Chapter 7

Pricing Reform and Enhanced Investment in the Energy Sector: A Way towards East Asian Economic Development

Satoshi Kojima
Institute of Global Environment Strategies (IGES)

Anindya Bhattacharya
Institute of Global Environment Strategies (IGES)

December 2011

This chapter should be cited as
Kojima, S. and A. Bhattacharya (2011), 'Pricing Reform and Enhanced Investment in the Energy Sector: A Way towards East Asian Economic Development', in Kimura, F. and X. Shi (eds.), *Deepen Understanding and Move Forward: Energy Market Integration in East Asia*. ERIA Research Project Report 2010-25, Jakarta: ERIA. pp.191-212.

CHAPTER 7

Pricing Reform and Enhanced Investment in the Energy Sector: A Way towards East Asian Economic Development

SATOSHI KOJIMA AND ANINDYA BHATTACHARYA

Institute of Global Environment Study

The combination of energy pricing reform and energy sector investment liberalisation is thus expected to enhance economic development in the region and also to encourage people to use more efficient and cleaner fuels. This study indicates that even if the partial removal of energy subsidies has occurred, further removal can yield further benefits of market efficiency. Energy sector investment liberalisation is another important issue of energy market integration that has been associated with methodological difficulty in quantitative economic analysis. This study developed a new multi-regional computable general equilibrium (CGE) model for conducting a quantitative assessment of electricity sector investment scenario in which the investment demands in the EAS member countries projected by the International Energy Agency are met. The most interesting finding shows that introduction of FDI increases not only the national GDP of the investing countries but also the regional GDP as the whole EAS region by 0.04%.

1. Introduction

The East Asian Summit region including ASEAN and six other major economies of Asia is expected to be the economic growth hot spot over the next few decades. Being the growth engine of economic development, this region needs the attainment of dual objectives of sustainable economic development and achieving emissions reductions targets to combat global warming and climate change. Therefore, it is imperative to have an efficient and integrated energy market in the region. On one hand, efficient market can bring an affordable, reliable and sustainable supply of energy and can also ensure its effective consumption. Integrated markets can additionally ensure the trade competitiveness of the countries in the region, which can protect the economic development of individual country. The EAS region comprises 16 members, who have varied economic, social and environmental conditions. The EAS region comprises five developed, two transitional and nine developing economies with a population of more than 3 billion people. The region needs between 5 and 6 trillion USD of investment in the energy sector by 2030 to meet the tremendous energy demand required to fuel its economic growth.

Taking the note of conclusions and recommendations made in the AAECP Energy Policy and Systems Analysis Projects – ASEAN Energy Market Integration published in August 2005, which provides the starting point of the current study, we have identified the following priority issues which are required to be addressed in this region to develop a harmonized and integrated energy market:

- Removal of energy trade barriers
- Improvement of physical linkages of energy infrastructure across the EAS region
- Liberalisation of investments in the energy sector in the region as a consequence of market integration
- Energy pricing reform
- Liberalisation of domestic energy market and deregulation

However, in this study we have mainly focused on two major issues: energy pricing reform and liberalization of energy sector investments in the domestic markets. This is part of a continued effort to assess the impacts of such changes in the regional economy and environment.

Energy market integration is expected to be followed by energy investment liberalisation in the region. Investment capital is expected to flow from developed to developing countries to explore, develop and trade energy commodities across the region. It is expected that due to eased border restrictions and an improved investment environment, foreign direct investments will increase in the developing economies' energy sector. However, it is also envisaged that China and India being the two major transitional economies in this region might also get involved in supporting energy resources and infrastructure development in other developing countries.

It is also envisaged that in the process of energy market integration, member countries will make some attempts to rationalise their respective energy markets through energy price reform and more specifically by removing energy subsidies. Energy subsidies are downplaying the development prospects of the region by inserting more market distortions and revenue losses to the Governments. High subsidies are also fuelling the excess use of energy which is often imported at high cost. Therefore, energy market harmonization and integration will require a uniform and undistorted pricing system across the region so that energy can be traded freely and without much economic downturn among the participating countries.

2. Research Objectives

East Asian energy market integration is viewed as a step towards overall regional economic development and narrowing the development gap. With varied energy resources, demand and availability, the East Asian region needs a coordinated approach to harness and utilize its huge potential of energy resources to fuel its economic growth. Among various actions required for energy market integration, the removal of energy price distortions and creation of an enabling environment for investment in this sector are the two key tasks for policy makers. Across the region energy commodities are variedly taxed and subsidized which engender huge market distortion and hinder harmonization of the energy market. It is also estimated that the region needs 6 to 10 trillion USD of investment over the next couple of decades in the energy sector to meet the future demand. Such huge investment is also expected to impact the domestic and regional economy.

Given this background, our research objectives are as follows:

- Economy wide impact analysis of reduction and removal of subsidies on energy commodities; and
- Economy wide impact analysis of increasing level of investment in the energy sector.

