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A qualitative and quantitative design of low-carbon development in Cambodia: Energy policy

Mao Hak[a,d,*], Yuzuru Matsuoka[b,d], Kei Gomi[c,d]

[a] MoE, Cambodia and Kyoto University, Japan
[b] Department of Environmental Engineering, Japan
[c] Center for Social and Environmental Systems Research, National Institute for Environmental Studies, Japan
[d] Graduate School of Engineering, Kyoto University, C-cluster, Kyoto-Daigaku-Katsura, Nishikyo-ku, Kyoto 615-8540, Japan

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ABSTRACT

The formulation of a policy for a low-carbon development plan is one of the most important steps to help Cambodia achieve sustainable development objectives, promote a greener development path, and contribute to the global effort to reducing CO_2 emissions. This study is designed to propose some low-carbon energy strategies and quantitatively to assess CO_2 emissions and reductions. The Extended Snapshot (ExSS) tool is used to quantify socioeconomic assumptions and to estimate CO_2 emissions and reduction potentials. The results show that CO_2 emissions are projected to increase to about 23,277 (by about 5.5 times) and 91,325 $ktCO_2$/year (by about 21.6 times) in 2030BaU and 2050BaU, respectively, from 4,221 $ktCO_2$/year in 2010. This study proposes five strategies for low-carbon development plan towards 2050 which are expected to reduce CO_2 emissions by about 12,826 (about 55%) and 52,153 $ktCO_2$/year (about 57%) in 2030CM and 2050CM, respectively. The present results should help researchers and experts gain a better understanding of CO_2 emissions and reduction potentials by applying a number of low-carbon measures in Cambodia. While the results should be counted as a preliminary study because of limited available country information, they are expected to provide useful insights for the government in formulating a concrete climate change mitigation policy for the country.

1. Introduction

CO_2 emissions from the energy sector had increased from about 26% in 2004 to 35% of total world anthropogenic greenhouse gas (GHG) emissions in 2010 (IPCC, 2007, 2014); however, this sector in Cambodia attributed only around 4% in 2000 (MoE, 2013). To achieve the ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC), Parties should protect the climate system on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities (UNFCCC, 1992). On this, international communities agreed to hold the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels (Article 2 of the Paris Agreement, UNFCCC, 2015). Although Cambodia is not obliged to reduce GHG emissions (MoE, 2013, 2013a), her participation could be important in contributing to the global effort to achieve the emissions reduction target (UNFCCC, 2015). Cambodia has developed a number of policies and strategies related to low-carbon development (LCD) and climate change mitigation, including its climate change strategic plan (2014–2023) (MoE, 2013a), the first and second national communication (MoE, 2013, 2002), its energy efficiency policy and action plan (MME, 2013), technology need assessment for climate change mitigation (RGC, 2013), national strategic plan on green growth (2013–2030) (NCGG, 2013), and Intended Nationally Determined Contribution (INDC) (RGC, 2015), and so forth. Thus, it is a good time to propose scenarios for the qualitative and quantitative design of a low-carbon development plan in Cambodia focusing mainly on energy policies.

The main objectives of this study were: (1) to propose several low carbon energy strategies; (2) to quantify the socioeconomic parameters and project CO_2 emissions and reduction potentials towards 2050; and (3) to conduct a systematic and quantitative assessment of CO_2 emissions reduction by using a quantitative methodology for each low carbon development strategy and associated actions. The structure of the paper is as follows: Section 2 introduces methodologies which include data quantification and assumptions in order to estimate energy demand and CO_2 emissions. Section 3 illustrates the results of energy demands and CO_2 emissions and reduction potentials. Section 4

* Correspondence to: Department of Environmental Engineering, Graduate School of Engineering, Kyoto University, C-cluster, Kyoto-Daigaku-Katsura, Nishikyo-ku, Kyoto 615-8540, Japan and MoE, Cambodia.
E-mail addresses: maohakccd.se@gmail.com (M. Hak), matsuoka@env.kyoto-u.ac.jp (Y. Matsuoka), gomi.kei@nies.go.jp (K. Gomi).

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discusses important findings and presents a low-carbon development plan towards 2050, while the last section offers conclusions and policy implications.

2. Methodologies

2.1. Scenario of the study

"Scenarios" in this study means a plausible description of how the future may develop based on a coherent and internally consistent set of social, economic, and industrial assumptions about key driving forces and relationships. The scenario for the LCD consists of two stages: 1) preparing and adjusting the tools for the Cambodian study to quantify projections, and 2) identifying the low-carbon measures based on projected quantitative information for developing a future sustainable society. The scenarios developed are valuable material for decision-makers to design an LCD with several images of the future, based on the different assumptions of socioeconomic indicators, from which decision-makers can select the most suitable for socioeconomic development and for lowering CO_2 emissions in Cambodia.

