Chapter 2

Technical Report:
Economic Impact Analysis of East Asia Energy Market Integration

Anindya Bhattacharya
Institute for Global Environmental Strategies

Satoshi Kojima
Institute for Global Environmental Strategies

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TECHNICAL REPORT

ECONOMIC IMPACT ANALYSIS OF EAST ASIA ENERGY MARKET INTEGRATION

Anindya Bhattacharya* and Satoshi Kojima

Institute for Global Environmental Strategies, 2108-11 Kamiyamaguchi, Hayama, Kanagawa 240-0115, Japan

1. INTRODUCTION

Being the hot spot of economic development of the world, the East Asia Summit (EAS) region needs an uninterrupted supply of energy at a reasonable and affordable price for a longer period of time to meet the development needs in the future. With the given condition, it is rather difficult to achieve a sustained growth path supported by steady energy resource supply just depending on individual domestic efforts. In the continued process of globalization it is economically, socially and environmentally prudent to have a regional approach. Following this, energy market integration in this region is an essential action for sustainable development. However, four major issues need to be considered in the whole process:

(1) Dispersed and heterogeneous energy demand across the region

(2) Asymmetric distribution of energy resource availability

(3) Asymmetric distribution of income and poverty

(4) Heterogeneous development prospect (combination of five developed, two transitional, seven developing and two least developed countries)

* Corresponding author. E-mail address: bhattacharya @iges.or.jp

Observing the EAS regional distribution of capital formation over the last couple of decades, it is imperative that the distribution of financial resources for EMI in the EAS region is much skewed towards China, India, Australia, Japan and Korea. Interestingly, these are the countries enveloping the EAS region comprising of total 16 countries (ASEAN+6). In addition, the central region of EAS, which is mainly the ASEAN sub region, is the gravity center of energy resource endowment which can share the surplus resources with the rest of the region provided a seamless network is established.

As a matter of fact, there are three major components need to be in place to create an energy market: technology, finance and policy & regulation. The hardware part of market creation covers the infrastructure development for energy production, supply and distribution whereas the software part creates the enabling environment for the smoother flow of energies across the border. Technology and finance are required for hardware development whereas policy and regulations are required for the software development. Finally, it has been envisaged that the basic structure of the EAS Integrated Energy Market (henceforth EIEM) would be follows:

1. Four major developed countries (Japan, Korea, Australia and New Zealand) will provide the necessary financial and technical resources to the rest of the region to create the market. Two transitional economies India and China will also provide financial and technical resources to the developing counter parts.
2. Rest of the developing member countries will receive the financial and technical supports from the rest of the countries to develop the hardware for cross border energy flow in exchange of allowing their surplus energy resources to trade across the border seamlessly.
3. Due to market integration, energy sector investment will be liberalized, and enabling environment will be created for foreign direct investments. Investors will be interested to increase the flow of fund to develop the energy sector in the developing countries.

4. Countries' domestic energy markets will also be liberalized and deregulated to cope up with the changes in the market structure. This will entail efficiency improvement of the domestic production, distribution and consumption of energy commodities.
5. Finally, a supra national watch-dog body has to be in place for implementation and enforcement of regulations and laws related to the functioning of the unified energy market in the region.

2. TERMS OF REFERENCE AND OBJECTIVE

Taking the note of conclusions and recommendations made in the AAECP Energy Policy and Systems Analysis Projects – ASEAN Energy Market Integration (Aug. 2005) (we considered this project report as our starting point) we identified that intra and inter regional energy commodity trade, which are by far not fully integrated in terms of export and import tariffs and other trade barriers, plays a crucial role for realization of market integration. In addition, we also noted that energy subsidies reform is very important in the context of market liberalization and unification thereafter. Besides, physical linkage of energy infrastructures like cross border gas and oil pipeline along with interconnected electricity grid are crucial for achieving successful integrated energy market. As a matter of fact, energy sector investment liberalization at the international and domestic level are considered as one of indicators of energy market integration which provides level playing field for all investors. In this report, we discussed about the following five specific issues in the context of energy market integration:

1. Removal of energy trade barriers
2. Improving physical linkages of energy infrastructure across the East Asia region.

3. Liberalization of investments in the energy sector in the region as a consequence of market integration.
4. Energy pricing reform
5. Liberalization of domestic energy market and deregulation.

It is envisaged that in the process of energy market integration in the EAS region, cooperating countries will liberalize their energy commodity trade through respective tariff and export subsidy/tax removal. This is to achieve unification of border taxes to the energy traded commodities. This is a step forward towards the formation of regional market of energy commodities.

In the process of achieving the benefits of energy market integration, it is required to have better physical linkages of various energy infrastructures in the region. In this context, it is envisaged that the EAS region will improve its cross border oil, gas and electricity transportation facilities through pipelines and electrical grids. Such interconnection will not only reduce the costs of transportation of energy commodities within the regions but also reduce the losses and improve the supply reliability. From the energy security perspective this is an excellent option for this region to reduce the energy supply vulnerability.

Energy commodity trade liberalization envisaged under the market integration is further expected to be followed by energy investment liberalization in the region. As a matter of fact, fund will flow from the developed countries to the developing countries to explore, develop and trade the energy commodities across the region. It is envisaged that due to eased border restrictions and improved investment security and environment, foreign direct investments will be increased in the developing economies in the 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.

This is also envisaged that in the process of energy market integration, member countries will make some attempt to rationalize their respective energy markets through energy price reform and more specifically by removing energy subsidies. In the EAS developing countries energy subsidies are quite significant in terms of their GDPs and therefore, reduction and removal of subsidies will affect the overall economic condition.

As an effect of energy market integration it is also envisaged that the respective domestic energy markets will also be liberalized and deregulated. So far in the East Asia region most of the domestic markets are regulated by the Governments which often bar the market to behave by itself. Under the integrated condition it is expected that the domestic market controls by the Government especially the prices of energy commodities will be removed or reduced so that investors can feel free to invest. It has been estimated that there are around USD 6 trillion investment requirements in this region over the next twenty years only in energy sector to meet the future demand and keep the economic growth at a reasonable rate of around 6% on average (IEA, 2003). Under this demand situation, it is obvious that only public investment cannot fulfil the need unless private sector investments pitch in. Domestic and regional market liberalization is therefore key to encourage private sector investors to invest in energy sector development.

3. MODEL

3.1 Outline of the REPA model

We employed the Regional Environmental Policy Assessment (REPA) model for assessing the potential impacts of policy scenarios representing the East Asia Energy Market Integration. 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 current version of the REPA model employs 22-region 32-sector aggregation of the GTAP database Version 7 (see Tables 3.1 and 3.2), 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 (coa, oil, gas, p_c, ely, and gdt) are classified.

Table 3.1 Regional aggregation

No.	Code	Description
1	chn	P.R. China (main land only)
2	jpn	Japan
3	kor	The Republic of Korea
4	khm	Cambodia
5	idn	Indonesia
6	lao	Lao PDR
7	mmr	Myanmar
8	mys	Malaysia
9	phl	Philippines
10	sgp	Singapore
11	tha	Thailand
12	vnm	Viet Nam
13	brn	Brunei Darussalam (see footnote 1)
14	ind	India
15	aus	Australia
16	nzl	New Zealand
17	bra	Brazil
18	eu	European Union (25 members)
19	usa	United States of America
20	rus	Russia

[1] GTAP Version 7 data set aggregates Brunei Darussalam and Timor-Leste as one region (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%.

21	mev	Middle East and North Africa (MENA) and Venezuela
22	row	Rest of the world

Table 3.2 Sectoral aggregation

No.	Code	Sector classification	No.	Code	Sector classification
1	pdr	Paddy rice	17	lum	Wood products
2	ogr	Other grains	18	ppp	Paper products, publishing
3	v_f	Vegetables, fruit, nuts	19	p_c	Petroleum, coal products
4	osd	Oil seeds	20	crp	Chemical, rubber, plastic products
5	c_b	Sugar cane, sugar beet	21	i_s	Ferrous metals
6	lvd	Livestock and daily	22	nfm	Metals nec
7	oag	Other agriculture	23	mvh	Motor vehicles and parts
8	frs	Forestry	24	ele	Electronic equipment
9	fsh	Fishing	25	mfn	Manufactures nec
10	coa	Coal	26	ely	Electricity
11	oil	Crude oil	27	gdt	Gas manufacture, distribution
12	gas	Gas	28	cns	Construction
13	omn	Minerals nec	29	tpn	Transport nec
14	pcr	Processed rice	30	atp	Air transport
15	fdp	Food products	31	dwe	Dwellings
16	twl	Textiles, wearing apparel and leather	32	osv	Other services

3.2 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

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 might be worth noting that the employed methodology does not use equation of motion of physical capital to update the stock of physical capital. The employed methodlogy 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).

3.3 CO_2 emission module

The current version of REPA model employs a different approach to calculates CO_2 emissions from the GTAP-E model. The REPA model calculates CO_2 emissions based on fossil fuel consumptions by each industrial sector as well as final consumers (private households and the government), with deducing fossil fuel uses as feedstocks, while 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 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 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 above deduced usage may include combustion usages in reality.

4. POLICY SCENARIOS FOR SIMULATIONS

4.1 Removal of energy commodity trade barriers within the EAS region

The first policy scenario represents complete trade liberalisation of energy commodities. This scenario is simulated by removing all the import tariffs and the export subsidies (or taxes) of energy commodities among 16 EAS members reflected in the base data as shown in Tables 4.1-4.8. Please note that there are neither import tariffs or export subsidies (taxes) on electricity (ely) and gas manufacture/distribution (gdt).

Table 4.1 Bilateral import tariff rates on coal among EAS members (%)

	Importing country															
	chn	jpn	kor	khm	idn	lao	mmr	mys	phl	sgp	tha	vnm	brn	ind	aus	nzl
chn	0.0	0.0	1.0	0.0	5.0	0.0	0.0	0.0	5.0	0.0	1.0	2.5	0.0	35.1	0.0	0.0
jpn	3.8	0.0	1.0	0.0	5.0	0.0	0.0	0.0	3.2	0.0	1.0	5.0	0.0	0.0	0.0	0.0
kor	3.3	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	1.0	4.6	0.0	0.0	0.0	0.0
khm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
idn	4.4	0.0	1.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	3.6	0.0	37.7	0.0	0.0
lao	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
mmr	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
mys	3.7	0.0	0.0	0.0	2.9	0.0	0.0	0.0	3.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0
phl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sgp	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	4.5	0.0	15.0	0.0	0.0
tha	0.0	0.0	0.0	0.0	5.0	3.0	0.0	0.0	3.0	0.0	0.0	5.0	0.0	15.0	0.0	0.0
vnm	3.0	0.0	1.0	0.0	5.0	3.7	0.0	0.0	3.0	0.0	0.0	0.0	0.0	15.0	0.0	0.0
brn	3.9	0.7	1.0	0.0	5.0	0.0	0.0	0.0	3.7	0.0	1.0	0.0	0.0	21.7	0.0	0.0
ind	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
aus	4.5	0.0	1.0	0.0	5.0	0.0	0.0	0.0	4.9	0.0	1.0	0.0	0.0	35.2	0.0	0.0
nzl	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0	0.0	0.0

Source: GTAP database version 7

Table.4.2 Bilateral import tariff rates on crude oil among EAS members (%)

	Importing country															
	chn	jpn	kor	khm	idn	lao	mmr	mys	phl	sgp	tha	vnm	brn	ind	aus	nzl
chn	0.0	0.0	5.0	0.0	0.0	0.0	0.0	2.5	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
jpn	0.0	0.0	0.0	0.0	4.6	0.0	0.0	2.5	3.0	0.0	0.0	6.3	0.0	0.0	0.0	0.0
kor	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
khm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
idn	0.0	0.0	5.0	0.0	0.0	0.0	0.0	2.5	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
lao	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
mmr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
mys	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	5.0	0.0	10.0	0.0	0.0
phl	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0
sgp	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.7	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
tha	0.0	0.0	5.0	0.0	0.0	0.0	1.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
vnm	0.0	0.0	5.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
brn	0.0	0.0	5.0	7.0	0.0	0.0	2.0	2.5	3.0	0.0	0.0	6.3	0.0	10.0	0.0	0.0
ind	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	3.0	0.0	0.0	11.7	0.0	0.0	0.0	0.0
aus	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
nzl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: GTAP database version 7