3. Energy Price Reform

In the context of market maturity, regulation on energy commodity pricing is considered very essential. The more matured the market is, the less regulated and controlled the energy prices are. Based on this basic principle we found that countries' overall economic growth is highly correlated to energy commodity pricing regulation and control. These price controls often happen through restricted price pass-through to the consumers, which are in essence price subsidies. Subsidies are provided with the objective of protecting the poorer sections of consumers being negatively affected by international oil price fluctuation. However, often these subsidies are perverse in nature and distort the market in a bigger way while producing negative incentive for misuse and overuse of cheaper energy sources. It has been further observed that in the East Asia region energy subsidies are deep rooted in their social and political structures starting from the ages of colonization by the Western forces when providing cheaper energy to the local people was a strategy for over extraction of natural resources without much protest. Nevertheless, the presence of energy subsidies is a stumbling block for East Asian economic development via the route of its energy market harmonization. In this study we therefore, would like to investigate the market and environmental impacts of energy price reform in the form of reduction and removal of subsidies for energy commodities, in particular coal, oil, and natural gas, electricity and gas.

3.1. Model

We employed the Regional Environmental Policy Assessment (REPA) model for assessing the potential impacts of energy pricing reform in the EAS region. The REPA model is a multi-regional computable general equilibrium (CGE) model developed based on the GTAP-E model (Burniaux and Truong 2002) for conducting integrated policy impact assessment encompassing environmental, economic and poverty impacts in East Asia (Kojima 2008). The version of the REPA model applied to this subsidy analysis employs 22-region 32-sector aggregation of the GTAP database Version 7 (see Annex-I and II), in which all the 16 EAS members are treated as a single region.[1] The sectoral aggregation maintains the most detailed energy sector (commodity) classification of the GTAP database where six energy sectors are classified.

3.1.1. Recursive Dynamic Setting

The REPA model incorporates dynamics towards 2020 by solving for a series of static equilibria connected by exogenous evolution of macroeconomic drivers. For each time step, the following macroeconomic drivers were exogenously shocked to update the data sets: Population, Capital stock, Skilled and unskilled labour and Economy-wide total factor productivity (TFP).

Except for economy-wide TFP, growth rates of exogenous drivers and GDP were estimated based on the unpublished macroeconomic projections of the Center for Global Trade Analysis at Purdue University. Then, growth rates of economy-wide TFP were obtained by calibration against the projected GDP growth and other macroeconomic drivers. It is worth noting that this methodology does not use an equation of motion of physical capital to update the stock of physical capital. The employed methodology assumes that the evolution of the economy during each time step is represented as the shift of steady-state equilibrium caused by exogenous shocks. This method is consistent with the steady-state equilibrium assumption underpinning static general equilibrium theory. The current study employed single time step for the entire simulation period (2004-2020).

[1] GTAP Version 7 data set aggregates Brunei Darussalam and Timor-Leste as one region (labelled as other South-east Asia), but we assume that this region represents the economy of Brunei Darussalam as its GDP share based on 2008 World Bank GDP ranking reaches 95.8%.

3.12. CO_2 Emission Module

The current version of REPA model employs a different approach to calculate CO_2 emissions from the GTAP-E model. The REPA model calculates CO_2 emissions based on fossil fuel consumption by each industrial sector as well as final consumers (private households and the government) and deduces fossil fuel uses as feedstock. The GTAP-E model focuses on the supply of fossil fuels to the domestic market. The GTAP-E model deduces crude oil use by the petroleum and petroleum and coal products sector only, but applying this method to the energy volume data included in the GTAP version 7 data sets with coefficients provided by Lee (2008) resulted in a significant overestimation (by 11.8 % as the whole world) compared with the CO_2 emission data for the GTAP version 7 (Lee 2008). Therefore we added other potential feedstock usage of fossil fuels and we finally deduced the following fossil fuel uses as feedstock purposes:

- Coal (coa), crude oil (oil) and petroleum and coal products (p_c) used by the petroleum and petroleum and coal products sector (p_c)
- Natural gas (gas) used by the gas manufacture/distribution sector (gdt)
- Petroleum and coal products (p_c) used by the chemical, rubber, and plastic products sector (crp)

This method resulted in a slight underestimation (by - 0.9% as the whole world), which seems reasonable as some portion of the deduced usage may include combustion usages in reality.

3.2. Database Construction

Identification of actual subsidized energy commodity is a challenge due to very complex pricing mechanism. Starting from well head to retail pump there are several taxes and duties levied on the energy commodity in various stages. Moreover, across the region there are different types of price protections given by the national Governments which affect the final pricing of the commodities in the markets. The majority of them come in the form of reduced taxes and duties on occasions of higher international crude oil price. Energy price pass-through is an overall indicator of such price protectionism based on the price-gap concept, which is used to identify subsidized commodities in the retail market.

Using the price gap analysis followed by the price pass-through test, it has been identified that in the East Asia Summit region there are mainly three types of refined fuels in the markets whose retail market prices are less than the actual market determined prices: Domestic LPG, kerosene and transport diesel. All these fuels' market prices are not fully pass-through in the case of international crude oil price changes during 2004 and 2005. These are the subsidized fuels which are in general prevailing across the region in all the 16 member countries. Other fuel types more or less follow full market price pass-through except certain exception like gasoline in Indonesia and Malaysia.

