within the districts directly and urgently affected by nuclear disasters. On this account, relatively objective data can be obtained in questionnaire survey. Therefore this research take residents in Hsinchu area as population of survey to evaluate the benefit of offshore wind power compared to nuclear power.

The expected results of this research are stated as follows:

1. By using the questionnaire, surveyed people in Taiwan for their awareness of/attitude to offshore wind power and risk of nuclear power.
2. By using the questionnaire, collect empirical data which shows how people's awareness of offshore wind power and risk of nuclear power affect their willingness-to-pay (WTP).
3. By combining Choice Experiment and Contingent Valuation Method, evaluate Taiwanese people's willingness-to-pay (WTP) for substituting nuclear power with offshore wind power and investigate whether 'benefit of terminating nuclear power' or 'nuclear power plant decommissioning' will influence people's willingness-to-pay or not.

Keywords: offshore wind power, nuclear power, willingness to pay, contingent valuation method, choice experiment, risk perception