Table 4.3 Bilateral import tariff rates on natural gas among EAS members (%)

	Importing country															
	chn	jpn	kor	khm	idn	lao	mmr	mys	phl	sgp	tha	vnm	brn	ind	aus	nzl
chn	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
jpn	3.1	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
kor	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0
khm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
idn	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0
lao	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
mmr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
mys	0.0	0.0	1.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0
phl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sgp	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0
tha	6.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
vnm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
brn	3.0	0.0	1.0	0.0	5.0	0.0	0.0	0.0	7.0	0.0	0.0	3.0	0.0	10.0	0.0	0.0
ind	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
aus	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
nzl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: GTAP database version 7

Table 4.4 Bilateral import tariff rates on petroleum and coal products among EAS members (%)

	Importing country															
	chn	jpn	kor	khm	idn	lao	mmr	mys	phl	sgp	tha	vnm	brn	ind	aus	nzl
chn	0.0	1.5	5.2	23.0	2.6	5.1	1.4	7.2	2.7	0.0	2.3	18.6	3.7	15.0	0.0	6.1
jpn	6.5	0.0	5.1	22.6	2.8	0.0	0.9	9.2	2.7	0.0	1.1	12.0	2.1	15.0	0.0	5.9
kor	6.5	3.4	0.0	23.2	2.7	9.6	1.2	7.8	2.7	0.0	1.0	18.8	0.0	15.0	0.0	6.1
khm	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
idn	6.0	3.1	5.1	23.2	0.0	0.0	0.0	0.2	0.0	0.0	0.9	12.4	0.0	14.9	0.0	0.0
lao	0.0	0.0	0.0	23.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0
mmr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
mys	6.4	3.7	5.1	18.8	1.9	0.0	1.2	0.0	0.6	0.0	1.0	16.4	1.8	11.4	0.0	1.0
phl	6.5	4.2	5.1	23.2	2.3	0.0	0.0	0.2	0.0	0.0	1.0	19.0	2.1	15.0	0.0	7.8
sgp	6.5	0.0	5.1	23.1	1.2	9.6	1.2	0.4	1.8	0.0	1.0	18.0	1.5	14.8	0.0	0.0
tha	6.9	4.1	5.1	20.0	1.8	9.4	1.2	0.2	1.5	0.0	0.0	13.1	1.8	14.6	0.0	5.8
vnm	6.4	3.0	5.1	23.1	2.8	5.0	0.9	0.4	1.9	0.0	1.0	0.0	0.0	13.3	0.0	4.8
brn	6.1	1.6	5.1	0.0	1.8	0.0	0.0	0.0	3.0	0.0	4.0	3.8	0.0	13.4	0.0	3.7
ind	5.0	2.8	5.1	23.2	2.7	0.0	1.1	10.1	2.9	0.0	1.4	18.6	0.0	0.0	0.0	4.4
aus	6.7	0.7	5.0	0.0	2.7	9.6	1.2	12.0	2.9	0.0	1.0	10.1	3.2	15.0	0.0	0.0
nzl	6.6	3.5	5.1	0.0	2.9	0.0	0.0	7.3	0.0	0.0	1.0	0.0	0.0	15.0	0.0	0.0

Source: GTAP database version 7

Table 4.5 Bilateral export subsidy rates on coal among EAS members (%)

	Importing country															
	chn	jpn	kor	khm	idn	lao	mmr	mys	phl	sgp	tha	vnm	brn	ind	aus	nzl
chn	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
jpn	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
kor	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
khm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
idn	-0.5	-0.5	-0.5	-0.5	0.0	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
lao	7.2	7.2	7.2	7.2	7.2	0.0	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
mmr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
mys	3.1	3.1	3.1	3.1	3.1	3.1	3.1	0.0	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
phl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sgp	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
tha	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	0.0	3.1	3.1	3.1	3.1	3.1
vnm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
brn	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ind	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
aus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
nzl	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	0.0	0.0

Source: GTAP database version 7

Note: The negative figures indicate export tax.

Table 4.6 Bilateral export subsidy rates on crude oil among EAS members (%)

	Importing country															
	chn	jpn	kor	khm	idn	lao	mmr	mys	phl	sgp	tha	vnm	brn	ind	aus	nzl
chn	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
jpn	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
kor	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
khm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
idn	-0.5	-0.5	-0.5	-0.5	0.0	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
lao	-1.6	-1.6	-1.6	-1.6	-1.6	0.0	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
mmr	1.4	1.4	1.4	1.4	1.4	1.4	0.0	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
mys	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.0	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
phl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sgp	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
tha	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	0.0	1.3	1.3	1.3	1.3	1.3
vnm	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.0	1.4	1.4	1.4	1.4
brn	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ind	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
aus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
nzl	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	0.0	0.0

Source: GTAP database version 7

Note: The negative figures indicate export tax.

Table 4.7 Bilateral export subsidy rates on natural gas among EAS members (%)

	Importing country															
	chn	jpn	kor	khm	idn	lao	mmr	mys	phl	sgp	tha	vnm	brn	ind	aus	nzl
chn	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
jpn	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
kor	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
khm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
idn	-0.4	-0.4	-0.4	-0.4	0.0	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
lao	-5.8	-5.8	-5.8	-5.8	-5.8	0.0	-5.8	-5.8	-5.8	-5.8	-5.8	-5.8	-5.8	-5.8	-5.8	-5.8
mmr	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	0.0	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9
mys	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	0.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0
phl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sgp	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
tha	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	0.0	-3.0	-3.0	-3.0	-3.0	-3.0
vnm	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	0.0	-2.9	-2.9	-2.9	-2.9
brn	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ind	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
aus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
nzl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: GTAP database version 7

Note: The negative figures indicate export tax.

Table 4.8 Bilateral export subsidy rates on petroleum and coal products among EAS members (%)

	Importing country															
	chn	jpn	kor	khm	idn	lao	mmr	mys	phl	sgp	tha	vnm	brn	ind	aus	nzl
chn	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
jpn	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
kor	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
khm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
idn	-0.4	-0.4	-0.4	-0.4	0.0	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
lao	-5.8	-5.8	-5.8	-5.8	-5.8	0.0	-5.8	-5.8	-5.8	-5.8	-5.8	-5.8	-5.8	-5.8	-5.8	-5.8
mmr	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	0.0	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9
mys	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	0.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0
phl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
sgp	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
tha	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	-3.0	0.0	-3.0	-3.0	-3.0	-3.0	-3.0
vnm	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	-2.9	0.0	-2.9	-2.9	-2.9	-2.9
brn	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ind	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
aus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
nzl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: GTAP database version 7

Note: The negative figures indicate export tax.

For trade liberalisation simulations, we gave exogenous shocks to import tariffs and export subsidies of all the energy commodities among the EAS members such that these values become zero.

4.2 Physical linkage of energy infrastructure

Originally it was planned to assess the impacts of physical linkage of energy infrastructure by removing international margin transport costs of energy commodities among the EAS members, but it was found that no significant margin transport costs are recorded in the base data in 2004. Instead, we refer to a previous study on potential impacts of cross-border energy infrastructure development in order to provide policy implications of physical linkages of energy infrastructure (Bhattacharya and Kojima 2008).

Bhattacharya and Kojima (2008) assumed that the cross border electricity infrastructure (CBEI) projects substitute a part of electricity development and that a half of the public investment directly contributes to capital accumulation of the electricity sector and the remaining portion is spent for government purchase of the outputs of the other services sector that include public administration etc. Bhattacharya and Kojima (2008) used a previous version of REPA model with the GTAP database version 6 (corresponding to the year 2001), and conducted simulations with giving the following four types of exogenous shocks to the database updated from the year 2001 to the year 2020:

- Total baseline public investment by 2020 for electricity sector without CBEI projects
- Incremental power generation between 2001 and 2020 due to the above baseline investment without CBEI project
- Total public investment by 2020 for electricity sector with CBEI projects
- Value of power traded between two countries due to CBEI projects

Then, the corresponding changes in capital stock in the electricity sector, in government purchase of outputs of the other services sector, and in outputs of the electricity sector due to electricity trade were endogenously solved. For the details about the estimation of these shocks, see Bhattacharya and Kojima 2008.

4.3 Liberalization of investment to the energy section

Although there have been some attempts to reflect investment liberalisation issues to CGE models (e.g. Hanslow et al. 2000), it is widely recognised that measurement of investment barriers and modelling investment liberalisation in straight forward manner are very challenging tasks. This study tackled this issue by estimating energy sector investment demands of each EAS member country and reallocating capital stocks among the EAS member countries. Table 4.9 shows the estimated energy sector investment demands in the EAS region.

We assume that investment liberalisation will allow China, Japan, Korea, Singapore and Australia to be proactive to invest in the remaining EAS member countries. Among these five investing countries, the total energy sector investment demands of the remaining EAS member countries are shared based on the GDP share of each investing country. The investment outflow from these investing countries is modelled as a reduction in national capital endowment without financial return as if the investment took a form of grant. Modelling foreign direct investment in a realistic manner is left for future research.

Table 4.9 Estimated energy sector investment demands in the EAS recipient countries (million US$)

	khm	idn	lao	mmr	mys	phl	tha	vnm	brn	ind	nzl
coa	2.0	101.9	0.0	3.1	2.3	33.8	64.7	17.2	0.1	423.2	9.6
oil	5.7	295.5	0.3	9.0	158.6	1.7	187.6	49.9	6.5	327.3	30.4
gas	14.4	753.4	0.0	22.9	339.9	14.4	450.8	7.3	15.6	694.1	87.0
p_c	4.1	213.9	0.2	6.5	114.9	167.3	135.8	36.1	4.7	237.0	37.1
ely	69.4	3,616.8	37.7	109.8	1,631.6	1,199.6	2,296.1	611.0	81.4	12,273.7	299.0
gdt	2.2	112.6	10.8	3.4	50.8	272.9	99.0	139.0	3.4	152.4	19.1

Source: Authors' estimation based on the World Energy Investment Outlook 2003, IEA. (p51)

The inflow side of investment is also modelled as an increase in national capital endowment corresponding to the total of energy sector investment demands in that country, without payment of return to the investors. We also attempted to simulate *sectoral* capital allocation such that investment demands of each energy sector in the recipient countries are satisfied, by exogenising sectoral capital demand of energy sectors and endogenising sectoral factor productivities, but we could not get feasible solutions from this preferable simulation setting.

4.4 National energy pricing reform

Energy subsidy reform is one of top priority issues worldwide and particularly in some of the EAS member countries such as Indonesia and Malaysia. When fossil fuel commodities are highly subsidised, removal or reduction of such subsidies is expected to bring three types of benefits: environmental benefit of reduced CO_2 emissions through discouraging wasteful fossil fuel usage, economic benefit of improved efficiency through mitigating market distortion, and fiscal benefits from reducing the financial burden of the government. Unfortunately, in the GTAP database heavily subsidised fossil fuels and heavily taxed fossil fuels are aggregated and we cannot single out heavily subsidised ones (see Tables 4.10 and 4.11).