In the GTAP database and model there are three types of prices: producers' price, market price and consumers' price. From the zero profit condition we obtain the producers' price. From supply and demand equilibrium, otherwise known as market clearing condition, we obtain market-determined prices. Finally from the household welfare maximization we obtain the consumers' price. Though the prices are determined separately and endogenously, they are linked to each other via government intervention as taxes or subsidies. The final prices of fuels in the market comprises both producers' tax/subsidy and consumers' tax/subsidy. If P_H, P_D and P_Y are the consumer price, market price and producers' prices of some domestic fuel, say kerosene, then they are linked as follows in the GTAP model:

$$P_H = P_Y\,(1+\alpha)\,(1+\beta)$$

$$P_D = P_Y\,(1+\alpha) \text{ and}$$

$$P_H = P_D\,(1+\beta)$$

Where, α is the producer' tax/ subsidy and β is the consumers' tax/subsidy (sign is positive when it is tax).

It has been observed that for the domestic subsidized fuels (kerosene, LPG and diesel) the subsidies are provided at the consumer price end rather than producers' price end.

In the GTAP 7 database, we have petroleum and coal products (p_c) as a combined sector which includes all the major refined petroleum products: gasoline, diesel, aircraft fuel, kerosene, LPG, lubricants, naphtha and other petroleum products like coke and bitumen. GTAP records all these items together as net taxed mainly due to heavy taxation on gasoline, aviation fuel, naphtha and fuel oils. Across the region all these petroleum refined products are taxed domestically at different stages of their production chain. In the context of energy subsidy removal for full-scale price pass-through in the region, it is necessary to differentiate the taxed and subsidized items from the common heading of petroleum and coal products in the GTAP database. Based on the above discussion, we have further created two different sectors after separating the petroleum and coal products combined sector as follows:

- **p_c_tax:** This includes all commercial fuels which are primarily taxed in all the countries in the EAS region. This sector includes gasoline, naphtha, fuel oil, heavy oil, lubricants, petroleum coke and bitumen and other refinery products.
- **p_c_sub**: This includes all domestically used fuels plus fuel that affects household disposable income, i.e. transport diesel. It is assumed that the transport diesel price is highly elastic to the consumer price index and cost-push inflation in the market. So in most countries the transport diesel prices are not fully passed through to the market. Remaining fuels are domestic LPG and kerosene which are often subsidized as a welfare measure of the Government.

Figures 1 and 2 show the major country-wise percentage distribution between commercial and domestic use fuels as per our given definitions above. This indicates that in the region, developing countries have more price supported fuels for domestic users than developed countries and, excluding gasoline, diesel fuel comprises the majority of petroleum refined products. Therefore, continued price support for such a major fuel will have significant economic impacts.

Figure 1. Country-wise Composition of Supply of Petroleum Products

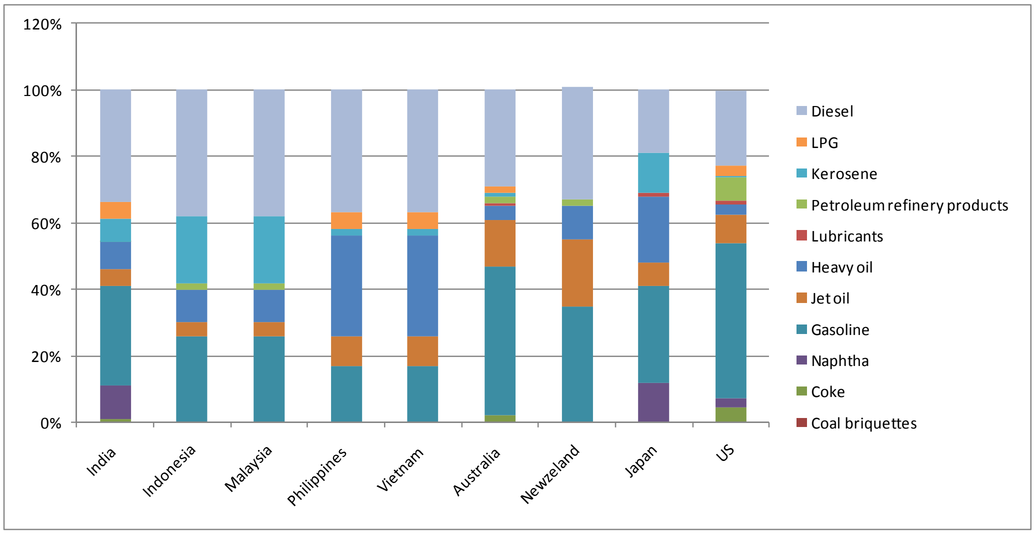
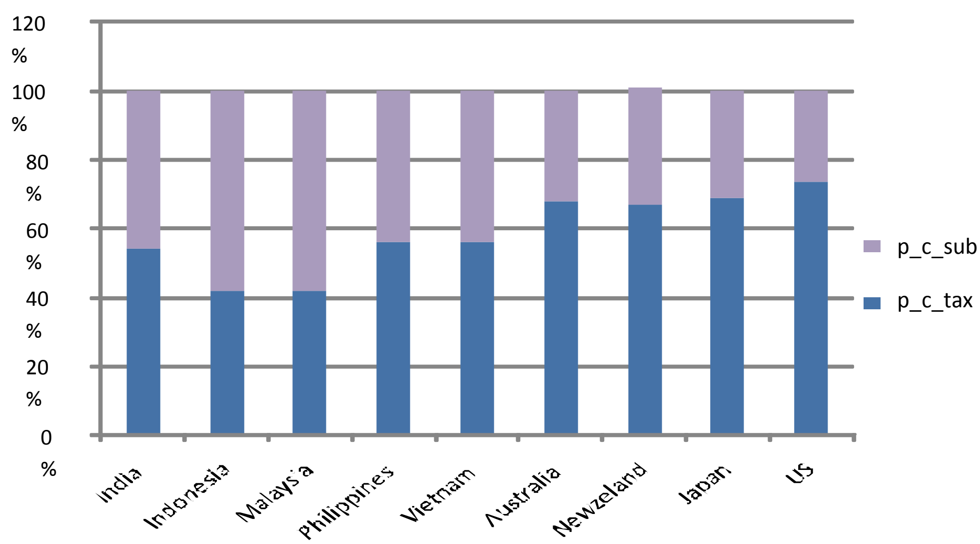


