The Future Development of Energy-Environment-Economy Integrated Assessment Modelling

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One of the greatest challenges faced by the energy and economic system is the risk of environmental and climate change. The models that have been developed to study the principle and dynamics of the energy, environment, and economic system are called the Energy-Environment-Economy Integrated Assessment Model (IAM). Since the 1980s, IAM models have played important roles in analyses of the environmental impact and climate change trends of the energy and economic system. The models have also supported the design of global policy targets that addresses climate change.

With research into energy and climate change advancing, there are several new trends appearing in IAM modelling.

Firstly, at its early stages, the IAM model mainly focused on studying variables, such as economic development, energy consumption, GHG emissions and the impact of climate change, at the global level. Since then, some simple approaches to regional IAM modelling have been adopted (e.g. the regional climate impact is determined by comparing a region's emission share to the global total). The new trend is to generate more detailed descriptions of national and regional energy-environment-economy systems and to include national policies in order to provide guidance for the country's sustainable development and climate change negotiation. For example, Professor FAN Ying's team adopts national emission allowance constraints to take the place of the inaccurate climate loss function. Some new IAM models also introduce sectoral activities, land use and water resource cycling and include population dynamic functions to study the impact of regional labour evolution on sustainable development.

Secondly, because of the complexity of the losses resulted from climate change, its measurement is no longer confined to a direct monetary amount but now takes non-market losses into account as well. This reflects a deeper understanding of sustainable development. The ideas and approaches from game theory have also been introduced into IAM modelling. Such alterations make it possible to express the opinions of different stakeholders and strengthen the role of IAM models in supporting climate change negotiations.

Thirdly, current IAM modelling not only focuses on the learning effect of low-carbon energy technology adoption, but also emphasizes the effects of R&D input and other policies on technology development. Additionally, the two-factor learning curve has been more widely used. The description of energy technologies in the new IAM model has been designed to correspond to energy policies in the real world, and technology classification has become more detailed. The technology spillover effect and diffusion barriers can be better considered in new IAM models, which also reflect global cooperation in addressing climate change.

Fourthly, the new IAM models consider co-benefits and the coordination of environmental and climate policies. Other environmental pollutions have been included in regional IAM models designed to investigate the co-benefits of GHG emission reduction actions to other pollution control. Meanwhile, the model can also evaluate the GHG emission reductions that result from environmental governance policies. Such alterations can help decision makers to design reasonable and compatible policy for environmental and climate change governance. Also, the new IAM models have been used to assess the external effects of emission abatement activities on the optimal utilization of energy, land and water resources.

In brief, the future development of IAM modelling will be more focused on policy support and on the unity of sustainability and addressing climate change in social-economic development.