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Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Drought and energy security in key ASEAN countries

F. Shadman^a, S. Sadeghipour^a, M. Moghavvemi^{b,c,1}, R. Saidur^a^a Faculty of Engineering, University of Malaya, 50603 Kuala Lumpur, Malaysia^b Center of Research in Applied Electronics (CRAE), Department of Electrical Engineering, University of Malaya, Malaysia^c University of Science and Culture, Tehran, Iran

ARTICLE INFO

Article history:

Received 19 January 2015

Received in revised form

13 July 2015

Accepted 5 August 2015

Keywords:

Drought

Climate change

Energy security

Electricity generation

Renewable energy

ABSTRACT

The availability and reliability of renewable energy sources are highly dependent on climate conditions, which may vary due to possible global climatic changes. Long-term energy planning, however, does not normally take into account future threats of climate change on energy security. This paper shows the impacts of drought, as one of the main features of climate change, on the technology of electricity generation and on CO₂ emissions in the Association of Southeast Asian Nations-6 (ASEAN-6). We provide insights into the extent of the vulnerability of electricity generation options to drought. The findings increase awareness for future planning of the energy generation mix and emphasizes on an integrated and collaborative management plan based on drought planning initiatives and measures.

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1. Introduction

The availability and reliability of renewable energy sources are highly dependent on climate conditions, which may vary due to possible global climate changes. Meanwhile, the severity of climate change is increasing due to human induced activities like electricity generation and the emission of greenhouse gases [1]. Long-term energy planning, however, does not normally incorporate future climate change variations. This may turn out to be a risky exercise for the Association of Southeast Asian Nations-6

(ASEAN-6) that is planning to rely more on renewable energy sources. Research and policy on adaptation and mitigation have largely focused on the growing share of fossil fuels in the energy mix, the increasing costs of fossil fuels and CO₂ emissions. In fact, although renewable energy is being promoted to curb greenhouse gas emissions and to reduce costs, the sources are likely to be the ones most vulnerable to climate change. Climate change and its impacts on disaster risks are threatening the electricity generation sector and making energy security a key challenge, particularly in Southeast Asia [2,3]. According to Golnaraghi [4], 85% of all natural disasters come from hydro meteorological hazards. These disasters have caused 75% of world economic losses from 1980 to 2005.

A thirty-year analysis of statistics on world natural disasters in the *Natural Disasters Data Book 2006* indicates that 90% of all the effects have been experienced in Asia with over 50% of total

E-mail addresses: foroogh.shadman@gmail.com (F. Shadman), mahmoud@um.edu.my (M. Moghavvemi).

¹ Tel.: +60 3 79676817; fax: +60 3 79675316.



Fig. 1. ASEAN countries (study area).

fatalities and economic losses [5]. The 4th Assessment Report by Intergovernmental Panel on Climate Change (IPCC) [6] expected that Southeast Asia would be seriously affected by the adverse impacts of climatic change due to reliance on natural resources in most of its economic activities. This is projected to intensify in the next 30–90 years [7,8]. Although drought, as an explicit feature of climate change, is not a new phenomenon in the 21st century, it brings many new issues and challenges to the power sector's operation and performance [1] in terms of an augmented demand for electricity due to a rise in temperature and a consequent rise in power generation capacity. Drought is exacerbating water shortages and resulting in load losses or outages, insufficient cooling water, decreasing generation efficiency and biomass fires that often coincide with periods of heavy demand, thereby forfeiting revenues [2,9]. Drought can lead to production shifts that can change the load patterns in particular areas [1]. Hence, assessment of drought impacts on changes in technology, production costs and CO₂ emissions will find significant importance to power sector development and presents a framework for investors regarding power generation.

Here we focus on drought risks and electricity generation options to address implications for energy policy and planning, recognizing that drought plays an important role in energy production and technological change. Due to the strong interrelation between energy and the economy, our scope is restricted to the six largest economies (ASEAN-6) of the Association of Southeast Asian Nations (ASEAN) in Southeast Asia (SEA). ASEAN-6 countries, illustrated in Fig. 1, include Thailand, Malaysia, Singapore, Indonesia, the Philippines and Vietnam. These countries act as a crossroad for international trade given their large populations and robust projected economic growth. They also intend to promote greater regional development through mutual assistance [10]. sharing the same tropical, hot and humid climate, ASEAN-6 nations account for more than 80% of energy demand growth in the medium term to 2030 [11]. Despite substantial studies on the implications of effective policies the growth of on renewable energy market to ensure energy security, impacts of drought on electricity sectors have not been formally explored in the region

[2,3]. We analyze the evidence from ASEAN-6 regarding the hitherto under-emphasized dimension of drought and its impact on climate change risks and responses and suggest why this dimension might advise adaptation planning.

2. Drought and power generation

With an increase in population from 1990 to 2011, electricity demand in Southeast Asia increased by about a factor of five. In the same period, carbon-dioxide (CO₂) emissions more than tripled in line with the growing share of fossil fuels in the energy mix. This has brought serious concerns regarding climate change in Southeast Asia [12]. Meanwhile, awareness of the need for action on climate change, the high price of oil and gas and the excellent potential of renewable-based electricity [12] have brought about strong motives for expanding renewable electricity generation. Renewable based generated electricity offers multiple energy security and environmental benefits, including greater diversity in the power mix and reduced local air pollution. Thus, Southeast Asia governments are prompted to set medium- and long-term targets for renewable energy production [13,14]. In the meantime, global renewable energy investors are increasingly looking towards Southeast Asia as a new destination for renewable energy investment. This is in parallel with the supportive policy framework that the countries in the region have set to attract private sector investment. The greatest potential lies in hydro resources, in particular, the Philippines, Thailand and Vietnam. To date, hydro has been the most exploited of the region's renewable energy resources with more than a quarter of the potential realized [14]. ASEAN-6 has also diverse and abundant biomass feedstock, ranging from agriculture and forestry residues to forestry products.

There is increasing evidence that developing countries are already faced with severe climatic changes [15]. According to the fourth assessment report [16] of the (IPCC), drought is a "prolonged absence or marked deficiency of precipitation that results in water shortage for some activity or for some group" or a "period of abnormally dry weather sufficiently prolonged for the lack of

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