Figure 2. Country-wise Ratio of Taxed and Subsidized Fuels



In the process of conducting GTAP 7 database splitting, we need detailed information on production, consumption, export and import values of commercial and domestic fuels which are at present aggregated under the petroleum and coal products sector. Though data availability is very poor, especially for domestic fuels like kerosene and LPGs in the developing countries, we used the following assumptions to simplify the splitting process.

- For splitting production inputs such as capital, labour and intermediate inputs, we assume that the input shares for the domestic and commercial fuels are the same as those of crude oil intermediate input. Crude oil is the single largest intermediate input for all these fuel commodities.
- We obtained export and import data of domestic and commercial fuels and the ratios used to split the petroleum and coal products sector export and import values from the national statistics.
- We use the same ratio of consumption of domestic and commercial fuels in the market for splitting the value of household purchase of domestic and commercial fuels. These ratios are obtained from the refined fuels consumption data for each country. The same ratios have also been used to split household imports and intermediate purchase and imports.

We have used the Splitcom Software developed by Monash University in Australia to split the GTAP 7 database with our desired sectoral disaggregation of p_c_tax and p_c_sub. The software can use varieties of information on different parameters to split the variable into desired sub categories. In general, the standard splitting occurs under the assumption of equal ratio of 50-50 of all the factor inputs, intermediate purchase, imports and exports and also among household, government and intermediate firms' consumption. However, simple level splitting was not useful for this study as it dealt with the tax and subsidies related to the energy commodities. Splitcom also provides an option to disaggregate the sector using market prices and taxes (altogether the agent's price).

During the process of subsidy data collection it has been identified that the majority of the subsidies are going to the consumers rather than the energy producers. As a matter of fact, the GTAP recorded Producers' Tax (i.e. PTAX) were not subject to our modification. We only focused on consumer level taxes and subsidies (i.e. DPTAX) which are determined in GTAP as the difference between the VDPA (value of domestic purchase at agent's price) and VDPM (Value of domestic purchase at market price). In general if the difference is positive then consumers are paying tax for that commodity to buy and if it is negative then it is subsidy for the consumers. Therefore, in the Splitcom software we used the output, supply and price level splitting for the consumers which are denoted by the row weights in the split matrix. Colum weights represent the splitting weights of the producers of the commodities using different factor inputs and intermediate commodities including labour and capital. As PTAX is not the target of our analysis, we therefore, used the standard ratio of 50-50 split of the base price and taxes of all the inputs for the production. Table 1 shows the final splitting ratios that have been used for the consumption and production side splitting of the petroleum and coal products sector of the GTAP 7 database.

Table 1. Final Splitting Shares Used for Splitcom Splitting User Weights Preparation

	Petroleum and Coal Products Consumption Share		Petroleum and Coal Products Import Share		Petroleum and Coal Products Export Share		Petroleum and Coal Products Output Share	
	p_c_tax	p_c_sub	p_c_tax	p_c_sub	p_c_tax	p_c_sub	p_c_tax	p_c_sub
China	0.46	0.54	0.60	0.40	0.60	0.40	0.54	0.46
Japan	0.70	0.30	0.69	0.31	0.69	0.31	0.69	0.31
Korea	0.70	0.30	0.69	0.31	0.69	0.31	0.69	0.31
Cambodia	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Indonesia	0.11	0.89	0.10	0.90	0.16	0.84	0.16	0.84
Laos	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Myanmar	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Malaysia	0.11	0.89	0.10	0.90	0.16	0.84	0.16	0.84
Philippines	0.56	0.44	0.56	0.44	0.56	0.44	0.56	0.44
Singapore	0.70	0.30	0.74	0.26	0.74	0.26	0.74	0.26
Thailand	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Vietnam	0.56	0.44	0.56	0.44	0.56	0.44	0.56	0.44
Brunei	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
India	0.46	0.54	0.60	0.40	0.60	0.40	0.54	0.46
Australia	0.62	0.38	0.69	0.31	0.41	0.59	0.68	0.32
New Zealand	0.59	0.41	0.67	0.33	0.67	0.33	0.67	0.33
Brazil	0.46	0.54	0.60	0.40	0.60	0.40	0.54	0.46
EU	0.70	0.30	0.74	0.26	0.74	0.26	0.74	0.26
USA	0.70	0.30	0.74	0.26	0.74	0.26	0.74	0.26
Russia	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
MENA and Venezuela	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Rest of the world	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50