2.2. Methodology development

In order to estimate energy demand and CO_2 emissions and reduction potential, the Extended Snapshot (ExSS) tool (Gomi and Fukuda, 2010), which has been applied to several Asian countries (Gomi et al., 2009; Bundit et al., 2010; Nguyen, 2012; Tahsin et al., 2012; Ochi et al., 2013; Siong et al., 2013), is applied. It is also used to quantify information on macro-socioeconomic indicators and environmental variables. Because of the limited country information, additional calculations and assumptions are made to apply the model. A number of parameters are adjusted to reflect the real economic structure of Cambodia. The Input-Output (IO) table 2010 is converted from the IO table 2008 by using an IO table conversion tool. In addition, the Analysis of Global Energy Markets (SAGE, 2003), which is an integrated set of regional models that provides a technology-rich basis for estimating regional energy supply and demand, is used to split energy consumption by energy service sector.

2.3. Data quantification

In order to estimate the activity of industrial, commercial, and residential sectors related to a macro-socioeconomic framework, an input-output approach is applied, and adjustments of parameters are made to reflect the real economic structure of Cambodia. Using these sectoral activities coupled with energy device characteristics, energy consumption and CO_2 emissions are calculated. Based on the prescribed changes in population and numbers of households, gross domestic product (GDP), industrial structure, employment, passenger and freight transport, and energy consumption, the ExSS tool can project CO_2 emissions at present and in the future in a consistent way to assess the impact of low-carbon measures in Cambodia.

2.4. Data collection

Given the limited country information, additional calculations and assumptions were used to apply the model based on available data, historical trends, and the professional insights of the authors. The data collection was based primarily on relevant government documents and a series of discussions with key government officers, and involved institutions were conducted so as to envision the future development pathway of Cambodia. The data estimates and assumptions were done in three steps. First, relevant documents were collected and discussed with the involved government officers and experts (Table 1) to ensure the validity, reliability, and applicability of the collected information. Second, a series of workshops (Table 2) were organized to disclose a

Table 1
Lists of a number of collected documents and the interviewees who are mainly from the government officers.

Sectors	Documents	Interviewees	Explanation
Demography	Statistical Year Book of Cambodia 2011; Cambodia Socioeconomic Survey 2010 of National Institute of Statistics of the Ministry of Planning (MoP)	H.E. Mom Marady, Advisor to MoP	Discussed about demographic data and future population projection
Economy	Economic Statistics (main macroeconomic indicators) of Supreme National Economic Council (SNEC); IO table 2008 provided by Dr. Oum Sothea; Rectangular strategy phase III; National Strategic Development Plan (2014–2018)	H.E. Ung Luyna, Head of Social Policy Devision, (SNEC); Dr. Oum Sothea, Economist of Economic Research Institute for ASEAN and East Asia in Indonesia	Discussed about the IO table and its validity; Government development strategy; long term economic development target (to be an upper middle-income level by 2030 and a high-income one by 2050), etc.
Energy	Energy balance table (1995–2010) provided by Mr. Heng Kun Leang; Analysis on Energy Saving Potential in East Asia by Mr. Lieng Vuthy; National Policy, Strategy and Action Plan on Energy Efficiency in Cambodia in 2013; Power Development Master Plan towards 2030 in 2014 of the Ministry of Mines and Energy (MME)	Mr. Hang Seiha, Vice Chief of Office of Energy Efficiency; Mr. Heang Bora, Deputy Director; Mr. Touch Sovanna, Director of Energy Technique Department, MME; Mr. Heng Kunleang, Director of Department of Energy Development, MME and National Focal Point for the IEA; Mr. Por Nimol, Deputy Director General, MME	Discussed about energy efficiency development plan; long term energy demand projection; power development plan and master target. Clarified about the information used to construct energy balance table and the cooperation with International Energy Agency (IEA), etc.
Transport	Data on vehicle fleet of Cambodia in 2009; Overview on Transport Infrastructure Sectors; Annual Transport Sector Report; National Implementation Plan on Environmental Improvement in Transport Sector of the Ministry of Public Works and Transport (MPWT)	Mr. Bong Vuthy, Director of Inland Water Transport Department, MPWT; Mr. Chhreng Phollak, Director of Department of Planning, MPWT; Mr. Taing Peou, Chief of Office of Land Transport; Mr. Preab Chanvibol, Director of Land Transport Department, MPWT	Discussed about the registered vehicles; vehicle fleet data for second national communication; transport development strategy and action plan; and long term perspective, inland, air, and railway transport sector, etc.
Cross sector	Draft Second National Communication; Technology Needs Assessment and Technology Action Plans for Climate Change Mitigation; Cambodia Climate	H.E. Dr. Tin Ponlok, Secretary General of Green Growth, MoE; Mr. Sum Thy, Director of Climate Change Department, MoE	Discussed about the data used for the second national communication as some parts used for this study and technology improvement for energy and

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