The Philippines energy future and low-carbon development strategies

Md Alam Hossain Mondal*, Mark Rosegrant, Claudia Ringler, Angga Pradesha, Rowena Valmonte-Santos

International Food Policy Research Institute (IFPRI), 2033 K Street, NW Washington DC, USA

ABSTRACT

This paper presents an assessment of alternative, long-term energy supply and low-carbon strategies for the Philippine power sector from 2014 to 2040 using TIMES model. It examines the potential contribution of renewable energy to diversify the Philippine energy supply-mix to meet future electricity demands. The reference scenario compares the impact of four alternative policy goals: (1) carbon tax, (2) targeted renewable-based power generation, (3) limited coal share in supply-mix, and (4) renewables subsidy. The reference scenario shows a significant increase of the share of coal-based power generation and import dependency of fossil-fuel increases from 227 PJ in 2016 to 1073 PJ in 2040. The model results for the alternative policy scenarios show a large potential for renewable energy-based power generation. The alternative policy options show a significant decrease of import dependency in the energy supply-mix for power generation. Most alternative policy scenarios project a higher total system cost, with the exception of the subsidy scenario. System cost increases only 2.6% in the renewables target scenario relative to the reference scenario. However, long-term benefits from investing in the alternative policy options would need to be considered, including diversification of energy supply-mix, improved energy security, and progress toward a low-carbon society.

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1. Introduction

Energy consumption drives economic growth and is a key input for socio-economic development [1]. Access to clean energy is considered vital for modern living and a necessary element for all production sectors to function well [2]. The Philippines’ energy sector faces the dual challenges of (1) heavy reliance on fossil fuels and imported energy and (2) high energy demand. The average annual growth of Philippine gross domestic product (GDP, a notation list is given in Table 1) in the past ten years has been 5.4% [3] and the country plans to increase its GDP growth to 7% by 2040 [4]. The planned, higher GDP growth will drive higher energy demand growth.

The country's primary energy supply consists of 60% fossil fuels and 40% renewable energy. The share of oil in the total energy supply-mix is significant, at about 31% in 2014 [5,6]. The country's self-sufficiency in primary energy supply has decreased in recent years. The renewable energy share declined from 43% in 2012 to 40% in 2014 [6]. Total primary energy supply and final energy consumption were 36.01 million tons of oil-equivalent (mtoe) and 22.36 mtoe in 2006, and increased to 47.5 mtoe and 28.57 mtoe in 2014, respectively [5]. Total imported energy was 14.26 mtoe in 2006 and increased to 20.86 mtoe in 2014; this represents a share of 44% in the primary energy supply-mix. About 75% of fossil-fuel demand is met through imports [7]. Coal imports increased about two-fold between 2006 and 2014 [5]. Fuel consumption by the Philippine power sector accounts for about 46% of total primary energy. The country's demand-supply outlook between 2015 and 2030 shows an additional 7 gigawatt (GW) capacity required to meet the expected electricity demand by 2030 [6].

The Philippine power sector currently relies largely on fossil-fuels (about 77%) and is expected to increase use of coal-based plants to meet future energy demand, which would negatively affect environmental outcomes. Coal consumption in the power sector increased from 7 million tons (mt) in 2006 to 15.5 mt in 2014. Due to heavy reliance on coal-based power generation, greenhouse gas (GHG) emissions are expected to grow rapidly. CO2 emissions from coal power plants amounted to 26 mt and are projected to increase to 92 mt of carbon dioxide per year if all planned coal plants are installed [8].

The country has been suffering electricity outages or shortages, particularly during the summer months, since the 1990s. Electricity
demand was about 25.6 GWh (GWh) in 1991 and increased to about 53 GWh in 2003 and 77.3 GWh in 2014 [5]. Primary energy supply is expected to double between 2011 and 2030. Energy scarcity has detrimental impacts on economic growth. Current challenges in the electricity sector in the Philippines include a supply-demand gap characterized by unmet demand; high electricity prices; under-investment in generation; reduced self-sufficiency; and expected high growth of GHG emissions levels. A national renewable energy program was adopted to dramatically increase (three-fold) the generation capacity of renewable energy technologies for power generation by 2030 [9]; this help to substantially mitigate GHG emissions from the power sector.

To help reduce global climate change, the government of the Philippines has made a commitment to limit the future growth of GHG emissions by implementing alternative policy options, such as carbon taxes, improvement of energy efficiency in both generation and consumption, diversification of the energy supply-mix, and accelerated development of renewable energy [10]. The country intends to reduce emissions by about 70% from different sectors, such as energy, transport, waste, forestry, and industry, by 2030, compared to the business-as-usual scenario of emission levels between 2000 and 2030 [11].

Potential ways to address these challenges include diversification of the energy supply-mix and inclusion of climate-change mitigation strategies in energy development and infrastructure support. These efforts should support national economic development through employment generation, increased food security, and reduced poverty.

The renewable energy potential of the Philippines is relatively high and could contribute to the supply of modern reliable energy services and improved overall energy security. The government’s energy reform agenda highlights the importance of access to a more reliable energy supply, using indigenous energy resources while minimizing imported fossil fuels in an optimal and cost-effective way. The government’s energy reform agenda focuses on (1) ensuring energy security, (2) achieving optimal energy pricing, (3) diversifying sources of fuel, and (4) developing a sustainable energy system.

The feasibility of this type of diversification of the energy supply-mix, integration of renewable energy into the energy system, and policy implications for long-term sustainable energy policy development can be assessed by applying bottom-up energy optimization models. This can provide important insights into the implications of prospective technologies that can be pursued by the Philippine government to improve energy security and develop a low-carbon society in a cost-efficient and effective way. Energy planning using a comprehensive modeling tool helps national governments anticipate and respond to the rapid changes occurring in the energy sector, including changes in technology learning curves in lowering costs for clean energy technologies and introduction of innovative technologies. However, comprehensive energy assessment, designed to support long-term energy policy development, is currently lacking in the Philippines.

Relevant energy supply modeling tools for national and regional scale analysis include: MARKAL/TIMES, MESSAGE, POLES, and WASP [12]. The TIMES model (a successor of the MARKAL model) used in this study is the most widely used energy systems optimization model. The MARKAL/TIMES model has been used for many national [13–18], regional [19–22], and global studies [23–25].

This study develops a TIMES (The Integrated MARKAL–EFOM System) modeling framework for the Philippines to identify least-cost solutions for alternative technology selection and policy options to meet the projected electricity demand over 26 years (2014-2040). The main objective of this study is to identify alternative energy development pathways applying the TIMES optimization framework that meet the Philippines’ rising electricity demand while improving energy security, promoting access to reliable modern energy, and mitigating GHG emissions. Sensitivity analysis is performed considering variation of key parameters such as discount rates, coal price, investment cost of renewable energy technologies and impacts on natural gas supply curve.

The intention of this study is not to predict future developments of the energy sector, but rather to provide insights into the implications of different technology and energy options that can be pursued by the government of the Philippines in a sustainable way over the long term.

2. TIMES model

TIMES combines advanced versions of the MARKAL (market allocation) model. The MARKAL model is a linear programming model developed shortly after the oil crisis in 1976 by a consortium of members of the International Energy Agency’s Energy Technology Systems Analysis Program (ETSAP) to serve as an energy-system planning and optimization tool in order to understand whether: (1) alternatives to oil were technically feasible and economically and environmentally sustainable, (2) solutions were global or dependent on national circumstances, and (3) global energy research and development paths were possible or advantageous. TIMES is the successor of MARKAL and the executive committee of ETSAP began promoting the TIMES model for new
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