The major problem that we faced in the database preparation was data inconsistency between the GTAP record and subsidy data recorded from other external sources. GTAP doesn't record subsidies separately in the database. So we had to collect from third party sources which were often very large compared to the total output values. As a result, it was impossible to use the collected information as subsidy amount for p_c_sub commodity as it was creating negative agents' price for the particular energy commodity. In other words, consumers are getting paid for buying the commodity. In reality this situation doesn't exist. We had to make the subsidy data consistent with the GTAP recorded data on VDPA and VDPM for each commodity. To do so, we made some data adjustments using the following assumptions:

– If the country's VDPM of petroleum and coal products sector is higher than the total subsidy amount recorded from the external sources, then we will take the whole amount (100%) as consumer subsidy for the petroleum and coal products sector for that particular country.

– If the VDPM of petroleum and coal products sector is lower that the total subsidy amount recorded from the external sources then for the East Asian developing countries we use the ratios between 30-40% as the consumer level subsidies depending upon the country's energy sector profile, total amount of subsidy paid and historical trends of subsidy etc. As a result, Indonesia and Malaysia falls under the highest level, i.e. 40% of total subsidy goes to the consumers and 30% is for the transitional economies like China and India. However, due to data inconsistencies, our adjustments are envisaged to undermine the total impacts of subsidy in the analysis. It is partial in nature and therefore, the impacts are also indicative and partial. Table 2 shows the adjustments in the total subsidy amount which are used for the analysis.

Table 2. Adjustment of Subsidy Amounts for GTAP Base Data Consistency

Region	Actual Subsidy Amount Recorded (M$)	GTAP Derived VDPM for p_c_sub (M$)	Subsidy Removal for the Simulation (M$)	Adjusted Subsidy as % of Total Recorded Subsidy
China	27,800	8,657.7	8,340	30%
Japan	465	4,366.3	465	100%
Korea	400	1,895.1	400	100%
Cambodia	300	13.8	0	0%
Indonesia	11,400	4,616.5	4,570	40%
Laos	N/A	7.4	0	0%
Myanmar	N/A	87.8	0	0%
Malaysia	3,500	1,803.1	1,400	40%
Philippines	200	275.7	200	100%

Table 2. ***(Continued)***

Region	Actual Subsidy Amount Recorded (M$)	GTAP Derived VDPM for p_c_sub (M$)	Subsidy Removal for the Simulation (M$)	Adjusted Subsidy as % of Total Recorded Subsidy
Singapore	0	58.3	0	0%
Thailand	3,100	2,006.0	1,240	40%
Vietnam	1,400	74.0	0	0%
Brunei	2,000	33.9	0	0%
India	18,300	7,199.7	5,759	31%
Australia	8,000	1,230.9	615	8%
New Zealand	N/A	250.3	0	0%
Brazil	1,000	4,209.5	1,000	100%
EU	3,900	14,155.2	3,900	100%
USA	184	24,185.0	184	100%
Russia	38,700	3,726.8	1,863	5%
MENA and Venezuela	9,000	8,740.4	8,653	96%
Rest of the world	270,000	19,356.3	9,678	4%

With this subsidy data we further developed the splitting ratio of the subsidised energy commodity prices for their base value and the tax/subsidy amount. In addition, we used the ratios mentioned in the table 1 under the column heading of consumption, export and import for the output and supply ratio of the taxed and subsidized petroleum commodities. Finally, using all these ratios we created the final weights for splitting the petroleum and coal products sector in the consumer side in the database. For the producer side, where petroleum and coal products is used as production intermediates of other goods and services, we used the output ratios mentioned in the table 1, determined from the national refinery through-put. For intermediate supply we used the 50-50 ratio between domestic and import supply and for the base and tax, we also used a 50-50 share.

After aggregating all these ratios we finally derived the column weights for splitting the petroleum and coal products sector from the producers' point of view. Splitcom finally use the row and column weights all together to split the original GTAP 7 database petroleum and coal products sector into p_c_tax and p_c_sub sectors. Moreover, after splitting the database it is appeared that very few countries are actually net subsidized. In our estimation, Indonesia, Cambodia and Brunei are net subsidized. In the policy simulation we could only reduce subsidies from these countries in the East Asia Summit region.

3.3. Simulation Results

After adjusting the subsidies that can be reduced or removed without creating the negativity of the VDPA (which otherwise makes the energy commodity free of charge), we shocked the model with the 100% subsidy removal policy. This 100% subsidy removal is not the 100% actual amount of subsidy removal that exists in the market. The simulation results are analysed for three main indicators of the economy and environment: GDP as macro economic performance indicator, equivalent variation to measure social welfare and CO_2 as the environmental indicator. Table 3 shows the simulation results.

