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The economic effects of renewable energy expansion in the electricity sector: A CGE analysis for Malaysia

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ABSTRACT

Electricity is a critical factor in developing a robust and modern economy and for improving the quality of life. In Malaysia, the electricity sector benefits from heavy subsidies to its gas inputs. Such economic interventions disrupt price mechanisms and result in inefficient resource allocations, over-consumption of electricity, CO_2 emissions, and government budget deficits. Under the Tenth Malaysia Plan price controls and subsidies have been rationalized to achieve complete market pricing. In addition, in consideration of climate change issues, environmental concerns, and strengthening energy supply security through diversification, the government encourages the use of renewable energy for electricity production through the Feed-in-Tariff (FiT) strategy. This study employs a Computable General Equilibrium (CGE) model to examine the potential impacts of gas subsidy reform in the power sector and on the Malaysian economy. The model evaluates and compares the impacts of two methods of providing funds for encouraging the development of renewable energy production, reallocating revenues from gas subsidy removal, and remunerating the FiT mechanism. The simulation results show that reducing gas subsidies without recycling the revenues gained decreases electricity demand and emissions significantly while having only minimal negative effects on macroeconomic variables. The results indicate that utilizing a recycling plan in which additional revenues from subsidy reforms are re-allocated to finance the FiT framework contributes significantly to the production of renewable energies within the power generation sector in Malaysia.

1. Introduction

Energy is a key factor that powers the economy and promotes the sustainable development of countries. The challenge of continuously generating electricity and coping with rising demand exerts enormous pressure on the energy infrastructures of both developed and developing countries. As such, governments maintain or control electricity and transport fuel prices at very low levels, especially through the provision of input subsidies or cash transfers to offset the production costs of energy producers [1].

As a developing country seeking to maintain its economic growth and promote development, Malaysia relies heavily on fossil fuels namely coal, natural gas, and oil to meet the energy demands of power producers and final commercial energy consumers. Fuel subsidies in the power sector are mainly provided for gas and oil rather than coal. Although oil-based energy generation is subsidized, the amounts are not as much as directed to the transportation and other (direct) usage sectors as its share in power generation in Malaysia is relatively small [2].

A study by Birol [3] shows that Malaysia's expenditure of US$5.7 billion on subsidies for the energy sector was the third-highest among the ASEAN-5 nations in 2010 and 2016 compared to the US$15.9 billion for Indonesia and US$8.5 billion for Thailand. Subsidies for the electricity sector accounted for nearly US$0.8 billion (see Fig. 1 for more details). [1]

The Malaysian power sector has long been reliant on gas which, on average, accounted for two-thirds of its generation, specifically after 1995. After a series of major investments in coal-fired power stations (1994), Malaysian energy policy shifted its focus back to gas which currently accounts for more than half of its generation until now.

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[1] It should be noted that the mentioned direct subsidy on electricity prices is not the focus of this study although we have noted them as part of the discussion. The focus of this study is to simulate the impacts of a consumption subsidy specific to the fossil fuels consumed by electricity producers (input) and not the electricity commodity itself (final demand).

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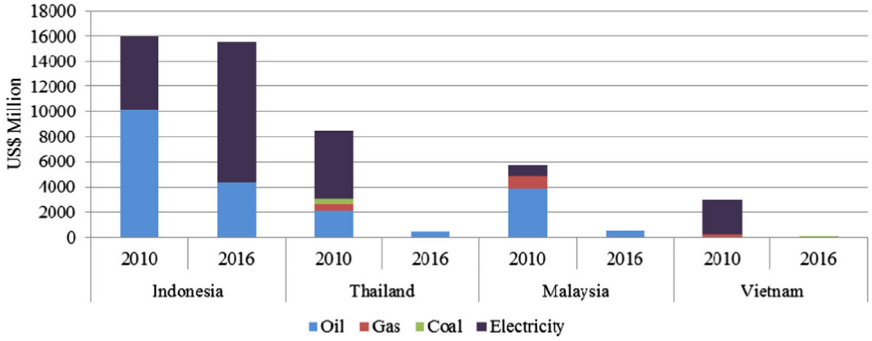

Fig. 1. Energy subsidies for selected ASEAN countries, (2010, 2016).
Source: International Energy Agency [4,5].

Therefore, gas-based generation capacity continues to be built at a rate that has barely kept pace with the domestic supply capacity of PETRONAS.[2] As shown in PETRONAS imports 36% of Malaysia's natural gas which is then supplied to Tenaga Nasional Berhad (TNB) at approximately 25% of the imported cost price and nearly half of what it costs in neighboring Singapore [2]. In 2010, the Malaysian Energy Commission embarked on gradually removing the subsidy on gas prices which increased from MYR10.70 ($3.32) per MMBtu to per MYR22 ($6.83) MMBtu by 2015 [2]. In 2015, the natural gas prices of power producers was capped at MYR15.2 ($3.90) per MMBtu compared to the market rate of around MYR46.04 ($11.8) per MMBtu [7], thus benefiting electricity producers with a 67% discount on the purchased gas price. As such, Malaysian power generators enjoy one of the cheapest gas prices in the region, behind Brunei and Indonesia [2].

