ACHIEVING THE TAIWAN'S 2020 AND 2025 CARBON EMISSIONS REDUCTION TARGETS

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Overview

Mitigating the environmental impacts caused by human activities such as global warming has become a critical issue in the post-industrial era. In response to the global GHGs mitigation trend, Taiwan government has set ambitious CO_2 reduction target by 2020 and 2025. Besides, the government has played a predominant role proposing a series of important polices related to energy savings and carbon reductions recently. For the governemnt, it is important to figure out the suitable energy portfolio from unbiased systematic results, and feasible combinations of parameters should be considered when conducting the scenario analysis. While choosing and developing the optimum long-term energy technology system, it requires to meet the three policy goals including cleanliness, safety, and competitiveness (efficiency). Additionally, economic condictions should also been taken into account when discussing the energy supply and demand. In consequance, it is essential to analyze the different pathways achieving the emission reduction targets and assess the effects caused by different power mix in each scenario.The paper is organised as follows: Section 1 is the introducion. Section 2 describes the research methodology used in this stud. Section 3 addresses the assumptions and scenario design. Section 4 presents the results and uncertainty analysis. Finally, section 6 provides the conclusions and suggestions..

Methods

This research applied the MARKAL-ED (MARKet ALlocate – Elastic Demand) model to analyze Taiwan's power supply and demand, provide a feasible solution through scenario analysis, and find the pathway to achieve the emissions reduction targets. MARKAL model is a linear programming tool supported by IEA-ETSAP (Energy Technology Systems Analysis Program). It is a technology-rich model that maps out appropriate technologies to satisfy the endogenous energy service demands under minimizing total cost. The model will arrange appropriate technologies to satisfy the endogenous energy service demands under minimizing total cost (or maximizing net total surplus). It is widely used not only for energy system research but strategy research of energy-related emission reduction. In this study, we analyzed five scenarios including two scenarios for uncertainty analysis. The main assumptions underpinning each scenario are as follows:

- $\mathbf{N_1}$: Achieve the Taiwan's CO_2 reduction targets by enlarging gas-fired generation, promoting renewable energy, and enforcing economic political actions.
- $\mathbf{N_2}$: The life extension of existing nuclear power plants provides one more solution to achieve the nation's CO_2 reduction targets.
- $\mathbf{N_3}$: Assumes that two reactors in new nuclear power plant (The 4th nuclear power plant) will begin operating in 2020 and 2025 respectively.
- $\mathbf{UC_H}$: Uncertainty analysis scenario represents high carbon emissions.
- $\mathbf{UC_L}$: Uncertainty analysis scenario represents low carbon emissions.

Results

Initially, we focus on the results of $\mathbf{N_1}$, $\mathbf{N_2}$, and $\mathbf{N_3}$ scenarios. In $\mathbf{N_1}$ scenario, the existing nuclear power plants will decommission as scheduled. Gas-fired plants will be certainly the main power generation source, and their capacities are up to 42% of the entire electricity system in 2025. Besides, under the promotion from government agency, the total capacity of renewable energy will grow to 15% in 2025. In $\mathbf{N_2}$ scenario, the development of most power generation technologies have similar trends with that in the $\mathbf{N_1}$ scenario. However, the life extension of existing nuclear power plants results in the percentage of its capacity still maintain in 8% of the entire electricity system. In $\mathbf{N_3}$ scenario, the dependence of using coal-fired plant as the option of base load power generation decreases significantly because of the usage of nuclear power. When it comes to net electricity generation, the results indicate that the net electricity generation of each scenario shows a growing trend from 2010 to 2025. Comparing to the statistical data in the base year, the net electricity generation increases almost 40% in 2025. On the other hamd, the amounts of CO_2 emissions in each scenario in 2020 and 2025 are higher than the reduction targets. The gap between CO_2 emissions and the target is especially significant in 2025, and it indicates that the emission targets could not be achieved if the agency only considers adjusting the ratio of low-carbon electricity generation with levying $13.17 /ton carbon tax. On the other hamd, trading the carbon credits is necessary. In this research, two carbon-credit prices are set as references. The lower one refers to CER (Certified Emission Reduction) average price set as $0.12 /ton-$CO_2$ in late May 2014; the higher one refers to