Table 3. Percentage Change to BAU 2020

Regions	Real GDP	CO_2	EV	Regions	Real GDP	CO_2	EV
China	-0.002	0.05	0.03	Brunei	-0.073	-0.85	-0.80
Japan	0.007	0.19	0.04	India	0.259	0.04	0.08
Korea	0.005	0.19	0.08	Australia	0.007	0.12	0.03
Cambodia	0.000	-0.06	0.01	New Zealand	0.004	0.14	0.05
Indonesia	0.812	-10.84	1.98	Brazil	-0.006	0.12	0.02
Laos	-0.157	0.02	0.01	EU	0.004	0.10	0.03
Myanmar	-0.048	0.09	0.04	USA	0.002	0.08	0.02
Malaysia	-0.017	0.06	-0.05	Russia	-0.039	0.16	-0.12
Philippines	-0.005	0.09	0.05	MENA and Venezuela	-0.034	0.12	-0.17
Singapore	-0.027	0.65	-0.07	Rest of the world	-0.003	0.07	0.00
Thailand	0.002	0.12	0.12	Total	0.010	-0.11	0.03
Vietnam	-0.023	0.03	-0.04	EAS Total	0.046	-0.50	0.14

The simulation results show that the removal of energy subsidies has all the positive impacts on the economy and the environment as desired. Subsidy removal works as a productivity efficiency improvement booster and agent for reduction of market distortions, which resulted in higher economic output. This has been reflected in the regional as well as domestic macroeconomic performance. As we mentioned earlier, due to subsidy data adjustment we only found Indonesia, Brunei and Cambodia as net subsidized countries. Due to subsidy removal they are the highest gainer of macroeconomic benefits and social welfare, including emissions reduction. Indonesia's economic gain is the highest among all other countries in all aspect. As a matter of fact, the whole region benefits even though only a few countries remove their energy subsidies.

3.4. Policy Implications

The major policy implication of this study is demonstration of the benefits of energy price reform on the economy, social welfare and environment as a whole. For example, a 475 Million USD equivalent subsidy removal[2] from the Indonesian domestic energy retail market (mainly the consumers' subsidy) resulted in a 10% decrease in the total amount of demand for domestic subsidised energy commodities i.e. kerosene, LPG and diesel compared to the baseline scenario. Policy makers in general perceive energy subsidies as a tool to provide social welfare to the poorer sections of their nations. Amidst increasingly volatile energy market, especially due to extreme uncertainties in the international prices, the East Asian Summit region seemingly face difficulties in continuing with the huge burden of subsidies. This study shows an indication that even a small removal or reform of the energy pricing could fetch desired results for policy makers. It is demonstrated that the common perception of subsidy removal that it will affect the welfare and national GDP due to inflationary effect of energy price increase, may not be correct for this region. There is ample evidence that energy price reform can bring larger benefits to the countries.

4. Energy Sector Investment

It is envisaged that the energy market integration will create an environment for satisfying anticipated energy sector investment demand by foreign direct investment (FDI) or domestic investment. According to the World Energy Investment Outlook

[2] Due to data inconsistency between the GTAP 7 database and the externally collected energy subsidy data for Indonesia, it appears in the modified GTAP 7 database that Indonesia is having 457 Million USD net subsidies in the economy on 2004. In this study we simulated the scenario of removal of entire 457 Million USD as a policy measure to reduce energy subsidies in Indonesia. Work needs to be done to remove these discrepancies and match the subsidy amount with the reality. However, rather than precisely, this simulation indicates the impacts of energy subsidy removal on the economy and environment more on direction of changes. This can help policy makers to further think on how to deal with the energy subsidy issues in the market.

2003 (IEA 2003), the electricity sector obtains the majority of energy sector investment, around 60-70% of the total. In this section we first assess the potential impacts of satisfying projected electricity sector investment demand without FDI. Then, we illustrate how FDI inflow would change the results.

4.1. Model

In computable general equilibrium (CGE) models, investment is usually specified as domestic investment such that all the household savings are invested to nationwide capital stock. The sectoral capital input is determined endogenously based on profit maximisation, conditional on factor price and market equilibrium, which determines the equilibrium factor price. It is a rather difficult task to simulate sector specific investment using CGE models due to this endogenous sectoral capital allocation determination mechanism. We found that the standard CGE models such as the GTAP model have practical difficulty in giving exogenous shocks to sectoral factor inputs, and we instead employ a multi-sectoral Ramsey-Cass-Koopmans type growth model to conduct energy sector investment analysis. In this model the household saving rate is endogenously determined based on dynamic utility maximisation of the representative household. Instead of conventional perfect foresight assumption, we employ a simple expectation formation process for households in which households assume that exogenous variables will stay constant at their current levels (Kojima 2007).

Production technology is specified as a Leontief function for intermediate goods and CES (constant elasticity of substitution) function of factors of production. Production factors are capital, skilled labour, unskilled labour, land and natural resources. Capital and labours are mobile across sectors, while other factors are sector specific. Similar to the pricing reform simulation, the growth rates of labour endowment were estimated based on the unpublished macroeconomic projections of the Center for Global Trade Analysis at Purdue University.

Based on the GTAP version 7, we constructed a global social accounting matrix (SAM) with 11-sector and 22-region aggregation. The regional aggregation scheme is the same as pricing reform simulation, while the sectoral aggregation scheme is much simpler than the pricing reform simulation as shown in Table 4.