Table 4.10 Output subsidy rates on energy commodities (%)

	chn	jpn	kor	khm	idn	lao	mmr	mys	phl	sgp	tha	vnm	brn	ind	aus	nzl
coa	-0.8	15.3	65.8	0.0	0.0	0.0	-5.2	0.0	0.0	-0.5	-4.6	-6.4	-0.4	-1.8	-1.0	-1.2
oil	-12.5	-1.9	0.0	0.0	0.0	0.0	-32.9	0.0	0.0	-0.4	-14.2	-4.3	-0.4	-1.2	-1.1	-0.1
gas	-4.6	-1.9	-4.9	0.0	2.6	0.0	-29.2	0.0	0.0	-3.7	-7.4	-4.3	-3.7	-1.0	-1.1	-0.3
p_c	-5.5	0.0	-26.4	-2.0	0.0	0.0	-0.4	0.0	0.0	10.7	-24.7	-9.4	-0.1	0.0	-0.8	-0.1
ely	-9.7	-4.7	-3.8	0.0	7.3	0.0	-3.3	0.0	0.0	-2.1	-2.8	-4.5	-2.0	-2.2	-1.0	-0.4
gdt	-4.6	-1.9	-5.0	0.0	2.6	0.0	-29.2	0.0	0.0	-3.7	-7.4	-4.3	-3.7	-1.0	-1.1	-0.3

Source: GTAP database version 7

Note: The negative figures indicate output tax.

Table 4.11 Consumption tax rates on energy commodities (%)

	chn	jpn	kor	khm	idn	lao	mmr	mys	phl	sgp	tha	vnm	brn	ind	aus	nzl
coa	0.0	5.7	0.0	0.0	0.0	2.5	0.0	0.0	0.0	16.5	-0.5	0.0	16.6	0.0	0.0	11.8
oil	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	16.6	0.0	-5.3	16.8	0.0	2.8	0.0
gas	0.0	45.2	57.7	0.0	0.0	8.4	0.0	0.0	0.0	16.6	0.0	0.8	16.6	0.0	0.0	65.1
p_c	0.0	202.0	115.3	43.9	1.9	49.9	135.6	0.0	41.2	16.6	29.8	0.0	17.0	118.3	120.6	145.1
ely	0.0	9.3	0.0	0.0	3.0	14.9	0.0	4.6	4.9	5.7	4.6	2.9	15.5	0.0	12.4	17.7
gdt	0.0	45.2	57.7	0.0	-7.7	3.0	0.0	-6.2	0.0	16.6	-6.2	-7.8	16.6	0.0	16.5	65.1

Source: GTAP database version 7

Against this data limitation, we conducted the following two types of simulations.

For the first type of simulations, we estimated the amount of energy subsidies directed to each of six energy commodities, and we shock output subsidy (or tax) and consumption tax (or subsidy) of energy commodities equivalent to certain portions (10%, 50% and 100%) of estimated energy subsidies. These simulations capture environmental benefits of energy subsidy reform as well as fiscal benefits of reduced government expenditure, but they cannot capture economic benefits because these simulations are implemented by increasing energy taxes in the model.

The second type of simulations demonstrate economic benefits of mitigating market distortion by removing energy commodity price distortion in terms of output subsidy (or tax) and consumption tax (or subsidy).

4.5 Liberalisation of domestic energy markets

This policy scenario assumes that liberalization of domestic energy markets will reduce the monopoly of energy distribution and retailing in domestic energy market through open access of transmission system by other retailers, domestically and internationally. Consequently, it is expected to improve efficiency of these energy services. In our simulations this improved efficiency of energy services is modelled as improvements of total factor productivity (TFP) of the electricity sector (ely) and the gas manufacturing and distribution sector (gdt). As there is no empirical data to estimate the magnitude of consequent TFP improvements, we conducted sensitivity analysis by giving TFP improvement of ely and gdt in the EAS member countries by 10%, 15%, and 20%.

5. POLICY IMPACT ASSESSMENT

As we have already mentioned in Sections 2 and 3, we conducted four sets of new simulations and cited one previous study in the year of 2008 on cross border energy infrastructure linkage which is relevant to the 2nd objective of this study. In this report, we mainly discussed about currently conducted simulations on the policy issues like energy trade barrier removal, liberalization of energy sector investment, energy pricing reform and domestic energy market liberalisation. However, to satisfy our Terms of Reference and overall objectives of this study, we also briefly discussed about the policy impacts of cross border energy infrastructure linkages citing from our previously published work.

5.1 Impact of energy trade liberalisation

In the context of energy market integration, it has been envisaged that the regional trade on energy commodities will be liberalized mainly in terms of complete removal of trade barriers like export and import taxes and subsidies. Energy commodities are expected to be freely traded within the region. As the EAS region comprises of both energy exporter and importer countries and some countries like China, Indonesia are the net importer of energy though they are one of the biggest exporters of energy in the region, free trade arrangement of energy commodities will have mixed economic impact on the regional economy. Heavily export driven countries are expected to be relatively big loser while the energy importers could be better of.

5.1.1 Impact on national economy (GDP)

In terms of real GDP, while some major countries in the EAS region gain due to tariff and export subsidy/tax removal, some major countries like Australia, Indonesia, Malaysia and Singapore also lose in that context. However, such lose is comparatively very small and in some cases negligible (viz. Australia). The following table 5.1 shows the percentage change in the GDP (in year 2020) due to complete removal of import tariffs and export subsidies/taxes of energy commodities among EAS member countries. The EAS region as a whole gains in real as well as in nominal term GDP due to energy trade barrier liberalization.

In the general equilibrium world reflected in CGE models, economic impacts of trade liberalisation occur through complicated inter-sectoral and international linkages. For example, this energy trade liberalization scenario negatively impacts Australian nationwide real outputs and the largest negative impacts are observed in the non-ferrous metal (nfm) and the other manufacturing sectors (mfn), and this real output reduction accounts Australian real GDP loss to a certain degree. On the other hand, the real GDP loss of Singapore is mainly due to a reduction in trade balance, as trade liberalisation will undermine comparative advantage of the current free trade policy of Singapore. Our simulation results are consistent with our expectation that trade liberalisation will improve economic performance as a whole even though some members or sectors will win and the others will lose. The most important political issue is how to share the overall benefits of trade liberalisation to all members in a convincing and effective way.

Table 5.1 Impacts of energy trade liberalization on GDP (Year 2020)

Region	% change from 2020 Baseline scenario **(nominal)**	% change from 2020 Baseline scenario **(Real)**
China	-0.030	0.000
Japan	-0.012	0.003
Korea	0.051	0.052
Cambodia	-0.177	0.128
Indonesia	0.102	-0.065
Lao PDR	-0.071	-0.130
Myanmar	-0.042	-0.044
Malaysia	0.150	-0.078
Philippines	-0.101	0.011
Singapore	-0.118	-0.070
Thailand	0.037	0.011
Vietnam	-0.451	0.263
Brunei Darussalam	0.807	-0.147
India	0.005	0.368
Australia	0.196	-0.002
New Zealand	-0.008	-0.003
Brazil	-0.011	-0.012
EU	-0.014	-0.004
USA	-0.014	-0.001
Russia	-0.003	-0.035
MENA and Venezuela	0.030	-0.052
Rest of the World	-0.006	-0.010
World Total	-0.006	0.000
EAS Total	**0.007**	**0.024**

5.1.2 Impact on sectoral real output

Sectoral output change after the trade liberalization shows due to energy trade liberalization all the major coal producing countries gain in their production except India (see Table 5.2). Indian coal sector will see around 1.2% output reduction by 2020. Similarly, the petroleum product output in Vietnam loses by around 13% but gained around 11% in Cambodia. On the other hand, countries like Australia will gain in coal production by around 0.3% compared to the baseline scenario in 2020. Indonesia, China, Vietnam will also gain in terms of annual coal output.

Table 5.2 Impact of Trade Liberalization on sectoral real output: Difference from baseline (%)

Region	coal	crude oil	gas	petroleum products	electricity	gas distribution
China	0.00	0.02	-0.03	-0.33	-0.02	0.07
Japan	0.19	0.03	-0.06	0.14	-0.04	-0.00
Korea	0.08	0.02	0.00	1.95	-0.05	0.47
Cambodia	0.11	0.22	-0.04	10.85	0.22	-0.36
Indonesia	0.20	0.18	0.02	-1.08	-0.21	-0.05
Lao PDR	-0.09	-0.02	0.00	-2.35	0.33	-0.21
Myanmar	0.12	-0.08	0.29	-0.08	-0.63	-0.71
Malaysia	0.13	0.14	0.31	-0.18	-0.31	0.21
Philippines	-0.13	1.41	-0.01	5.06	0.06	-0.18
Singapore	0.00	0.14	-0.36	5.02	0.16	0.25
Thailand	0.03	0.06	-0.01	1.08	0.00	0.03
Vietnam	0.13	-0.15	-0.48	-13.39	0.06	-1.99
Brunei Darussalam	0.05	0.21	-0.07	-0.18	0.15	-0.03
India	-1.21	-0.03	0.01	1.00	1.46	0.05
Australia	0.29	0.44	-0.08	5.12	-0.32	0.02
New Zealand	0.21	0.18	-0.01	-0.34	-0.02	-0.06
Brazil	0.07	0.01	-0.01	-0.08	-0.00	0.01
EU	0.08	0.01	-0.02	-0.11	-0.02	0.00
USA	0.01	0.01	-0.01	-0.12	-0.01	0.00
Russia	0.10	0.01	-0.02	-0.40	-0.03	-0.02
MENA and Venezuela	0.08	0.02	-0.06	-0.86	-0.03	-0.09
Rest of the World	0.08	0.02	-0.01	-0.21	-0.04	-0.00
World Total	0.03	0.02	-0.01	0.03	0.02	-0.02
EAS Total	0.01	0.08	0.08	0.63	0.11	-0.11

In the process of investigating the reasons of such changes we first looked into the existing tariff structures of different energy commodities in this region. Tables 4.1 to Table 4.8 show 2004 import tariff and export subsidy structure of the different energy commodities in this region. The tables indicate that India has relatively moderate around 5% of import tariff for coal while there is no export subsidy. In terms of coal export, Indonesia and Australia have some tariffs whose removal could impact the coal markets in the rest of the region.

Further investigating the results of simulation we observed that the domestic coal prices in India drastically reduced by around 28% compared to the 2020 baseline price. This price change can be attributed towards the reduction of domestic coal demand compared to the cheaper imported coal. It could be envisaged that due to trade liberalization coal imports become cheaper for India than its domestic coal. In fact, due to high ash content, domestically produced coals in India are not attractive to the coal users like power plants and steel and cement companies. Given the situation of future demand of coal mainly coming from power plants (more than 70% of the total production) , due to import tariff reduction, power plants can avoid using domestic high ash content coal and can replace the same by imports. As a matter of fact, after the trade liberalization, Indian coal import increased by 78% from the 2020 baseline level. Table 5.3 below shows the % change in energy commodity import volume compared to the 2020 baseline scenario.

Table 5.3 **Percentage change in energy import values compared to the baseline 2020**

Region	coal	crude oil	gas	petroleum products	electricity	gas distribution
China	3.421	-0.446	-2.427	10.048	-0.714	-0.599
Japan	-2.128	0.519	0.713	9.091	0.000	0.141
Korea	0.542	4.000	0.917	4.723	0.000	-0.134
Cambodia	16.726	26.923	15.315	63.946	-0.671	2.174
Indonesia	41.033	3.846	110.274	6.306	1.709	0.388
Lao PDR	-7.358	-5.729	-0.905	23.383	-1.481	-1.769
Myanmar	62.136	-4.911	86.141	1.042	3.140	-1.635
Malaysia	-1.705	10.000	88.387	4.000	1.481	0.254
Philippines	4.146	11.912	1.708	4.258	-1.733	0.000
Singapore	-1.754	9.231	1.351	2.963	0.741	0.000
Thailand	-3.873	2.157	1.047	12.472	0.000	0.000
Vietnam	18.807	-6.494	-23.419	22.727	0.420	-4.412
Brunei Darussalam	2.913	-0.862	-3.008	9.419	0.972	4.046
India	78.100	3.455	6.506	14.570	-17.508	0.000
Australia	22.386	22.238	4.762	11.624	2.752	0.000
New Zealand	-0.884	-0.778	0.655	3.983	0.259	-0.333
Brazil	-0.945	-0.562	0.000	0.000	-0.769	0.000
EU	-2.314	-0.431	0.229	-0.217	0.000	0.000
USA	-2.564	-0.552	-0.127	-0.174	-0.214	-0.181
Russia	0.000	-0.926	-0.877	-0.322	-0.658	0.000
MENA and Venezuela	-1.026	-0.832	-4.317	0.000	0.000	0.000
Rest of the World	-2.159	-0.943	0.000	0.000	0.000	-0.625

5.1.3 Impact on domestic prices of energy commodities

Another interesting finding is the domestic price changes of the energy sectors in the EAS region (See Table 5.4). Due to border tax reduction to level zero, more or less all the countries are experiencing reduced level of domestic energy prices except Indonesia and Malaysia. For example, Indian domestic consumer price for coal gets reduced by 28%. Such price reduction can be further attributed towards increase in imports of energy commodities. Due to increase in import of cheaper energy, domestic production of energy might fall due to lack of demand and thus can create downward pressure on market price. This has been actually observed in the case of India coal sector.

