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Renewable energy achievements in CO_2 mitigation in Thailand's NDCs

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ABSTRACT

Thailand had summited its Intended Nationally Determined Contributions (INDCs) in 2015 and ratified the Paris Agreement in September 2016. Its INDCs stated that by 2030 GHG emissions will be reduced by 20–25% when compared to the business-*as*-usual (BAU) scenario by using mainly domestic renewable energy resources and energy efficiency improvement. Therefore, this paper assesses the potential of greenhouse gas (GHG) emission reduction by the use of renewable energy in Thailand's INDCs and the economic impacts from GHG emission reduction. This paper employed the Asia-Pacific Integrated Model/Computable General Equilibrium (AIM/CGE). Besides the BAU scenario, four mitigation scenarios are assessed at given GHG emission levels and renewable power generation targets. Results show that Thailand's INDC can be achieved under the current renewable energy target in Thailand's Power Development Plan 2015. As a result, macroeconomic loss will be small under the light GHG reduction target; however, it will be large under the stringent GHG emission reduction target. The GDP loss ranges from 0.2% in the case of a 20% reduction target to 3.1% in the case of a 40% reduction target in 2030. Thus, the availability of land for deploying the renewable energy technologies such as solar, wind and biomass needs to be assessed.

1. Introduction

The climate change issue has achieved general consensus and become a common issue [1]. The IPCC Fifth Assessment Report (AR5) concluded that human activities are the main sources of GHG emission inducing the current climate change [2]. The current emission reduction reveals significant GHG emission gaps resulting in the global mean temperature rise of 3.7–4.8 °C by the end of the 21st century [3]. Therefore, the AR5 proposed the global carbon emission pathway to stabilize the global mean temperature to be less than 2 °C compared to the pre-industrial level and to require GHG emissions to peak before 2030 [3]. The GHG emission should decrease to net-zero emissions at the end of the 21st century. However, developing countries will require time to achieve such targets [3,4].

In order to lessen the GHG emissions while preserving both the economic growth and social development, the United Nations Framework Convention on Climate Change (UNFCCC) established an international climate agreement during the Conference of Parties (COP21) in December 2015 [5,6]. The Parties agreed to diminish the effect of climate change through low-carbon and climate-resilient development by preparing the post-2020 climate actions, so called Intended Nationally Determined Contributions (INDCs) [5–9]. The INDCs outline the intended climate actions, particularly the climate policies related to the cooperation between the government, policy-makers and infrastructure development. The agreement also stated that the adaptation plans are also engaged. Moreover, the implementation of INDCs not only guarantees the countries' commitment but also provides insight into climate actions ambition and financial supports [7]. Thus, INDCs can become key points for improving the energy production system, preventing damage to the environment through implementation of ambitious climate policies, and providing a mechanism for low-carbon development. As of May 2016, 162 INDCs have been submitted to the UNFCCC, representing 189 countries [10]. In October 2015, Thailand submitted its INDCs to the UNFCCC, in which the GHG emissions will be reduced by 20–25%. Therefore, total GHG emissions in 2030 should be approximately

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440 Mt-CO_2eq in the case of 20% reduction and 417 Mt-CO_2eq in the case of 25% reduction [11]. Fig. 1 illustrates quantified GHG emission reductions obtained from energy sector (including power sector, manufacturing industry, transport sector, and commercial and residential sector), waste sector, and industrial processes and product use (IPPU) sector by 2030. Finally, Thailand ratified the Paris Agreement in September 2016.

Several studies have focused on addressing climate change issues and INDCs through the economic development by the implementation of renewable energy. China has studied the economic aspects for achieving its INDC targets [1,12–14]. Dai et al. [15] examined the economic impacts of large-scale installation of renewable energy and its co-benefits in China and suggested that the renewable energy (RE) resources, and the availability and reformation of grid connectivity should be verified. Moreover, the installed capacity of RE will boost the RE manufacturing industries [15]. The economic impacts of international carbon market following the China's INDC target were investigated by Qi and Weng [14]. In addition, Mittal et al. [16] suggested that the role of renewable energy can reduce the economic loss and that the introduction of carbon capture and storage (CCS) can be another significant technology to control the GHG emission level [16]. Furthermore, Sundriyal and Dhyani [17] suggested that to achieve the target of 40% non-fossil fuel in its energy system by 2030, India will need 200 GW of renewable energy power plants by 2030. Altieri et al. [18] explored the economic impacts of concentrated solar power, solar photovoltaics and wind generation to achieve the South Africa INDCs. The gross domestic product (GDP) loss and welfare loss caused by renewable energy has been assessed for achieving the Vietnam INDCs target and establishes that renewable energy in the electricity generation sector could substantially reduce mitigation costs [4].