Table 4. Sector Aggregation Scheme

Code	Sector	Code	Sector
xag	Agriculture, forestry and fishery	p_c	Petroleum and petroleum and coal products
coa	Coal mining	ely	Electricity
oil	Crude oil	gdt	Gas distribution
gas	Natural gas	trp	Transportation
omn	Other mining	xsv	Other services
xmf	Other manufacturing		

Commodity trades are specified through the world market assumption. Given domestic and world prices, producers allocate their products to domestic and world markets according to the CET (constant elasticity of transformation) equation. Imported and domestically produced commodities form a CES composite (the Armington assumption). Note that accommodating endogenous determination of both export and import sides requires the world market clearance in which exported commodities from all sources are mixed and bilateral trade flows are not traceable. If policies affecting bilateral trade flows (such as import tariff reduction) are important, endogenous determination of either export or import must be abandoned and the world price is no more the market clearing price. For example, the GTAP model discards the export side optimisation and the bilateral trade flows are completely determined by import demands.

Another unique feature of our model is the introduction of FDI. In our model, household savings can be invested not only in domestic capital stock but also in the capital stock of other regions. The household receives a return from FDI while the capital goods corresponding to the invested amount are produced in the recipient region.

4.2. Policy Scenarios

First, we simulate the business-as-usual (BAU) scenario against macroeconomic projections of population and non-capital factor endowments. Then, the electricity sector investment scenario (INV) is simulated with exogenously given electricity sector capital input reflecting the projected electricity sector investment. The INV scenario assumes no FDI, while the FDI scenario introduces FDI in addition to the electricity sector investment scenario same as the INV scenario.

Annual electricity sector investment of the EAS member countries is estimated based on IEA's World Energy Outlook 2003 as shown in Table 5.

Table 5. Annual Electricity Sector Investment Demand in EAS

Unit: (Mil. USD/yr)

Regions	Annual Demand	Regions	Annual Demand
China	47,800	Philippines	1,200
Japan	14,442	Singapore	331
Korea	2,097	Thailand	2,296
Cambodia	69	Vietnam	611
Indonesia	3,617	Brunei	79
Laos	35	India	14,500
Myanmar	110	Australia	1,977
Malaysia	1,632	New Zealand	299

Source: Authors' estimation based on IEA (2003)

Then, the exogenously fixed electricity sector capital inputs are determined by the equation of motion of capital stock.

Under the FDI scenario, it is assumed that Japan, Korea, Singapore and Australia provide FDI to ASEAN members (excluding Singapore), China and India. The amount of FDI flown into each recipient country is equal to the 10% of the estimated electricity sector investment, and the FDI inflow is provided by the four countries with equal share (25%).

4.3. Simulation Results

Table 6 shows the impacts of two policy scenarios (INV and FDI) on real GDP. Please note that due to technical reasons the following simulation results were obtained based on 2004-2005 simulation period.

The assessment results show that meeting electricity sector investment demands without FDI can provide mixed economic and environmental impacts. As this simulation gives exogenous shock to electricity sector capital input, it results in negative impacts for the whole EAS region of 0.06%. This is understandable, because the employed model assumes that general equilibrium is already attained in the base year BAU, and the exogenous shock to electricity sector's capital input necessarily causes market distortion. In the real world, insufficient electricity supply due to insufficient accumulation of capital incurs social and economic loss, most notably energy poverty.

For example, a lack of electricity supply makes fresh food storage impossible in Indian rural areas and results in huge economic losses. Modelling such reality remains as a challenge.

Table 6. Impact on Real GDP

(% change from BAU)

Regions	INV	FDI	Regions	INV	FDI
China	-0.13	-0.46	Vietnam	0.00	-0.15
Japan	-0.03	0.10	Brunei	-2.14	-5.56
Korea	-0.06	0.29	India	0.04	-0.09
Cambodia	0.03	-0.08	Australia	-0.14	0.33
Indonesia	-0.16	-0.22	New Zealand	-0.03	-0.04
Laos	-0.01	-0.18	Brazil	0.06	0.05
Myanmar	-2.13	-2.24	EU	-0.01	-0.02
Malaysia	0.10	0.00	USA	0.00	-0.01
Philippines	0.08	-1.29	Russia	0.01	0.03
Singapore	-0.01	2.12	MENA and Venezuela	0.01	0.05
Thailand	-0.09	-0.18			
Rest of the world	0.00	-0.01	EAS Total	-0.06	-0.02

It is interesting that the introduction of FDI mitigates this negative economic impact by 0.04%. The results of FDI scenario show that four FDI investing countries gain from FDI. Table 7 shows the impacts of policy scenarios (INV and FDI) on CO_2 emissions.

Table 7. Impact on CO_2 Emissions

Regions	INV	FDI	Regions	INV	FDI
China	1.04	1.02	Vietnam	-0.03	-0.10
Japan	-0.34	0.70	Brunei	32.19	29.96
Korea	-0.27	-0.19	India	0.76	0.73
Cambodia	2.72	2.45	Australia	-1.02	-0.72
Indonesia	2.08	2.08	New Zealand	-0.18	-0.20
Laos	1.80	1.74	Brazil	-0.04	-0.07
Myanmar	-1.80	-1.78	EU	-0.02	-0.04
Malaysia	0.45	0.44	USA	-0.01	-0.03
Philippines	5.96	9.50	Russia	-0.01	-0.05
Singapore	-0.33	-0.03	MENA and Venezuela	-0.01	-0.06
Thailand	-0.62	-0.60			
Rest of the world	-0.02	-0.04	EAS Total	0.60	0.80

The introduction of FDI further increases the region wide CO_2 emissions. This result reveals the limitation of our analysis in which environmental benefits of energy sector investment such as replacement of inefficient energy technologies by cleaner technology are not reflected. This remains an important challenge for the future study.

