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Energy scenarios for Southeast Asia

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ABSTRACT

This paper describes energy scenarios for the 10 member nations of the Association of Southeast Asian Nations (ASEAN) and the different possible development pathways that they enable. Based on these scenarios and a case study of Indonesia, we develop a set of ASEAN meta-scenarios and discuss their policy implications, illustrating the alternative pathways to resolving conflicts between traditional and more sustainable development. While most ASEAN countries are pursuing policies aimed at addressing constraints stemming from the potential impacts of greenhouse gas emissions and the cost and availability of imported oil, we find that there is a significant variation in the level of flexibility and resilience inherent in the scenario pathways that they are following. The most developed and least developed of the ASEAN member nations appear to be on policy paths aimed at maximizing their flexibility and resilience, while some rapidly growing economies appear to be moving along less flexible and resilient paths.

1. Introduction

This paper describes a set of energy scenarios for the 10 member nations of the Association of Southeast Asian Nations (ASEAN).[2] The objective is to chart ASEAN's current and projected use of energy along development pathways leading to a future in which sufficient energy is available to sustain economic growth, while improving the quality of life of ASEAN citizens and mitigating environmental impacts. The focus is on 2013 to 2020, with a longer range view to 2030. The period from 2015–2020 is of special interest since ASEAN is planned to become an integrated economic community in 2015. ASEAN includes a rapidly developing set of economies that face significant challenges in providing the energy needed for sustainable economic growth. Formerly a net exporter of oil to the rest of the world, in recent years demand resulting from strong economic growth has outpaced production and has turned ASEAN into an oil importer. Rising use of coal to satisfy the rising demand for electricity raises environmental concerns. As greenhouse gas (GHG) emissions rise worldwide, adaptation and mitigation efforts, and their concomitant costs, may pose difficult challenges for ASEAN, a region surrounded by seas and dependent on rivers for water. In recognition of these difficulties, the ASEAN Centre for Energy has developed a plan of action for energy cooperation between its member nations (ASEAN Centre for Energy, 2013), based in part on energy scenarios (Institute of Energy Economics and Japan and ASEAN Centre for Energy, 2011) developed in collaboration with Japan's Institute of Energy Economics. This paper builds on these scenarios, as well as the results of focus groups on energy security held in January 2013 in Nakorn Pathom, Thailand, and April 2013 in Jakarta, Indonesia and Hanoi, Vietnam as part of an initiative for sustainable development and eco-resilience in ASEAN jointly sponsored by the Rockefeller Foundation and the Science, Technology and Innovation (STI) Policy Office of the Government of Thailand. This project follows the "Krabi Initiative 2010" paradigm endorsed by the ASEAN Science and Technology Ministers and includes, in addition to an energy security track, a focus on improved quality of life for those at the bottom of the economic pyramid (The ASEAN Krabi Initiative, 2013). Consequently, the energy scenarios

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[2] The member nations of ASEAN are Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam.

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discussed in this paper will consider issues of sustainability, eco-resilience, and social equity.

2. Methods

This work combines two approaches to develop a set of energy scenarios that: (1) describe pathways from the present as well as their policy implications; and (2) are based on the aspirations and input of ASEAN stakeholders. The first approach analyzes energy consumption and fuel mix using a method developed and previously applied by one of the authors to analyze United States energy scenarios (Silberglitt et al., 2003). This method uses three fundamental energy system metrics: total energy consumption, the amount of Gross Domestic Product (GDP) expended per unit of energy consumed (as a measure of energy efficiency), and a fuel mix metric (as a measure of greenhouse gas impact[3]) defined by Eq. (1):

$$C = \left(t_o E_o + t_g E_g + t_c E_c\right)/t_c E, \quad (1)$$

where C is defined as the carbon content of the fuel mix, normalized to unity for exclusive use of coal, t_o is the metric tons of carbon produced per unit of oil consumed, E_o is total oil consumption, t_g is the metric tons of carbon produced per unit of gas consumed, E_g is total gas consumption, t_c is the metric tons of carbon produced per unit of coal consumed, E_c is total coal consumption, and E is total energy consumption. These metrics can be combined to provide a third metric of carbon efficiency. From Eq. (1):

$$T = t_c C E, \quad (2)$$

where T is total carbon emissions from fossil fuels in metric tons. Eq. (2) can be rearranged as follows:

$$t_c(\$GDP/T) = (\$GDP/E)(1/C). \quad (3)$$

Thus the product of the energy efficiency and the inverse of C, which we call decarbonization, is proportional to the GDP expended per ton of carbon produced (from fossil fuel use), which we call the carbon efficiency.