In the past few years, there have been limited studies in Thailand that investigated climate policies under a low carbon economy by employing renewable energy [19–26]. Thepkhun et al. [21] assessed Thailand's Nationally Appropriate Mitigation Action (NAMA) in the energy sector under emission trading scheme (ETS), and they suggest that the ETS plays a vital role in reducing GHG emissions through energy efficiency improvements and the implementation of renewable energy together with CCS technologies. Winyuchakrit et al. [20] investigated the potential of renewable energy for achieving a low-carbon economy and concluded that the adoption of available renewable energy could eliminate a tremendous amount of the GHG emissions from the industrial sector and the transport sector. Moreover, Selvakkumaran et al. [26] assessed CO_2 reduction potentials together with energy security, other air pollutants and marginal abatement cost through the low carbon pathway of Thailand.

Many studies have presented assessments of global and national mitigation measures with several low carbon measures [1,4,5,9,14–16,18–28]. However, to facilitate a successful global climate agreement, ambitious and stringent actions on national scale are inevitable and would be valuable to be assessed. Therefore, this paper aims to analyze two research questions: firstly, the capability of GHG emission reduction scenarios through the use of renewable energy in Thailand's INDC and, secondly, the economic impact from GHG emission reduction targets. In this paper, the AIM/CGE (Asia-pacific Integrated Model/Computable General Equilibrium) model is used for the assessment. The AIM/CGE is a top down computable general equilibrium model which vastly used for assessing the macroeconomic impact of environmental policies [15,16,27–36].

This paper is arranged into six sections. After the introduction in Section 1, Section 2 reviews Thailand's power development plan 2015 (PDP2015) and Thailand's INDC. Section 3 describes the methodology and scenarios designed which gives the basic information of the AIM/CGE model and its applications for analyzing the macroeconomic impact of environmental policies. Results, including the economic impacts in all scenarios, are presented in Sections 4.1 to 4.4. Section 4.5 discusses the implication of modeling results and limitations. Section 5 gives the conclusions and policy implications of this study.

2. Thailand energy plans related to renewable energy

2.1. Thailand's power development plan 2015 (PDP2015)

Thailand launched an updated PDP in 2015. The PDP2015 considers changes in economic and infrastructure development. In 2015 the five master plans were integrated. They were PDP2015, Energy Efficiency Plan (EEP2015), Alternative Energy Development Plan (AEDP), natural gas supply plan, and petroleum management

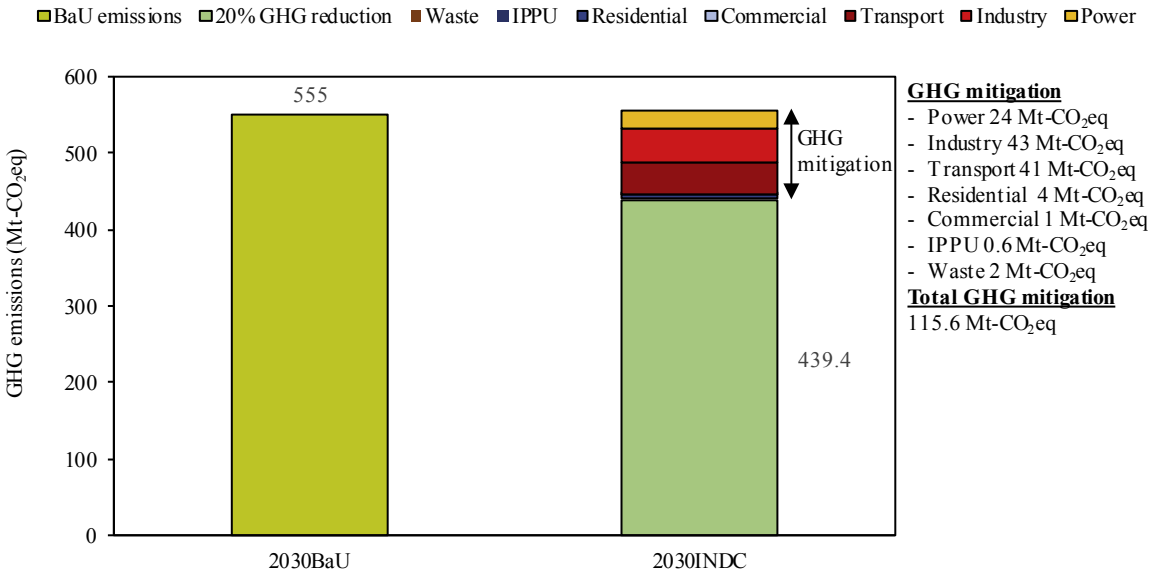

Fig. 1. GHG emissions in the BaU scenario and Thailand's INDC by 2030 [11].