Taipower Company (TPC) as \$25.98 /ton-CO_2. Figure 1 summarizes the scenarios' constitution of carbon credit cost. However, in order to emphasis that purchasing carbon credit is not the only solution to reaching the emission reduction targets, this study also evaluates the impacts on electricity generation and emission reduction cost without purchasing carbon credit. The result indicates that significantly reducing electricity demand and introducing low carbon or high-effeciency technologies are major means undertaken. After discussing $\mathbf{N_1}$, $\mathbf{N_2}$, and $\mathbf{N_3}$ scenarios, we implemented an uncertainty analysis on CO_2 emissions. As shown in Figure 2, the emissions of $\mathbf{UC_H}$ and $\mathbf{UC_L}$ could be taken as the upper and lower bonnds of emissions in Taiwan. In $\mathbf{UC_H}$, the emissions are higher than $\mathbf{N_1}$, $\mathbf{N_2}$, and $\mathbf{N_3}$ due to higher GDP growth. We have to take this situation into account when evaluating the difficulties achieving reduction targets. It is necessary to further develop appropriate low-carbon technologies to provide enough electricity. After all, compelling to reduce electricity demand might cause economic impact.

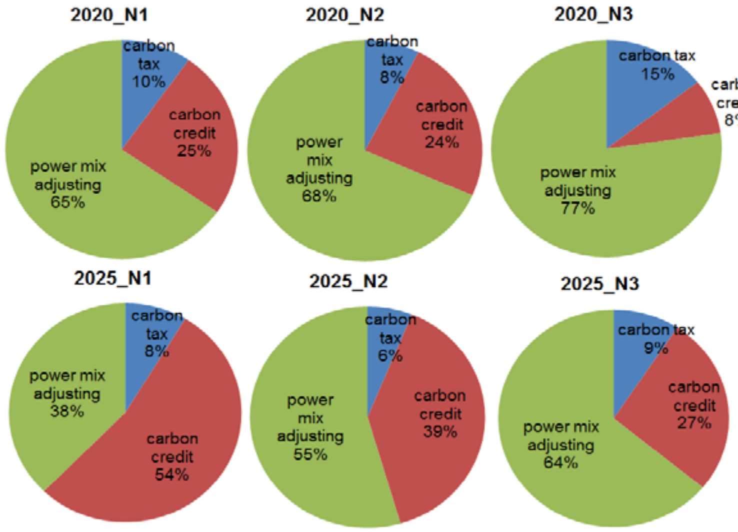

Fig.1 Constitutions of emission reduction cost in 2020 and 2025

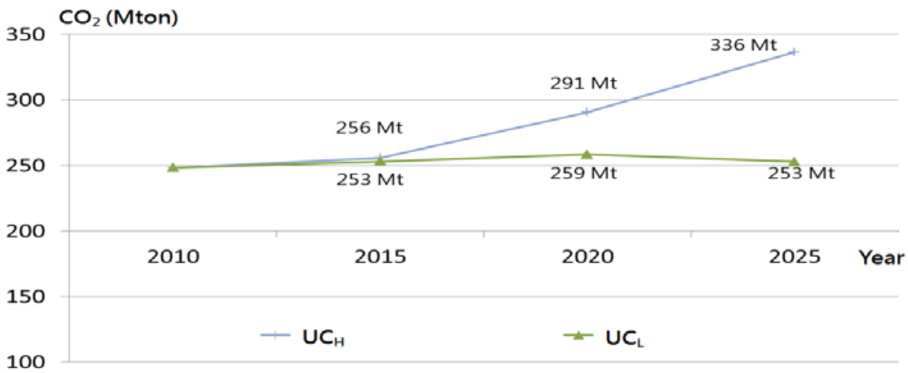

Fig.2 The CO_2 emissions of UC_H and UC_L scenarios.

Conclusions

In response to the global GHGs mitigation trend, Taiwan government has set ambitious CO_2 reduction targets. The result indicates that adjusting power generation mix including excessive usage of nature gas and the development of renewable energy could make low-carbon electricity account for more than 60% in 2025; however, compared with the government's CO_2 reduction target, the gap would still exist. It is necessary to incorporate economic political actions such as purchasing carbon credit into consideration. It is suggested that the government have to figure out coping strategies basing on the consideration of trade-off relationships embedded in each strategy. It is necessary to further evaluate the possibilities and effects of enlarging renewable policy objectives, keeping the usage of nuclear power, or purchasing carbon credit. After all, the government should adopt rolling management, and adjustments and changes can be made to energy policies over time.

References

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