Table 5.4 Impact of energy trade liberalization on consumer price of energy commodities

Region	coal	crude oil	gas	petroleum products	electricity	gas distribution
China	0.010	0.131	-0.235	-0.037	-0.060	-0.227
Japan	2.351	0.111	-0.266	0.082	0.041	-0.009
Korea	1.148	-0.128	-0.783	-0.160	0.024	-0.058
Cambodia	1.792	1.705	-0.230	-4.275	-0.258	0.021
Indonesia	3.368	1.148	0.165	0.177	0.281	0.018
Lao PDR	-2.958	-0.032	-0.066	-1.894	-0.248	0.023
Myanmar	2.617	-0.031	1.418	-0.841	0.429	0.235
Malaysia	2.543	-0.214	0.494	0.568	0.338	-0.014
Philippines	-2.356	0.558	-0.036	-0.341	-0.224	0.021
Singapore	1.848	1.187	-0.141	0.114	0.023	-0.047
Thailand	0.951	0.284	-0.089	0.221	0.014	-0.018
Vietnam	5.161	-0.593	-6.136	-8.443	0.004	0.340
Brunei Darussalam	1.191	1.785	-0.220	0.405	0.071	0.155
India	-28.731	0.032	0.331	-0.569	-2.019	-0.011
Australia	3.834	0.835	-0.203	1.125	0.517	0.048
New Zealand	2.839	0.724	-0.101	0.533	0.037	-0.010
Brazil	1.242	0.047	-0.056	0.058	-0.003	-0.024
EU	0.617	0.050	-0.130	0.049	0.020	-0.015
USA	0.271	0.076	-0.060	0.053	0.009	-0.012
Russia	0.761	0.028	-0.081	0.033	0.018	-0.006
MENA and Venezuela	0.738	0.089	-0.214	0.041	0.009	-0.000
Rest of the World	0.879	0.069	-0.052	0.059	0.037	-0.011

5.1.4 Impact on GHG emissions

Trade barrier removal is also having an impact on emissions from economic activities in the region (See Table 5.5). Complete removal of barriers will increase the overall regional CO_2 emissions by 0.6%. But several countries will individually reduce their emissions too. India will have the largest increase in CO_2 emissions under this scenario of around 6.8% increase.

Table 5.5 Impacts of energy trade liberalization on CO2 emissions

Region	% change from 2020 Baseline scenario CO_2 emissions
China	0.05
Japan	-0.19
Korea	0.02
Cambodia	1.25
Indonesia	-0.37
Lao PDR	0.96
Myanmar	-0.37
Malaysia	-0.47
Philippines	0.38
Singapore	0.12
Thailand	-0.13
Vietnam	3.21
Brunei Darussalam	-0.02
India	6.83
Australia	-0.95
New Zealand	-0.23
Brazil	-0.07
EU	-0.09
USA	-0.05
Russia	-0.06
MENA and Venezuela	-0.13
Rest of the World	-0.11
World Total	0.14
EAS Total	**0.58**

Two member countries, i.e. Singapore and Lao P.D.R., are associated with increase in CO_2 emissions and reduction in real GDP. The former is due to a combination of real output growth and reduction in the trade balance. The latter case, detailed analysis shows that energy trade liberalisation leads to increased CO_2 emissions from the electricity sector and the transportation sectors. Even though the current electricity generation in Lao P.D.R. is mainly from hydro power, our simulation indicates that electricity generation from coal and oil will increase.

5.2 Impact of physical linkage of energy infrastructure across the region

In the context of energy market integration, while the soft links work as the catalysts of unified market, the hard links like cross border infrastructural projects can really expedite the unification process and deliver the tangible benefits. Though the extension of the electric power grid and subsequent cross border interlinking brings varieties of benefits for the market integration but the economics plays the pivotal role.

It has been estimated that within East Asia region the total potential of electricity trading is about 160 Twh/year with total installed capacity of 32,000 MW exclusively for electricity trading. Net benefits of such cross border grid interconnection projects could be in the tune of USD 3 billion /year considering the environmental, social and economic advantages (Bhattacharya and Kojima 2008). This region has been extremely active in terms of its economic development. Since the early 1990s, the region has been the Asian economic growth centre with an average growth rate of 8-9% per year. In addition to tremendous energy demand growth rate of around 5% per year (APERC, 2006), the major characteristics of this region are plenty of diversified energy resources, scattered demand points and close geographical proximity of the countries, which are basically the ideal conditions for energy supply interlink and trade in the context of market integration.

As the total electricity demand forecasted by 2020 in this region is around more than double the current level of consumption and the total installed capacity required is around 232,573 MW (Phinyada, 2005), this region still needs additional energy production and cross border energy infrastructure development which no longer can be handled by single country (AMEM 2004). Tables 5.6 and Table 5.7 list out future cross border energy infrastructure projects in EA region.

Table 5.6 Future cross border grid interconnection projects in the EA region

Name of the project	Project Description	Expected Total Investment (Million USD)*
Thailand - Cambodia PTL Projects;	Total Capacity 300 MW, Type: HVAC EE Maximum power transmission: 2.3 TWh/y Year: 2007	7.0
Peninsular Malaysia- Sumatra, Indonesia PTL Projects;	Total capacity 600 MW; Type: HVDC EE Maximum power transmission: 4.6 TWh/year Year : 2012	143.0
Batam (Indonesia) – Singapore PTL Project	Total capacity:200 MW; Type: HVDC EE Maximum power transmission: 1.5 TWh/year Year : 2015	177.0
Malaysia - Brunei PTL Project	Total capacity:300 MW; Type: HVDC EE Maximum power transmission: 2.3 TWh/year Year : 2015	18.4
Malaysia - West Kalimantan PTL	Total capacity:300 MW; Type: HVDC EE Maximum power transmission: 2.3 TWh/year Year : 2012	18.4
Thailand – Lao PRD PTL Project	Total capacity:2000 MW; Roi Et- Nam Theun by 2009 Udon- Nabong by 2010 Mae Mo- Hong Sa by 2013 Maximum power transmission: 15.6 TWh/year	124.8
Thailand – Myanmar PTL Project	Total capacity: 1500 MW; Type: HVDC EE Maximum power transmission: 11.4 TWh/year Year : 2014	91.2
Lao PDR – Vietnam PTL Project	Total capacity: 1887 MW; Type: HVDC EE Maximum power transmission: 14.7 TWh/year Year : 2010	117.6
Vietnam- Cambodia PTL Project	Total capacity: 120 MW; Maximum power transmission: 0.9 TWh/year Year : 2008	7.2
Total of 9 projects in SEA	**Transmission capacity: 7200 MW;** **Power transmission: 55 TWh/year**	**697.6**

Source: ASEAN Centre for Energy, 2008 (Maximum power transmission has been estimated by the authors considering 90% of the transmission capacity utilisation).
* The investment costs have been estimated using the data provided in the Annex-1 of Von Hippel (2001).

Table 5.7 Future cross border hydro power projects in the EA region

Name of the project	Project Description	Expected Total Investment (Million USD)*
Nam Theun 2 HPP	Installed capacity: 1088 MW (PLF: 40%)	2477.6
Lao PDR- Thailand	Total Power Generation: 3.7 TWh/y	
Nam Ngum HPP	Installed Capacity: 615 MW	1400.5
Lao PDR- Thailand	Total Power Transfer: 2.1 TWh/y	
Xe Pian HPP	Installed Capacity: 390 MW	887.9
Lao PDR- Thailand	Total Power Transfer: 1.3 TWh/y	
Xe Khaman 1 HPP	Installed Capacity: 468 MW	1065.8
Lao PDR- Thailand	Total Power Transfer: 1.6 TWh/y	
Tasang HPP	Installed Capacity: 3600 ME	8200
Myanmar- Thailand	Total Power Transfer: 12.5 TWh/y	
Jinghong HPP	Installed Capacity: 1500 MW	3416.6
China – Thailand	Total Power Transfer: 5.2 TWh/y	
Nuozhadu HPP	Installed Capacity: 5500 MW	12,527.8
China – Thailand	Total Power Transfer: 19.1 TWh/y	
Sambor CPEC HPP	Installed Capacity: 465 MW	1059.0
Cambodia – Vietnam	Total Power Transfer: 1.6 TWh/y	
Total of 8 projects in EA	**Generation capacity: 13,625 MW;**	**31,035.3**
	Power transmission: 47 TWh/year	

Source: ASEAN Centre for Energy, 2008 (Total power generation estimated by the authors using the capacity utilisation factor of 40% in average)
* The investment costs have been estimated using the data provided in the Annex-1 of Von Hippel (2001).

Understanding the immense importance of physical linkages of the energy infrastructures across the region for smooth and easy integration of the energy market, in this report we tried to refer couple of case study analysis done previously by these authors (for detail please see Bhattacharya and Kojima, 2008). The selected case studies aim to capture the spectrum of potential impacts of cross-border energy infrastructure linkages on energy market integration. The pre-selected four major case-study countries in this region which are expected to be heavily involved in the future cross border energy trading include China, Thailand, Indonesia and Malaysia.

There are mainly two set of transactions: China-Thailand with total power trading of 24.3 TWh/year and Indonesia- Malaysia with total power trading of 14.6 TWh/year by the end of 2020. Then we assess the potential impacts of these projects under the assumed market integrated condition mainly on national economy and environment. For the analysis purpose we have selected two major projects as follows:

1) China – Thailand Power Trading: Jinghong and Nuozhadu HPP Project

2) Malaysia-Indonesia Power Grid Interconnection (Peninsular Malaysia- Sumatra, Indonesia 600 MW PTL and Malaysia - West Kalimantan 300 MW PTL)

In our simulation setting we tried to capture the step wise benefits of cross border energy projects which mean observing the benefits at every step of adding new project in the region. Thus we first estimated the benefits of baseline scenario without any cross border projects but only with national energy investment plan. In the second step we added the China-Thailand project and observed the benefits. Finally we added the Malaysia-Indonesia project to the list to see the overall benefits.

5.2.1 Impact on national economy (GDP)

As we have considered only a couple of projects to demonstrate the impacts of such cross border projects, as a matter of fact, the real impact on GDPs is very small of these two projects. However, our main purpose was to indicate that these kinds of projects under the condition of integrated market might have positive impacts on the participating countries' national economy. In the estimation process we have also given the due importance to the national scale energy plans which are irrespective of the regional cooperation and market integration plan. We assumed that the physical linkages of the energy infrastructures will be purely additional to the national plans of energy sector development of each country and there is no scope of substituting the national plans. In spite of all such conservative assumptions, our simulation still shows some positive gain in terms of GDP by every participating country.