Fig. 2, due to the sharp increase in world oil prices and to balance the ratio of the fuel-mix, especially since Malaysia is blessed with abundant natural gas reserves, natural gas usage has increased substantially from less than 5% in 1978 to as high as 41% in 2015.

PETRONAS imports 36% of Malaysia's natural gas which is then supplied to Tenaga Nasional Berhad (TNB)[3] at approximately 25% of the imported cost price and nearly half of what it costs in neighboring Singapore [2]. In 2010,[4] the Malaysian Energy Commission embarked on gradually removing the subsidy on gas prices which increased from MYR10.70 ($3.32) [5] per MMBtu[6] to per MYR22 ($6.83) MMBtu by 2015 [2]. In 2015, the natural gas price of power producers was capped at MYR15.2 ($3.90) per MMBtu compared to the market rate of around MYR46.04 ($11.8) per MMBtu [7], thus benefiting electricity producers with a 67% discount on the purchased gas price. As such, Malaysian power generators enjoy one of the cheapest gas prices in the region, behind Brunei and Indonesia [2].

At the same time, the growing size of the gas subsidy due to the increase in electricity consumption imposes a heavy burden on the government's budget. Since 1997, PETRONAS lost an estimated MYR238.3 ($61.1) billion in foregone revenues by subsidizing gas used by the power and non-power sectors [8]. The total value of the gas subsidy reached MYR10.9 ($2.79) billion in 2015 representing a major increase of 47.3% since 2005. Of that amount, 49.5% or MYR5.4 ($1.38) billion was for the non-power sector which includes industries,

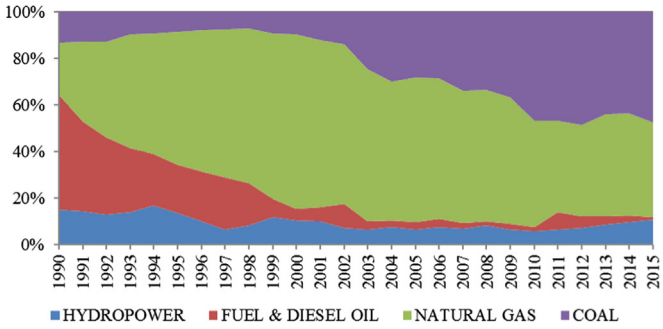

Fig. 2. Electricity generation fuel mix, Malaysia (1990–2015).
Source: author's based on [6].

and commercial and residential users, with the balance 50.5% (MYR5.5 ($1.41) billion) going for power generation. The government continues to subsidize gas by as much as 71–77%, which means lost opportunities for the country and a less than cost-efficient economy. Table 1 shows the natural gas subsidies provided to the power sector.

Although subsidies can generate social benefits in terms of improving the income distribution for low income households, the other key policy issues involved regarding the electricity sector in Malaysia are firstly, providing natural gas at a lower price to electricity producers translates into the supply of electricity with prices below actual price to the final consumers which in turn increased electricity consumption. Secondly, from a budgetary point of view, these subsidies are costly for the government since any increase in natural gas market prices would require greater budget allocations to cover the gap between domestic and market sale prices. Thirdly, in terms of the environment, while subsidized natural gas inputs have contributed to keeping emissions down, the lower prices for end-users results in increased consumption.[7] According to [9], about 47% of total CO_2 emissions from fuel combustion is produced by the power generation sector in Malaysia. Therefore, electricity generation is the largest emitting factor and its higher consumption leads to greater greenhouse-gas emissions. Fourthly, 53% of the Malaysia's total energy mix is attributed to natural gas, while gas reserves are projected to last another 32 years[8][10]. This will have implications for sustainability and energy security when the switch to alternative energy solutions such as renewable energy (RE) occurs in the fuel-mix [11]. Further, a cut in the natural gas subsidy can be used to improve productivity in the power generation sector in

[2] Malaysia's state-owned national oil company Petroleum Nasional Berhad (PETRONAS).

[3] Malaysia's National Power Corporation.

[4] Since the benchmark data used in the paper is the latest input output tables for 2010 (published in 2015) and due to the linkages between database and the real economic situation, the data presented here refers to 2010.

[5] Based on data from the International Monetary Fund (International Financial Statistics), 1 $ equals 3.221 Malaysian Ringgit or MYR (Malaysia's currency unit) in 2010.

[6] Million metric British Thermal Units or MMBtu (natural gas unit of measurement).

[7] This point is different from first one, since this mentions environmental concerns. In other words, by providing natural gas with subsidized price, contributes to keeping emissions down while an increase in electricity will increase emissions.

[8] Malaysia's natural gas reserves and production in 2010 were 88.587 (Tscf) and 2.7 (Tscf) respectively.