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ScienceDirect

Energy Procedia 138 (2017) 470–475

Energy Procedia

www.elsevier.com/locate/procedia

2017 International Conference on Alternative Energy in Developing Countries and Emerging Economies
2017 AEDCEE, 25-26 May 2017, Bangkok, Thailand

Electric and Biogas Stoves as Options for Cooking in Nepal and Thailand

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Abstract

Solid biomass accounts for eighty percent cooking share in Nepal whereas in Thailand it accounts for nearly 40%. With the increase in income of the people in urban as well as rural areas, fuel switching from biomass to LPG for cooking has been the most prevalent. Domestic hydropower resources in Nepal have remained unutilized. Electricity based cooking is one of the option to reduce fossil fuel consumption in Nepal. Likewise, the use of biogas in rural areas can be another option to reduce LPG consumption as well as fuelwood consumption. In the case of Thailand, nearly 60 percent cooking is attributed to LPG based cooking. Shift from LPG to electric and biogas based cooking can reduce its dependency on LPG as well as dependence on biomass resources. This study aims to develop a business as usual (BAU) scenario and various levels of electric and biogas based cooking scenarios to analyze its implication on primary energy use, energy mix, electricity generation requirement and GHG emissions during 2010-2050 in the case of Nepal and Thailand. The study uses Asia-Pacific Integrated Model (AIM)/Enduse model, a long-term bottom-up energy system model as an analytical tool. In Nepal, fuelwood would remain the dominant source of energy during 2010-2050 in the residential sector in BAU. The consumption of imported fossil fuels would decrease with the use of electricity and biogas for cooking while that of domestic hydropower would increase. In the case of Thailand, the consumption of LPG would decrease while that of coal and natural gas would increase due to additional power generation. The national GHG emission level would decrease in the case of Nepal whereas it would increase in the case of Thailand.

Peer-review under responsibility of the scientific committee of the 2017 International Conference on Alternative Energy in Developing Countries and Emerging Economies.

Keywords: Biogas; hydropower; AIM/Enduse; CO_2 emissions; Nepal and Thailand

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Peer-review under responsibility of the scientific committee of the 2017 International Conference on Alternative Energy in Developing Countries and Emerging Economies.
10.1016/j.egypro.2017.10.227

1. Introduction

In developing countries, people in rural areas mostly rely on traditional biomass such as fuelwood, animal dung and agricultural residues in order to meet their energy demand [1]. Cooking is one of the major energy consuming end-use services in developing and under developed countries. The use of biomass is not of concern if it used in sustainable way using efficient conversion technologies. However, if used unsustainably and inefficiently, it can have adverse effects on health, environment and economy. Every year more than 1 million people die due to indoor air pollution from use of biomass. People in rural areas waste their valuable times to collect firewood for cooking which could have been otherwise used for education or income generating activities. The unsustainable use of firewood can also cause forest degradation which can cause other environmental damages like landslides and soil erosion [1]. Liquefied petroleum gas (LPG) is the most commonly used fuel in the urban areas in the developing countries. This paper aims to analyze the energy and environmental implications of replacing LPG and solid biomass by electricity and biogas for cooking in the case of Nepal and Thailand. Both countries are LPG importing countries. Nepal is a country blessed with abundant hydropower resources while Thailand has limited renewable energy resources.

In Nepal, residential sector accounts for more than eighty percent of the total energy consumption in Nepal. Traditional biomass accounts for more than 90% of the energy consumption in the residential sector, out of which 49% is consumed for cooking. Less than 6% of the cooking service demand is met by modern fuel like electricity, LPG and biogas [2]. In the case of Thailand, 24% of the population still relies on solid fuels for cooking while almost 60% depends on LPG. In urban areas, only 11.3% of the population uses solid fuels for cooking while in rural areas, nearly 48% of the population uses solid fuels for cooking. Biogas technology in Nepal has been found to benefit the country in terms of improved health, better economy, reduced deforestation and energy savings, however, so far only 9% of the total biogas potential has been utilized. [3]. Likewise, less than 2% of the hydropower potential has been utilized in the country. There are no studies that quantifies the energy and emissions related to electric and biogas cooking in long term energy planning in the case of Nepal. This study aims to analyse the effect of electric and biogas cooking in residential energy consumption and total primary energy supply, and corresponding energy related GHG emissions in the case of Nepal and Thailand.

2. Methodology

The overall framework of the study includes developing an energy system model of Nepal and Thailand; and analysing the implications of electricity- and biogas- based cooking in energy and greenhouse gas (GHG) emissions. Based on the historical socio-economic, energy consumption and technology use patterns, a bottom up long-term energy system cost minimization model of Nepal and Thailand was developed for this study. The energy model is based on Asia-Pacific Integrated model/Enduse (AIM/Enduse) framework [4]. A Business-as-usual (BAU) scenario and three cooking scenarios with various levels of biogas and electricity based cooking options were considered. The effects of cooking scenarios in the primary energy supply and primary energy mix, cooking energy consumption and cooking energy mix and the corresponding GHG emissions has been compared with the BAU. The GHGs considered in this study includes carbon dioxide (CO_2), methane (CH_4) and nitrous oxides (N_2O).

In the energy system model of Nepal, the end use service demand module has been divided into five economic sectors, i.e., residential, commercial, agricultural, transport and industrial. The residential sector is divided into two regions: urban and rural. The enduse service demand in the residential sector include lighting, cooking, water heating, space heating, agro-processing, animal feed preparation and electrical appliances. All the enduse service demand projection of Nepal has been projected based on regression analysis, with population and GDP as the drivers of service demand, following similar studies [5-7]. The cooking technology options considered in the study includes LPG, electric, biogas, kerosene, biomass (fuelwood, agro residues) and briquette based cook stoves.

In the energy system model of Thailand, the enduse services are divided into five sectors: residential, commercial, industrial, transport and power. The residential sector is divided into three regions: Bangkok, Municipal and Rural. The enduse in residential sectors includes cooking, lighting, cooling, heating, entertainment and other electrical devices. The cooking technology options in Bangkok includes electric, LPG, charcoal, biomas and kerosene based cookstoves. The cooking options in municipal and rural includes biogas options in addition.