Table 5.8 Impact of energy infrastructure linkage on GDP

Country/region	BAU (2020) (Million USD)	Baseline (Million USD)	China-Thailand + Malaysia-Indonesia Project (Million USD)
China	3,322,748	3,361,013	3,361,089 (0.002) [1.15]
Japan	5,038,493	5,033,913	-
Korea	825,789	825,070	-
Indonesia	291,015	293,943	293,952 (0.003) [1.009]
Malaysia	183,687	183,889	183,843 (-0.024) [0.08]
Philippines	120,246	120,206	-
Singapore	160,161	160,048	-
Thailand	213,538	220,868	220,914 (0.02) [3.45]
Viet Nam	53,432	53,473	-
Other ASEAN	111,701	111,529	-
Other OECD	28,890,102	28,861,821	-
Rest of the world	7,570,850	7,560,629	-

(xx) : shows the % change of GDP to the baseline 2020 energy investment scenario
[xx]: shows the % change of GDP to the BAU scenario without any national energy investment

5.2.2 Impact on GHG emissions

In the context of GHG emissions reduction, cross border energy infrastructure linkage projects show some positive gain, too. Emissions reduction mainly happens due to reduced use of fossil fuels for energy trading. Both the exporter and importer countries optimize their primary energy extraction, refining and utilization due to combined and complimentary market of energy supply and demand. As a matter of fact, under and over capacity additions are avoided in the both the countries which further improves the system and operating efficiency. As a whole, less fossil energies are used and corresponding emissions are also reduced. The following simulation result shows how the physical linkage of the energy infrastructure can help to address the GHG emissions (CO_2 emissions) reduction target under the energy market integration condition.

Table 5.9 Impact of energy infrastructure linkage on GHG emissions

Country/region	BAU (2020) (Million ton-CO_2)	Baseline (Million ton-CO_2)	China-Thailand + Malaysia-Indonesia Project (Million ton-CO_2)
China	9,774	9,447	9,446 (-0.01) [-3.35]
Japan	1,571	1,575	-
Korea	908	911	-
Indonesia	814	777	776.6 (-0.05) [-4.6]
Malaysia	450	439	439.8 (0.18) [-2.26]
Philippines	142	142	-
Singapore	135	135	-
Thailand	445	378	377.2 (-0.21) [-15.2]
Viet Nam	143	145	-
Other ASEAN	34	34	-
Other OECD	21,316	21,323	-
Rest of the world	15,267	15,245	-

(xx) : shows the % change of CO_2 emissions to the baseline 2020 energy investment scenario
[xx]: shows the % change of CO_2 emissions to the BAU scenario without any

5.3 Impact of energy sector investment liberalisation

It has been envisaged that due to energy market integration, energy sector investments will also get liberalized in the context of easier fund flow to the energy demand points. Due to various investment barriers, developing countries in the East Asia region are suffering from inadequate supply of money to develop their energy sectors. Market integration can remove this bottleneck and can create an enabling environment for the investors. In this simulation we assumed that under the integrated condition an enabling environment of easier fund flow has been created. As a matter of fact, investing countries like China, Japan, Korea, Singapore and Australia became proactive to invest in the domestic and regional energy markets of the EAS region. Therefore, investment goes to the rest of the developing markets in this region which are funded by the above mentioned five major countries in the EAS region. Selection of investing countries is primarily based on the historic trend of their respective private and public fund allocation to other recipient countries. China has been recently added in the list of donors in the regional energy market mainly due to their massive investments in the renewable and off-shore oil exploration funding in this region.

At the beginning of this simulation, we first estimated the demand of capital investment for each energy sector in each country. For the developing countries (or the expected recipient countries) we assumed that these capital investment demands in the energy sector would be funded by the donor countries' investment due to liberalized investment market under the integrated market condition. Due to computational difficulties, instead of satisfying sector specific capital demand for energy sectors, donors' investment increases nationwide capital endowment. As a consequence, we left the simulation to endogenously determine how to allocate the fund among all sectors including energy sectors rather than exogenously allocate the investment to each energy sector. Major rationale of such assumption is energy being the input factor to all sectors of the economy. Finally, in our simulation, we considered no revenue gain by the investor countries in exchange of capital investment in the recipient countries. This further restricted the wider application of this result for the purely private sector investment in the sector.

5.3.1 Impact on national economy (GDP)

In the context of impact on national economy as whole, the simulation shows that due to capital flow from investor countries to the recipient countries, real GDPs for the investor countries reduce by certain percentage while the real GDPs increases for all the recipient countries. Table 5.10 shows the percentage change in real GDP for each country in the region due to capital reallocation for energy sector development.

Table 5.10 Impacts of investment liberalization on GDP (Year 2020)

Regions	% change from 2020 Baseline scenario **(nominal)**	% change from 2020 Baseline scenario **(Real)**
China	-0.102	-0.086
Japan	-0.236	-0.305
Korea	-0.184	-0.225
Cambodia	0.830	0.974
Indonesia	0.593	0.819
Lao PDR	1.339	0.479
Myanmar	0.983	0.849
Malaysia	0.605	0.825
Philippines	1.123	1.218
Singapore	0.018	-0.170
Thailand	0.848	1.276
Vietnam	0.563	0.907
Brunei Darussalam	0.745	1.041
India	0.892	1.041
Australia	-0.113	-0.248
New Zealand	0.197	0.346
Brazil	-0.002	-0.011
EU	-0.009	-0.003
USA	-0.011	-0.001
Russia	0.014	-0.027
MENA and Venezuela	0.030	-0.052
Rest of the World	-0.002	-0.009
World Total	-0.009	-0.011
EAS Total	-0.016	-0.026

The overall negative impact of investment liberalization could be due to the fact that potential positive impacts are not fully captured by the model. For example, with capital shortage, the marginal productivities of capital in the recipient country usually are much higher than those in the investing countries. With capital transfer, some low marginal productivity capital will be transformed to the high marginal productivity capital. This productivity gain, although is demonstrated in economic theory, cannot be modeled by the current model. Furthermore, in this estimation the investor countries are simply transferring a portion of their capital to the recipient countries without any revenue gain, and reduced capital endowments as a result of transfer simply reduce production capacity of investing countries. It highlights the importance of proper specification of full dynamics and investment mechanisms, which remains as an important future task.

Table 5.11 below shows the ratio of allocated investment in each energy sector against the investment demand of that sector. These results show the importance of careful investment strategies to fulfil the investment demands of energy sectors.

Table 5.11 Ratio of allocated investment in each energy sector against the investment demand

Region	coal	crude oil	gas	petroleum products	electricity	gas distribution
China	-	-	-	-	-	-
Japan	-	-	-	-	-	-
Korea	-	-	-	-	-	-
Cambodia	0.55%	2.68%	0.25%	2.42%	1.23%	27.72%
Indonesia	27.14%	25.97%	5.26%	8.88%	4.10%	61.82%
Lao PDR	0.01%	0.04%	0.00%	0.67%	6.27%	20.88%
Myanmar	4.83%	18.21%	31.93%	1.67%	21.25%	376.68%
Malaysia	0.01%	29.27%	4.65%	4.91%	4.66%	137.30%
Philippines	0.10%	0.00%	0.02%	1.98%	5.78%	6.75%
Singapore	-	-	-	-	-	-
Thailand	2.63%	1.29%	0.66%	9.45%	3.23%	35.19%
Vietnam	8.40%	28.08%	0.12%	11.89%	16.48%	156.62%
Brunei Darussalam	0.12%	73.22%	15.76%	5.70%	1.09%	168.95%
India	3.07%	5.38%	1.29%	6.47%	6.84%	0.82%
Australia	-	-	-	-	-	-
New Zealand	0.69%	0.74%	0.44%	1.26%	7.47%	12.90%

5.3.2 Impact on sectoral real output

The simulation result further demonstrates that due to free capital flow the investor countries' national economy suffer mainly due to loss of real output in their respective energy sectors. Due to reduction in domestic capital flow, the investor countries might have lost some economic gain for their own country. Table 5.12 shows the percentage change in real output in the energy sector compared to the baseline 2020 scenario which demonstrates this issue.

Table 5.12 Impact of Investment Liberalization on sectoral real output: Difference from baseline (%)

Regions	coal	crude oil	gas	petroleum products	electricity	gas distribution
China	-0.01	-0.00	-0.02	-0.06	-0.09	-0.05
Japan	-0.02	-0.04	-0.03	-0.44	-0.56	-0.38
Korea	-0.01	0.00	0.00	-0.23	-0.32	-0.36
Cambodia	0.06	0.12	0.13	0.89	0.81	1.37
Indonesia	0.16	0.26	0.26	0.99	1.62	2.30
Lao PDR	0.06	0.05	0.00	1.22	2.11	3.40
Myanmar	0.14	0.35	0.43	0.35	3.38	6.62
Malaysia	0.04	0.13	0.12	0.70	1.55	2.12
Philippines	0.10	0.39	0.17	1.05	1.63	1.70
Singapore	0.00	-0.01	-0.05	0.27	-0.15	-0.27
Thailand	0.26	0.16	0.12	0.93	1.44	1.81
Vietnam	0.04	0.12	0.09	1.52	1.69	2.23
Brunei Darussalam	0.16	0.16	0.16	1.71	2.26	2.74
India	0.11	0.13	0.13	0.79	1.38	0.45
Australia	-0.03	-0.05	-0.06	-0.29	-0.43	-0.46
New Zealand	0.02	0.07	0.10	0.30	0.58	0.67
Brazil	0.00	0.01	0.00	-0.02	-0.00	-0.00
EU	0.00	0.01	0.01	-0.02	0.00	-0.03
USA	0.00	0.01	0.01	-0.03	-0.00	0.00
Russia	-0.00	0.01	0.00	-0.02	-0.01	-0.04
MENA and Venezuela	-0.00	0.01	-0.00	-0.04	0.00	-0.03
Rest of the World	0.00	0.01	0.01	-0.01	-0.00	-0.01

World Total	0.00	0.01	0.02	0.01	0.02	0.13
EAS Total	0.01	0.07	0.15	0.07	0.07	1.48

5.3.3 Impact on domestic energy prices

Simulation result also predicted the expected changes in the domestic market price of the energy commodities in our model. It mainly predicts up ward increase of all primary energy commodities in almost all member countries while showing reduction in electricity and gas prices in the domestic markets of the recipient countries. Electricity and gas prices increase in the investor countries. This further explains that majority of the investment will happen in the electricity and down stream gas market in the developing countries as they have major requirement their. As a consequence, the supply of electricity and gas will increase in the market which will push the price down. But for the investor countries, as we have already seen that all major energy sectoral outputs reduce, the price increases as demand remain unaltered. It has also been observed that, due to investment liberalization, investor countries' energy import overall reduces which further creates additional pressure on energy prices to move upward. The table 5.13 shows the percentage change in domestic price compared to the 2020 baseline scenario.

Table 5.13 Impact of investment liberalization on consumer price of energy commodities

Regions	coal	crude oil	gas	petroleum products	electricity	gas distribution
China	-0.210	0.030	-0.033	0.014	-0.005	-0.020
Japan	0.013	0.025	0.013	0.046	0.124	0.090
Korea	-0.012	0.042	0.015	0.044	0.058	-0.004
Cambodia	0.499	0.151	0.185	0.025	-0.198	-0.266
Indonesia	0.153	0.150	0.016	0.031	-0.371	-0.426
Lao PDR	1.485	0.098	0.033	0.045	-0.475	-0.596
Myanmar	0.886	0.158	0.160	0.310	-0.975	-1.477
Malaysia	0.066	0.046	0.017	0.072	-0.268	-0.357
Philippines	0.702	0.179	1.046	0.035	-0.339	-0.146
Singapore	0.266	0.103	0.016	0.043	0.072	0.036
Thailand	1.794	0.216	0.173	0.008	-0.098	-0.223
Vietnam	0.643	0.047	0.327	-0.047	-0.491	-0.590
Brunei Darussalam	1.368	0.070	0.007	-0.070	-0.615	-0.816
India	0.020	0.203	0.732	0.036	-0.257	0.039
Australia	0.011	0.071	-0.006	0.056	0.169	0.126
New Zealand	0.094	0.054	0.613	0.018	-0.182	-0.151
Brazil	0.005	0.032	0.016	0.023	-0.004	-0.000
EU	-0.000	0.036	0.015	0.028	-0.005	-0.014
USA	-0.004	0.038	0.016	0.028	-0.006	-0.008
Russia	-0.006	0.034	0.016	0.028	0.012	0.005
MENA and Venezuela	0.002	0.045	0.015	0.036	0.020	0.005
Rest of the World	0.010	0.036	0.017	0.028	0.000	-0.008

5.3.3 Impact on GHG emissions (CO2)

Due to investment liberalization sectoral outputs of energy commodities increase in all the recipient countries and while the majority of the energy outputs in the investor countries decrease. As a consequence the overall regional CO_2 emission increases. However, CO_2 emissions decease in the investor countries and increase in the recipient developing countries. Varied level of output efficiency across the investor and recipient countries could be attributed for such overall negative impact on the regional GHG emissions. Table 5.14 below shows the percentage change of CO_2 emissions compared to the 2020 baseline emissions.

