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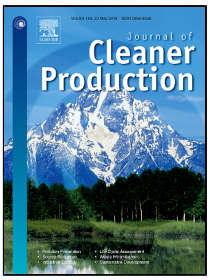

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Bioenergy Strategies under Climate Change: A Stochastic Programming Approach

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Abstract

The replacement of nuclear power with renewable energy sources is the main theme of Taiwanese energy policy. While nuclear power provides approximately 16% of total electricity supply, investigation of whether renewable energy could generate sufficient electricity to replace nuclear power becomes an important research question. Bioenergy, whose development is highly dependent on stable supply of agricultural commodities and residuals, is of particular interest to Taiwanese government because a significant amount of cropland is currently available. However, change in past climate is evidenced to alter regional temperature and precipitation, resulting in non-neglectable influences on agricultural activities and crop production, and consequently on bioenergy production. To explore how climate change plays a role in bioenergy development, this study incorporates multiple climate change scenarios and develops a two-stage stochastic programming model to analyze Taiwan's bioenergy development under different market conditions. The results show that under a small climate-induced crop yield change, net bioenergy production will not change a lot, while land use and agricultural resource allocation could vary considerably. In addition, at higher GHG prices, ethanol will not be produced and all feedstocks will be used in pyrolysis electricity, providing approximately 1.58% of total energy demand. The result also indicates that a desired level of carbon emission can be achieved, but high fluctuation of government expenses on supporting policies may occur when climate impacts are uncertain. Based on our findings, bioenergy alone is not able to provide enough electricity if nuclear power plants are shut down, and collaborative development of other renewable energy such wind power and solar energy may be required.

Keyword: climate change; crop response; mathematical programming; nuclear power; renewable energy.

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