These three metrics allow the comparison of the energy efficiency and GHG impact of alternative energy scenarios versus total energy consumption. By including historical data in the comparisons, this method provides a way to characterize scenarios, their pathways, and the challenges and opportunities that these present. It also provides a vehicle for considering how policy actions can enable or hinder different scenarios and pathways.

The second approach uses the Three Horizons method of technology foresight (Curry and Hodgson, 2008), applied by focus groups on energy security as part of the initiative for sustainable development and eco-resilience in ASEAN mentioned in Section 1. This method starts with the 1st Horizon, the "current prevailing system," which for us is the current energy consumption, energy efficiency, and fuel mix, then jumps to the 3rd Horizon, which for us is the future vision for energy consumption, energy efficiency, and fuel mix—a future which differs for each energy scenario. The method, as elucidated by Curry and Hodgson, then comes back to the 2nd Horizon, which they characterize as a place of conflict resolution between the embryonic forms of different future visions that are beginning to grow within the 1st Horizon. In our application of this method, the focus groups discussed the problems and issues arising from current energy usage and the desirable features of their future energy visions, and then characterized the 2nd Horizon pathways in terms of the policies and actions that would need to be implemented to reach a desirable future. The most important conflicts here involved governance, availability of energy, environmental impact, and social equity. This resulted in an energy scenario logic in which alternative scenarios are defined along the following dimensions: (1) the effectiveness of actions to support energy efficiency and renewable energy: and (2) the impact of constraints such as GHG emissions and cost and availability of imported energy. When discussing and characterizing alternative scenarios, the focus groups also stressed the need to make sustainable energy available to currently underserved (e.g., rural, poor) citizens—the bottom-of-the-pyramid issue. We build on this ASEAN stakeholder focus group-derived energy scenario logic to analyze Indonesian energy scenarios and develop ASEAN meta-scenarios in Section 4.

3. Calculations

We used the following basic sources of data for total energy consumption and in calculating our metrics of energy efficiency and GHG impact for energy scenarios:

- The 3rd ASEAN Energy Outlook (see Ref. Institute of Energy Economics Japan and ASEAN Centre for Energy, 2011);
- The World Bank's online data base (As of July 30, 2013);

We relied on The 3rd ASEAN Energy Outlook for ASEAN energy projections and GDP growth projections. Actual GDP projections were calculated by applying these GDP growth assumptions to the 2010 GDP values for each ASEAN country in the World Bank data base.[4]

3.1. Level of development and energy use in ASEAN

The ASEAN economies are at various stages of development, as measured for example by per capita GDP in 2009. Singapore is the most advanced, at just under $30,000,[5] Brunei next at over $20,000, followed by Malaysia ($5400), Thailand ($2600), Indonesia ($1400), and the Philippines ($1200). The four least developed countries, with per capita GDP less than $1000, are Cambodia, Laos, Myanmar, and Vietnam. This group of countries also lags in energy efficiency, as shown in Fig. 1, which compares the 2009 per capita GDP and per capita energy consumption of the ASEAN economies with those of several developing and developed countries. The figure also shows the GDP per capita and energy per capita for the group of eight ASEAN economies

[3] Eq. (1) measures the greenhouse gas impact from fossil fuel use. Any impact from alternative or renewable energy, for example, from biomass production, is not included.

[4] We did this because the 3rd ASEAN Energy Outlook GDP projections were calculated based on World Bank data for 2007 that have since been revised. Values projected for 2020 have already been reached in some cases.

[5] All figures based on World Bank data. US dollars adjusted to constant year 2000 value are used throughout this paper.

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