Table 5.14 Impact on GDP and CO2 emissions due to capital reallocation

Region	% change from 2020 baseline CO_2 emissions
China	-0.05
Japan	-0.45
Korea	-0.26
Cambodia	0.82
Indonesia	1.42
Lao PDR	1.71
Myanmar	2.95
Malaysia	1.26
Philippines	1.21
Singapore	-0.10
Thailand	1.16
Vietnam	1.37
Brunei Darussalam	2.03
India	0.88
Australia	-0.33
New Zealand	0.41
Brazil	-0.01
EU	-0.01
USA	-0.01
Russia	-0.01
MENA and Venezuela	-0.01
Rest of the World	-0.01
World Total	0.04
EAS Total	**0.15**

5.4 Impact of energy price reform and subsidy removal

It has been observed that the energy subsidy data recorded for various countries in the East Asia region are unclear and convoluted within various accounting headings. It is difficult to get the distribution percentage of the total subsidy paid by the governments to the industries and households. Subsidies are also hidden in the intermediate goods and purchases which are often unrecorded. As a matter of fact, in this study, we first obtained data from IEA on total subsidy amount given by each Government to each energy sector like coal, oil, gas and electricity as our base information for energy subsidy. It is also understood that in the countries like India, Government is also collecting huge taxes on certain fuels which are more than the total subsidy amount paid. In China, energy subsidies are gradually going down and Government is driving the price more towards market determined price. Another important issue we observed is that most of the cases majority of the subsidies are for the consumers and end users rather than the producers. Unfortunately, consumers' subsidies are not properly recorded due to complexities of distribution. Anyway, in this study, we tried to simplify the issue mainly due to time and data non availability to the level of understating the energy subsidy removal is nothing but increasing tax on the respective energy commodities.

Subsidy data taken from IEA World Energy Outlook 2008 is of year 2007. Based on this 2007 data we estimated the corresponding percentage change in the tax level at GTAP 7 database (base year 2004) if the subsidy amount is to reduce by 10% at 2007. We consider that 10% subsidy reduction is reasonable start of subsidy reform.

Subsidy has been allocated between the producers and consumers at the general rate of 95% to consumers and 5% to the producers assuming that in most of the countries end users of energy are mostly subsidized. For producers subsidy removal the market price increased by equivalent amount through upward tax adjustment which increases the output value at market price (VOM). On the other hand for the consumers' subsidy removal the household consumers' purchase price increases which is reflected in the upward adjustment of the consumers’ payment for the energy commodities in the market. 100% consumer oil subsidy has been allocated to the petroleum products sector which represents the oil end use. It is further assumed that majority of the oil sector subsidy goes to transport fuel or refined fuels like kerosene for domestic consumption. 100% consumer coal subsidy has been allocated to the industrial consumption assuming that there is limited use of coal in the domestic households. For the gas subsidy, we allocated most of the subsidies to the downstream uses captured under the gas distribution sector in the model. However, to avoid computation difficulties we further adjusted certain distribution percentages of subsidies among produces and consumers in certain countries.

5.4.1 Impact on national economy (GDP)

Due to energy subsidy reduction by 10% most of the countries will suffer from corresponding real GDP reduction except India. India is expected to gain its real GDP by 0.22% due to 10% subsidy reduction. The negative GDP impacts are results of higher degree of market distortion, as energy subsidy removal was only modelled through equivalent tax increase due to lack of more disaggregated dataset which can single out subsidized energy commodity. Overall, EAS region will not suffer from any major GDP loss due to 10% energy sector subsidy reduction. Table 5.15 shows the impacts of energy subsidy reduction by 10% (SR20-10), 50% (SR20-50) and finally 100% (SR20-100) on respective national GDPs compared to their baseline 2020 scenarios.

Table 5.15. Impact of Energy Subsidy Reduction on GDP (Year 2020)

Region	**SR20-10 (nominal)**	SR20-10 **(Real)**	SR20-50 **(nominal)**	SR20-50 **(Real)**	SR20-100 **(nominal)**	SR20-100 **(Real)**
China	0.214	-0.017	0.913	-0.109	1.620	-0.265
Japan	0.019	0.005	0.065	0.009	0.110	0.009
Korea	0.036	-0.003	0.103	0.013	0.131	0.010
Cambodia	0.011	0.000	0.021	0.007	0.011	0.007
Indonesia	0.515	-0.083	1.120	-0.605	0.828	-1.371
Lao PDR	0.033	-0.150	0.083	-0.150	0.149	-0.150
Myanmar	0.018	-0.048	0.054	-0.021	0.089	-0.005
Malaysia	0.522	-0.117	1.040	-0.880	0.942	-1.660

Region	**SR20-10 (nominal)**	SR20-10 **(Real)**	SR20-50 **(nominal)**	SR20-50 **(Real)**	SR20-100 **(nominal)**	SR20-100 **(Real)**
Philippines	0.023	-0.004	0.062	-0.001	0.084	0.001
Singapore	-0.021	-0.035	-0.132	-0.186	-0.239	-0.321
Thailand	0.203	-0.031	0.870	-0.132	1.556	-0.313
Vietnam	0.284	-0.038	1.119	-0.209	2.223	-0.365
Brunei Darussalam	-0.195	-0.105	-0.488	-0.074	-0.525	-0.063
India	0.260	0.229	1.150	0.101	2.082	-0.095
Australia	0.144	-0.041	0.549	-0.213	0.868	-0.420
New Zealand	0.018	0.003	0.054	0.007	0.081	0.009
Brazil	0.017	-0.008	0.069	-0.005	0.126	-0.005
EU	0.012	0.001	0.047	0.006	0.089	0.006
USA	0.014	0.001	0.052	0.002	0.095	0.003
Russia	-0.043	-0.034	-0.061	-0.036	0.024	-0.028
MENA and Venezuela	-0.062	-0.043	-0.106	-0.032	-0.024	-0.029
Rest of the World	0.014	-0.005	0.055	0.000	0.105	0.002
World Total	0.037	-0.002	0.146	-0.019	0.255	-0.046
EAS Total	0.130	0.000	0.484	-0.080	0.796	-0.198

Legend: SR20-10: Energy subsidy reduction by 10 %
SR20-50: Energy subsidy reduction by 50 %
SR20-100: Energy subsidy reduction by 100 %

5.4.2 Impact on sectoral real output

As a matter of fact, due to energy price reform almost all countries' sectoral output in the energy sector decreases to adjust the upward revision of taxes. It is further envisaged that such loss in real output especially in the energy sectors will not affect the economy much as already reflected in the no change in the real GDP for 10% subsidy removal. Hence, such output loss is getting adjusted in other sectoral output of the economy with better efficiency. Table 5.16 shows the % change in real output compared to the baseline 2020 scenario.

Table 5.16 Impact of Energy Subsidy Reduction on real output (% change to the baseline 2020)

Regions	coal	crude oil	gas	petroleum products	electricity	gas distribution
China	-0.02	-0.06	-0.62	-0.21	-0.18	-1.31
Japan	-0.01	-0.03	-0.02	0.11	0.00	-0.01
Korea	-4.20	-0.02	0.00	0.19	0.01	0.02
Cambodia	-0.00	-0.02	-0.01	0.05	0.02	-0.06
Indonesia	-0.00	-0.22	-0.55	-4.73	0.17	-0.03
Lao PDR	0.00	-0.01	0.00	0.06	0.01	-0.10
Myanmar	-0.01	-0.01	-0.02	-0.01	0.05	0.01
Malaysia	-0.01	-0.15	-0.28	-5.25	-0.09	-0.13
Philippines	-0.01	0.02	-0.00	0.14	0.02	0.03
Singapore	-1.18	0.04	0.10	3.06	0.16	0.40
Thailand	-0.32	-0.16	-0.15	0.10	-0.43	-0.40
Vietnam	0.00	-0.01	-0.32	-25.11	-0.42	-1.51
Brunei Darussalam	0.00	-0.04	-0.01	0.12	-0.00	-0.01
India	-0.02	-0.17	-0.61	-0.08	-0.28	-0.06
Australia	-0.05	-0.23	-0.05	-1.51	-0.18	-1.36
New Zealand	-0.01	-0.06	-0.00	0.18	0.01	-0.01
Brazil	-0.00	-0.02	-0.01	0.06	-0.00	-0.01
EU	-0.00	-0.03	-0.01	0.09	0.00	-0.02
USA	-0.00	-0.02	-0.01	0.10	0.00	-0.01
Russia	-0.00	-0.02	-0.00	0.10	0.04	0.01
MENA and Venezuela	0.00	-0.02	-0.01	0.17	0.04	0.05
Rest of the World	-0.01	-0.03	-0.01	0.09	0.01	-0.01
World Total	-0.02	-0.03	-0.05	-0.05	-0.03	-0.05
EAS Total	-0.03	-0.11	-0.34	-0.37	-0.11	-0.55

5.4.3 Impact on domestic energy price

Due to energy subsidy reduction (mainly for 10% of the 2007 level), the region will not suffer from major loss of economic development in terms of GDP. Energy prices will also go down in most of the medium and less developed countries in this region. China and India will have larger adverse impact on energy prices due to subsidy removal. Table 5.17 shows the percentage change of price due to subsidy removal by 10% to the baseline 2020 scenario.