Lastly, Table 8 shows the net present values of equivalent variations (EV), that represents social welfare. The net present value (NPV) of EV of electricity sector investment is mixed, and the introduction of FDI is basically favourable for investing countries (except for Australia).

Table 8. Net Present Value of EV

(USD per person)

Regions	INV	FDI	Regions	INV	FDI
China	0.079	0.064	Vietnam	0.001	-0.016
Japan	-0.021	0.137	Brunei	2.044	-0.728
Korea	-0.002	0.031	India	-0.014	-0.070
Cambodia	0.149	0.092	Australia	-0.124	-0.178
Indonesia	-0.002	-0.013	New Zealand	-0.000	-0.000
Laos	-0.005	-0.017	Brazil	0.034	0.034
Myanmar	0.428	0.428	EU	-0.000	-0.001
Malaysia	0.027	0.010	USA	-0.000	-0.000
Philippines	-0.617	-1.450	Russia	-0.002	-0.002
Singapore	0.002	0.114	MENA and Venezuela	-0.000	-0.001
Thailand	-0.162	-0.257	Rest of the world	0.000	-0.000

4.4. Policy Implications

Energy sector investment liberalisation is an important issue for energy market integration, and the development of quantitative assessment tools is an important research area. This section explained our CGE model designed for conducting such a quantitative assessment of electricity sector investment including foreign direct investment. The assessment results do not convincingly demonstrate the potential benefits of energy sector investment, but they provide useful insight to develop more empirically relevant policy assessment tools.

Given the above caveat in mind, the most important policy implication are the economic benefits of FDI compared with domestic investment. Our analysis shows that introduction of FDI increases not only the national GDP of the investing countries but also the regional GDP of the whole EAS region. Energy sector investment liberalisation is needed to boost FDI flows, and our analysis demonstrates its benefit. If some policy can encourage FDI to cleaner energy, both economic and environmental benefits can be achieved.

5. Conclusions and Recommendations

Energy price reform and increasing investment in the energy sector as measures of energy market integration do have significant impacts on both the regional economy and environment. Energy price reform removes market distortions and increases economic efficiency and productivity. In turn, this positively affects overall macroeconomic growth and the environmental through reducing GHG emissions. On the other hand, increasing sectoral capital flow emphasizes investments in cleaner and more efficient technologies, encouraging consumers to shift to cleaner fuels. This is especially beneficial for the developing economies where still majority of the consumers are using low cost, inefficient and dirtier energies.

The East Asia Summit region can consider its energy market to be integrated under the framework of gradual and systematic energy price reform. This will reduce the financial burdens of respective governments and will also help them to reduce the costs of market distortion with improvement in energy efficiency. Regional governments can also develop energy sector investment plans in their respective countries to bolster their economic growth and consumption of more efficient and cleaner fuels.

This study tries to demonstrate such potential benefits of energy pricing reform and an increasing level of energy sector investment in quantitative manner using computable general equilibrium models. The challenges associated with quantitative assessment of energy pricing reform are data issues in which further disaggregation of fossil fuel commodities are required to identify net subsidised commodities. On the other hand, quantitative assessment of energy sector investment requires a departure from the widely used CGE models like the GTAP model which are not well suited in giving exogenous shocks to sector specific factor inputs. Our original CGE model partially overcomes the challenge, and reveals the necessity of further improvements, such as the introduction of economic and social costs of insufficient energy supply, and further distinction between conventional technologies and cleaner technologies.

References

ADB. 2005. GMS Flagship Initiative: Regional Power Interconnection and Power Trade Arrangements. Manila: Asian Development Bank.

AMEM. 2004. Report on ASEAN Ministers on Energy Meeting. Jakarta, ASEAN Center for Energy.

APERC. 2006. APEC Energy Demand and Supply Outlook. Tokyo: Asia Pacific Energy Research Centre.

Burniaux, Jean-Marc, and Truong Truong. 2002. GTAP-E: An Energy-Environmental Version of the GTAP Model, GTAP Technical Paper No.16. West Lafayette, IN: Purdue University.

Hertel, Thomas W. 1996. Global Trade Analysis: Modeling and Applications. New York, NY: Cambridge University Press.

Hanslow, Kevin, Tien Phamduc, and George Verikios. 2000. The Structure of the FTAP Model. Research Memorandum, Productivity Commission.

IEA. 2003. World Energy Investment Outlook. Paris: International Energy Agency.

IEA. 2008. World Energy Outlook. Paris: International Energy Agency.

Kojima, Satoshi. 2007. Sustainable Development in Water-stressed Developing Countries: A Quantitative Policy Analysis. Cheltenham: Edward Elgar.

Lee, Huey-Lin. 2008. The Combustion-based CO2 Emissions Data for the GTAP Version 7 Data Base. West Lafayette, IN: Purdue University.

Phinyada, A. 2005. ASEAN Energy Cooperation: An Opportunity for Regional Sustainable Energy Development. Boston, M.A.: Harvard Law School.

Von Hippel, David F. 2001. Estimated Costs and Benefits of Power Grid Interconnections in N*orth East Asia*. Nautilus Institute.