Table 5.17 Impact of Energy Subsidy Reduction on consumer price of energy commodities: (Compared to the Baseline 2020 price)

Regions	coal	crude oil	gas	petroleum products	electricity	gas distribution
China	11.886	-0.239	0.959	13.150	6.279	41.304
Japan	-0.124	-0.126	-0.105	-0.112	-0.002	0.011
Korea	0.299	-0.158	-0.093	-0.137	-0.013	-0.006
Cambodia	-0.072	-0.123	-0.049	-0.124	-0.016	0.009
Indonesia	-0.103	-0.889	-0.139	16.882	-0.153	0.010
Lao PDR	-0.062	-0.123	-0.040	-0.108	0.010	0.026
Myanmar	-0.125	-0.139	-0.050	-0.152	-0.008	0.017
Malaysia	-0.099	-0.162	-0.136	24.530	-0.034	0.004
Philippines	-0.142	-0.148	-0.052	-0.140	-0.028	-0.047
Singapore	-0.107	0.376	-0.066	-0.151	-0.040	-0.133
Thailand	-0.165	-0.190	-0.073	3.165	4.001	-0.011
Vietnam	-0.380	-0.254	-4.963	6.873	4.831	-0.139
Brunei Darussalam	-0.096	-0.341	-0.106	-0.164	-0.053	-0.031
India	-0.104	-0.126	0.224	3.586	5.686	0.025
Australia	-0.132	-0.389	-0.113	8.911	0.658	11.553
New Zealand	-0.139	-0.249	0.014	-0.190	0.011	0.014
Brazil	-0.055	-0.104	-0.038	-0.074	0.008	0.000
EU	-0.029	-0.111	-0.041	-0.090	0.001	0.004
USA	-0.014	-0.123	-0.039	-0.092	0.003	0.007
Russia	-0.054	-0.111	-0.037	-0.093	-0.041	-0.018
MENA and Venezuela	-0.049	-0.128	-0.052	-0.104	-0.058	-0.022
Rest of the World	-0.0606	-0.1259	-0.042	-0.0951	-0.0099	0.0026

5.4.4 Impact of complete removal of energy taxes/subsidies

Apart from subsidy removal, we also conducted simulation on removing existing taxes and subsidies on various energy commodities to avoid any market distortion. It is assumed that, taxes and subsidies are all imposed on the economy to distort the normal market equilibrium. Removing taxes could also be possible for the countries under the complete integration scenario. As a matter of setting the policy shocks, we completely removed the energy taxes, private consumption taxes for domestic energy products and private consumption taxes for imported energy products. The results show that due to tax removal, overall regional economy will be benefited in terms of gaining real GDP by 0.4% compared to the base line scenario. The simulation results are as follows:

Table 5.18 Impact of tax removal on various energy commodities

Regions	% change to baseline 2020 GDP (Real)	% change to baseline 2020 GDP (Nominal)
China	0.111	-0.184
Japan	0.314	-1.533
Korea	2.090	-2.174
Cambodia	0.103	-0.264
Indonesia	-0.123	-0.224
Lao PDR	-0.108	-0.291
Myanmar	-0.006	-6.385
Malaysia	-0.129	0.081
Philippines	-0.003	-0.740
Singapore	0.286	0.936
Thailand	1.446	-3.158
Vietnam	0.049	1.598
Brunei Darussalam	-0.224	3.205
India	0.363	-3.361
Australia	0.120	-1.127
New Zealand	0.265	-1.742
Brazil	-0.072	-0.172
EU	-0.103	-0.333
USA	-0.031	-0.370
Russia	-0.020	1.201
MENA and Venezuela	-0.219	2.663
Rest of the World	-0.073	-0.089
World Total	0.038	-0.388

EAS Total	**0.393**	**-1.214**

Among 16 EAS members, six member countries will lose in terms of real GDP. In all six countries the nationwide real output will decrease as a result of energy tax/subsidy removal, and these output reduction account real GDP loss. The causal mechanism between energy tax/subsidy removal and real output reduction is not always straight forward in the general equilibrium world. For example, the most negatively impacted sector in Lao P.D.R. and Brunei Darussalam is the textiles, wearing apparel and leather (twl).

5.4.5 Impact on GHG emissions (CO_2)

As expected, energy subsidy removal and price reform has a positive effect on CO_2 emissions reduction in the region as a whole. However, energy commodity tax removal will have negative impact on environment as it would encourage more CO_2 emissions. Table 5.19 summarizes the CO_2 emissions result out of these policy scenarios:

Table 5.19 Impact of energy subsidy and tax removal on CO2 emissions

Region	SR20-10	SR20-50	SR20-100	TR20
China	-0.17	-0.70	-1.17	1.37
Japan	0.00	0.23	0.23	16.48
Korea	0.00	0.00	0.00	14.61
Cambodia	0.00	0.00	0.00	0.04
Indonesia	-1.56	-2.72	-1.17	-3.48
Lao PDR	0.00	0.00	0.00	1.17
Myanmar	0.00	0.12	0.23	25.34
Malaysia	-1.52	-2.27	-0.76	-1.77
Philippines	0.28	0.28	0.28	0.76
Singapore	0.34	0.68	1.02	-1.07
Thailand	-0.81	-1.61	-3.23	10.67
Vietnam	-3.14	-4.96	-5.29	4.67
Brunei Darussalam	0.00	0.17	0.17	2.08
India	0.00	-0.83	-1.38	1.06
Australia	-0.67	-2.68	-4.70	7.21

New Zealand	0.00	0.73	0.73	11.56
Brazil	0.00	0.00	0.00	-2.15
EU	0.06	0.12	0.18	-1.82
USA	0.03	0.10	0.10	-1.49
Russia	0.13	0.13	0.13	-0.76
MENA and Venezuela	0.09	0.18	0.27	-3.19
Rest of the World	0.04	0.11	0.15	-1.34
World Total	-0.06	-0.21	-0.31	0.13
EAS Total	-0.30	-0.86	-1.17	**3.52**

Legend: TR20: Energy tax removal

5.5 Impact of liberalization of domestic energy market

As a consequence of energy market integration in the region, we envisaged that the domestic energy markets will also be liberalized and deregulated. Governments will allow the markets to take the decision on price and quantity of supply of energy. This will encourage the private sector investors to pitch in for the development of the domestic market. In this study we have conducted two different sets of simulation in the context of domestic market liberalization. We assumed that there could two different scenarios: 1) due to market integration all the energy sectors will improve their corresponding overall efficiency through total factor productivity improvement and 2) only the secondary energy market like electricity and gas distribution sector will improve their overall efficiency due to market liberalization and deregulation. It is envisaged that domestic market liberalization will have greater impact on the secondary energy supply market than the primary markets. Therefore, in this scenario case we have two different sub sets of simulations which are coded as MR-20W and MR-20. MR-20W is about overall energy sector TFP improvement of 20% due to domestic market liberalization and MR-20 is about 20% TFP improvement for electricity and gas distribution sectors only. Hence, for overall improvement in the factor productivity of the energy sectors, the model is shocked with output augmenting technological changes in each energy sector.

5.5.1 Impact on national economy (GDP)

The first set of results that we obtained is mainly the reflection of the improvement in the output efficiency in the six energy sectors in the model. It fundamentally means that coal, oil, natural gas, electricity, petroleum products and gas distribution sectors all improved their productivity through efficiency improvement. As a matter of fact, there is more energy commodity output per unit of input to produce them. Due to output efficiency improvement an overall economic development has been observed through improved GDP. The second set of results that we obtained shows the impacts of national economies in terms of GDP due to TFP increase only in the electricity and gas distribution sectors. Table 5.20 shows the impacts of such TFP increase on GDPs.

Table 520 Impact of energy sector output efficiency improvement on GDP

Region	% change to baseline 2020 GDP with 20% TFP growth in all energy sectors (MR20W)	% change to baseline 2020 GDP with 20% TFP growth in ely & gdt sectors (MR20)
China	4.411	1.551
Japan	1.436	0.737
Korea	3.632	0.834
Cambodia	1.978	0.729
Indonesia	4.012	0.852
Lao PDR	2.111	0.943
Myanmar	7.141	1.927
Malaysia	5.642	1.278
Philippines	1.772	0.934
Singapore	3.327	0.759
Thailand	5.168	1.464
Vietnam	6.363	2.479
Brunei Darussalam	14.715	1.146
India	4.248	1.825
Australia	2.176	0.620

New Zealand	1.591	0.830
Brazil	0.067	-0.010
EU	0.103	0.003
USA	0.036	0.003
Russia	-0.284	-0.079
MENA and Venezuela	0.143	-0.029
Rest of the World	0.087	-0.004
World Total	0.783	0.259
EAS Total	3.055	1.090

5.5.2 Impact on sectoral real output

Due to domestic market liberalization, market competition increases which bring back efficiency. As a consequence, domestic market liberalization increases real output of all energy commodities in the economy. The following table shows the relative changes in real outputs under two different scenarios of MR20W and MR20.

Table 5.21 Impact of domestic market liberalization on real output
(% change to the baseline 2020)

Region	coal	crude oil	gas	petro prod	electricity	coal	crude oil	gas	petro prod	electricity
	MR20W					MR20				
China	18.70	22.04	38.39	24.73	25.09	-0.36	0.38	3.27	-0.31	17.30
Japan	18.13	21.65	22.27	22.68	13.31	-0.88	-0.43	-0.50	-0.92	14.32
Korea	18.17	21.05	17.00	30.08	18.00	-0.70	-0.14	0.00	-0.70	16.01
Cambodia	19.20	21.54	20.46	21.62	25.33	-0.36	-0.02	-0.11	0.00	19.56
Indonesia	18.34	20.12	20.70	17.90	18.08	-0.61	-0.29	-0.40	-1.41	12.42
Lao PDR	20.28	21.72	29.27	41.39	40.56	0.30	0.31	2.44	3.07	30.57
Myanmar	17.96	18.46	17.77	42.25	32.54	-0.67	-0.27	-0.84	-0.27	22.34
Malaysia	18.87	20.63	21.03	30.52	19.56	-0.51	-0.25	-0.34	-0.45	18.20
Philippines	20.79	49.09	16.73	17.54	14.72	-0.85	-1.07	-1.69	-1.97	12.84
Singapore	18.82	21.09	52.43	29.26	19.00	-1.18	-0.14	1.95	-1.47	13.63
Thailand	16.65	21.66	18.93	21.29	23.10	-1.04	-0.24	-0.57	-0.51	17.52
Vietnam	18.33	20.45	19.81	11.03	21.48	-0.45	-0.33	-0.25	2.12	18.93

Brunei Darussalam	19.17	20.80	20.99	20.69	21.72	-0.11	-0.12	-0.23	0.74	19.74
India	18.16	21.08	18.61	24.65	16.97	-0.85	-0.39	-0.62	0.02	14.39
Australia	18.46	21.46	22.08	26.99	15.68	-0.68	-0.21	-0.44	0.46	14.77
New Zealand	18.15	21.56	17.13	22.52	17.87	-0.74	-0.38	-1.30	0.35	17.56
Brazil	-1.03	-1.00	-0.98	0.65	-0.86	-0.20	-0.10	-0.18	0.11	-0.34
EU	-1.95	-1.15	-0.89	0.91	-0.31	-0.39	-0.09	-0.15	0.20	-0.16
USA	-0.68	-0.98	-0.78	1.61	0.61	-0.17	-0.06	-0.13	0.25	0.14
Russia	-2.43	-0.78	-0.39	-0.12	2.09	-0.51	-0.04	-0.08	0.06	0.21
MENA and Venezuela	-1.87	-0.91	-0.74	-5.35	1.38	-0.44	-0.08	-0.18	-0.16	0.11
Rest of the World	-2.31	-1.23	-0.90	-0.11	0.47	-0.47	-0.10	-0.16	0.14	-0.14
World Total	8.38	1.31	1.82	7.99	6.27	-0.38	-0.07	-0.17	-0.07	4.86
EAS Total	18.61	21.38	20.91	25.16	19.45	-0.44	0.04	-0.35	-0.52	15.82

5.5.3 Impact on GHG emissions (CO_2)

As a consequence of enhanced energy commodity output, CO_2 emissions are expected to be increased over the region. For the MR20W overall CO2 emissions drastically increases due to output increase. However, for the electricity and gas distribution sectoral TFP growth, CO_2 emission decreases in the region. As a matter of fact, it has been envisaged that due to efficiency improvement in the electricity and gas supply system, losses will be reduced. Subsequently, use of fossil fuel will also be reduced accordingly which will reduce the GHG emissions (Table 5.22).

Table 5.22 Impact of energy sector output efficiency improvement on CO2 emissions

Region	% change to baseline 2020 GDP 20% for TFP growth of 20% in ely & gdt sectors
China	-0.84
Japan	-2.23
Korea	-1.53
Cambodia	1.78
Indonesia	1.87
Lao PDR	8.47
Myanmar	10.54
Malaysia	2.48

Philippines	-2.11
Singapore	-2.85
Thailand	1.05
Vietnam	4.52
Brunei Darussalam	1.70
India	-2.49
Australia	-1.29
New Zealand	2.59
Brazil	0.27
EU	0.55
USA	0.43
Russia	0.38
MENA and Venezuela	0.11
Rest of the World	0.49
World Total	0.01
EAS Total	**-0.80**

5.6 Impact of combination policies of energy market integration

We assumed that for full scale implementation of the energy market integration in the EAS region all the above mentioned policies are introduced simultaneously. This combined policy scenario demonstrates the most optimistic situation of integrated energy market in the East Asia region. As a result, we simulated the economy with the following simultaneous shocks to observe the impacts on national economy, real output of each energy commodity, relative price changes and finally on GHG emissions in terms of CO_2:

Trade liberalization

Investment liberalization (capital reallocation)

Energy subsidy reduction (10%)

Market reform (20% increase in TFP for “ely” and “gdt” sectors)

In addition, we conducted this simulation with 15% increase in TFP for “ely” and “gdt” sectors for the purpose of sensitivity testing.

5.6.1 Impact on national economy in terms of GDP

Model result shows that due to simultaneous implementation of all the relevant policies for energy market integration, all the member countries of the East Asia region gain economically in terms of real GDP.

Table 523 Impact of combination policy on GDP

Region	% change from 2020 baseline real GDP (20% TFP)	% change from 2020 baseline nominal GDP (20%TFP)	% change from 2020 baseline real GDP (15% TFP)	% change from 2020 baseline nominal GDP (15%TFP)
China	1.459	1.996	1.111	1.562
Japan	0.427	0.365	0.261	0.227
Korea	0.695	0.576	0.502	0.419
Cambodia	1.844	1.355	1.665	1.187
Indonesia	1.692	1.897	1.483	1.733
Lao PDR	1.632	4.166	1.347	3.422
Myanmar	2.903	3.981	2.423	3.248
Malaysia	2.036	2.032	1.727	1.855
Philippines	2.190	1.699	1.976	1.548
Singapore	0.458	0.300	0.288	0.201
Thailand	2.802	2.393	2.460	2.094
Vietnam	3.760	1.778	3.172	1.429
Brunei Darussalam	2.291	1.038	2.008	1.123
India	2.709	4.371	2.353	3.631
Australia	0.329	0.886	0.188	0.734
New Zealand	1.176	1.163	0.985	0.934
Brazil	-0.011	-0.137	-0.011	-0.108
EU	0.002	-0.475	0.001	-0.371
USA	0.003	-0.476	0.002	-0.373
Russia	-0.087	-0.823	-0.076	-0.642
MENA and Venezuela	-0.028	-0.696	-0.033	-0.538
Rest of the World	-0.004	-0.328	-0.005	-0.254
World Total	0.252	-0.044	0.192	-0.031
EAS Total	1.059	1.305	0.815	1.033

5.6.2 Impact on sectoral real output

Due to simultaneous application of the relevant policies regarding energy market integration can further reduce the real outputs from the energy sector. Tables 5.24 and 5.25 show the changes in the baseline scenario under 20% and 15% TFP increase in "ely" and "gdt" sectors respectively.

Table 5.24 Impact of combined policy on sectoral real output: 20% TFP growth case (% change from baseline 2020)

Regions	coal	crude oil	gas	petroleum products	electricity	gas distribution
China	-0.39	0.34	2.51	-0.86	16.96	17.34
Japan	-0.71	-0.48	-0.63	-1.09	13.65	17.82
Korea	-5.23	-0.14	0.00	1.17	15.62	39.36
Cambodia	-0.18	0.31	-0.05	11.93	20.96	57.80
Indonesia	-0.25	-0.06	-0.67	-6.38	14.27	20.48
Lao PDR	0.30	0.33	2.44	2.03	34.46	56.38
Myanmar	-0.42	-0.00	-0.10	-0.00	26.03	36.69
Malaysia	-0.35	-0.12	-0.20	-5.38	19.61	34.36
Philippines	-0.91	0.74	-1.44	4.05	14.82	7.54
Singapore	-1.18	0.03	1.66	6.80	13.79	39.04
Thailand	-1.06	-0.17	-0.59	1.54	18.78	13.70
Vietnam	-0.26	-0.38	-1.02	-32.08	20.75	8.17
Brunei Darussalam	0.05	0.21	-0.16	2.42	22.69	10.62
India	-2.12	-0.47	-1.11	1.71	17.32	5.79
Australia	-0.47	-0.03	-0.66	3.70	13.76	11.39
New Zealand	-0.53	-0.18	-1.19	0.46	18.21	11.09
Brazil	-0.13	-0.10	-0.19	0.07	-0.35	-0.41
EU	-0.31	-0.09	-0.18	0.17	-0.18	-1.97
USA	-0.16	-0.07	-0.14	0.21	0.13	-0.16
Russia	-0.42	-0.04	-0.10	-0.25	0.21	-1.97
MENA and Venezuela	-0.36	-0.08	-0.24	-0.86	0.12	-0.92
Rest of the World	-0.40	-0.10	-0.18	0.01	-0.16	-1.02
World Total	-0.37	-0.06	-0.21	-0.08	4.88	1.28
EAS Total	-0.46	0.09	-0.46	-0.19	15.91	20.02

Table 5.25 Impact of combined policies on sectoral real output: 15% TFP growth case (% change from baseline 2020)

Regions	coal	crude oil	gas	petroleum products	electricity	gas distribution
China	-0.30	0.26	1.67	-0.77	12.65	12.39
Japan	-0.57	-0.41	-0.53	-0.88	10.15	13.33
Korea	-5.01	0.09	-3.67	1.33	11.67	29.54
Cambodia	-0.10	0.31	0.09	11.96	15.39	40.61
Indonesia	-0.11	0.01	-0.57	-6.04	11.16	15.64
Lao PDR	0.36	0.64	2.20	1.14	24.88	40.83
Myanmar	-0.27	0.15	0.09	0.02	19.93	28.31
Malaysia	-0.47	-0.06	-0.12	-5.24	15.05	25.22
Philippines	-1.09	1.15	-0.95	4.55	11.61	6.08
Singapore	-0.82	-0.01	1.17	7.15	10.42	29.24
Thailand	-0.88	-0.12	-0.45	1.66	14.35	10.74
Vietnam	-0.17	-0.30	-0.95	-32.37	15.76	5.72
Brunei Darussalam	-0.05	0.24	-0.11	2.20	17.60	8.61
India	-1.86	-0.38	-0.96	1.73	13.71	4.71
Australia	-0.31	0.02	-0.56	3.64	10.17	7.85
New Zealand	-0.35	-0.15	-0.94	0.37	13.80	8.63
Brazil	-0.01	-0.08	-0.09	0.04	-0.27	-0.30
EU	-0.22	-0.07	-0.15	0.12	-0.13	-1.43
USA	-0.12	-0.05	-0.12	0.15	0.10	-0.12
Russia	-0.30	-0.03	-0.08	-0.27	0.16	-1.45
MENA and Venezuela	-0.19	-0.06	-0.20	-0.84	0.10	-0.69
Rest of the World	-0.29	-0.08	-0.14	-0.03	-0.12	-0.75
World Total	-0.28	-0.05	-0.17	-0.06	3.68	0.96
EAS Total	-0.36	0.09	-0.38	-0.06	11.98	14.86

5.6.3 Impact on GHG emissions (CO_2)

In terms of CO_2 emissions, the combined policy drastically increases the emissions by 10% in the region as a whole. This happens mainly due to the increase in GDP in the region. Hence, it is a matter of policy choice for the policy and law makers to prioritize the developmental aspects. Table 5.25 shows the impacts of the combined policy scenarios on CO_2 emissions.

Table 5.26 Impact of combined policies on CO2 emissions

Region	% change from baseline 2020 CO_2 emissions (20% TFP growth)	% change from baseline 2020 CO_2 emissions (15% TFP growth)
China	-1.03	-0.84
Japan	-2.73	-2.23
Korea	-1.64	-1.29
Cambodia	3.89	3.27
Indonesia	2.20	1.70
Lao PDR	11.61	8.95
Myanmar	13.80	10.83
Malaysia	1.51	0.90
Philippines	-0.44	0.03
Singapore	-2.73	-2.12
Thailand	1.92	1.63
Vietnam	8.65	7.46
Brunei Darussalam	3.82	3.35
India	4.81	5.47
Australia	-3.18	-2.91
New Zealand	2.90	2.27
Brazil	0.23	0.17
EU	0.51	0.38
USA	0.41	0.31
Russia	0.35	0.26
MENA and Venezuela	0.04	0.01
Rest of the World	0.42	0.30
World Total	0.14	0.14
EAS Total	-0.31	-0.13

5.7 Welfare measures of energy market integration

Equivalent variations (EVs) are considered as a measure for welfare change in the economy due to the policies. We report the percentage change of EVs for different policy scenarios as follows:

Table 5.27 Impact of policy shocks on EV (% change from baseline 2020)

Region	TL2020	CT2020	SR2020	MR2020	Combined
China	-0.02	-0.07	0.00	2.58	2.48
Japan	-0.02	-0.88	0.03	3.57	2.69
Korea	0.09	-0.33	0.04	1.92	1.72
Cambodia	-0.18	0.93	0.02	1.72	2.48
Indonesia	0.13	1.27	-0.06	1.53	2.86
Lao PDR	-0.00	0.77	0.03	2.98	3.82
Myanmar	0.08	1.31	0.04	3.92	5.45
Malaysia	0.24	0.81	-0.29	2.77	3.54
Philippines	-0.14	2.13	0.04	2.70	4.76
Singapore	-0.22	-0.01	-0.07	1.94	1.64
Thailand	0.07	1.54	0.02	3.84	5.53
Vietnam	0.06	0.71	-0.24	4.92	5.43
Brunei Darussalam	1.53	2.01	-0.36	1.62	4.83
India	0.14	1.74	-0.01	7.12	9.04
Australia	0.16	-0.42	-0.09	1.86	1.47
New Zealand	-0.06	0.80	0.02	3.18	3.95
Brazil	-0.00	0.00	0.02	0.45	0.47
EU	-0.01	0.00	0.02	0.05	0.06
USA	-0.00	-0.00	0.01	0.05	0.05
Russia	0.01	0.02	-0.05	-0.26	-0.29
MENA and Venezuela	0.06	0.04	-0.08	-0.26	-0.25
Rest of the World	0.00	0.00	0.01	0.12	0.14
World Total	0.01	-0.01	0.00	0.70	0.70
EAS Total	**0.02**	**-0.05**	**-0.01**	**2.84**	**2.81**

Legend: TL2020: Trade liberalization
CT2020: Energy sector investment liberalization
SR2020: Energy subsidy reduction by 10 %
MR2020: Domestic energy market liberalization (20% increase in TFP for ely and gdt)
Combined: Combination of the above four policy scenarios

Table 5.27 shows that energy market integration can benefit all EAS member countries quite significantly.

6. CONCLUSIONS AND RECOMMENDATIONS

In this study we tried to demonstrate the impacts of various policy measures to pave the path for integrated energy market in the East Asia region. Full scale integration is a highly optimistic proposal, but it has been envisaged that for overall economic, environmental and social development some regional cooperation is required. Energy being the primary input for all economic activities and thereafter causes of environmental pollution, it is prudent to begin with some attempt of systematic cooperation among the member states of the East Asia Summit to integrate the development of this sector across the region.

In the context of estimating five different policy measures for energy market integration, it has been observed that no single policy can create the miracle of integrated market where all the member countries are winning. Economy being a system of dynamic equilibrium, it is obvious that in the process of regional cooperation, some country will lose and some will win. This a policy decision of the law makers to pick up the most relevant and appropriate policy to expedite the process. "Winners will compensate the losers" could be an overarching policy to mitigate the negative impacts of integrated market. However, we observed that energy commodity trade liberalization and domestic energy market liberalization could bring the regional economic benefit while the energy price reform and energy sector investment liberalization could have negative or no impact of the regional economy. Our very optimistic policy scenario of implementing four policy measures simultaneously, proved to be most promising in terms of economic and environmental benefits. No other policy scenario could achieve the dual benefits like this. This indicates that some strong policy measure to integrate the energy market in this region could be effective without much economic and environmental loss.