

**Australian Agency for International Development (AusAID)
ASEAN**

**AAECP ENERGY POLICY AND SYSTEMS
ANALYSIS PROJECT**

ASEAN Energy Market Integration

SECOND REGIONAL ENERGY POLICY STUDY

VOLUME 1: MAIN REPORT

Final Report, August 2005

EXECUTIVE SUMMARY

Introduction

This report presents the results of the second regional energy policy study conducted under the Energy Policy and Systems Analysis Project (EPSAP) sponsored by AusAID. The goal of EPSAP is to:

“...Enhance the capacity of ASEAN energy policy makers and planners to assess the impacts and cost effectiveness of alternative energy policy options which could assist countries to formulate policies and programs to help meet the demand for energy services at least cost.”

The ASEAN Centre for Energy (ACE) prepared the report with assistance from the Australian Managing Contractor for the project, with additional assistance from national project team members temporarily attached to ACE. Countries contributing were Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Thailand and Vietnam.

Study Topic: ASEAN Energy Market Integration

The topic of the report is “ASEAN Energy Market Integration”, an analysis of the options and impacts of further integration of the energy markets of countries in the ASEAN region. This study, endorsed by the EPSAP’s Project Coordinating Committee (PCC) was to examine and report on:

- ❑ Optimised energy trading opportunities and energy infrastructure development strategies for the region;
- ❑ The relative benefits of those strategies; and
- ❑ The value of those benefits under a range of possible scenarios.

The study was required to take account of:

- The latest available resource and cost data;
- The committed national energy policy positions of each country and, where applicable, the ASEAN region;
- Options for gas and electricity trade as previously identified and studied by the AIMS Working Group, the TAGP Taskforce, and the first EPSAP regional study group;
- Cost-reflective pricing, also taking account of taxes and subsidies on various forms of energy and their possible harmonisation;
- The impact of real or apparent differences between countries in the costs of energy infrastructure and technologies;
- A range of possible outcomes for future LNG prices;
- Possible improved performance and longer lifetimes of energy equipment such as power stations; and

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- Possible changes to the investment rate of return or the availability of investment capital.

This second regional study extends the work of the first regional study on the Trans ASEAN Energy Network, which analyzed the strategies and benefits associated with increased integration and interconnection of electricity and natural gas transmission networks between the countries of ASEAN. In contrast to both the HAPUA analysis that looks only at the optimal strategy from the point of view of electricity utilities and the ASCOPE study that only takes into account the gas market, the first regional study conducted by EPSAP attempted to synergize the plans of both HAPUA and ASCOPE within a consistent energy production, transmission and usage framework. As such, it aimed to provide inputs to decision makers from an analysis of the whole energy system rather than an analyses of gas or electricity individually, which sometimes can make different and possibly conflicting assumptions on basic issues such as fuel use patterns.

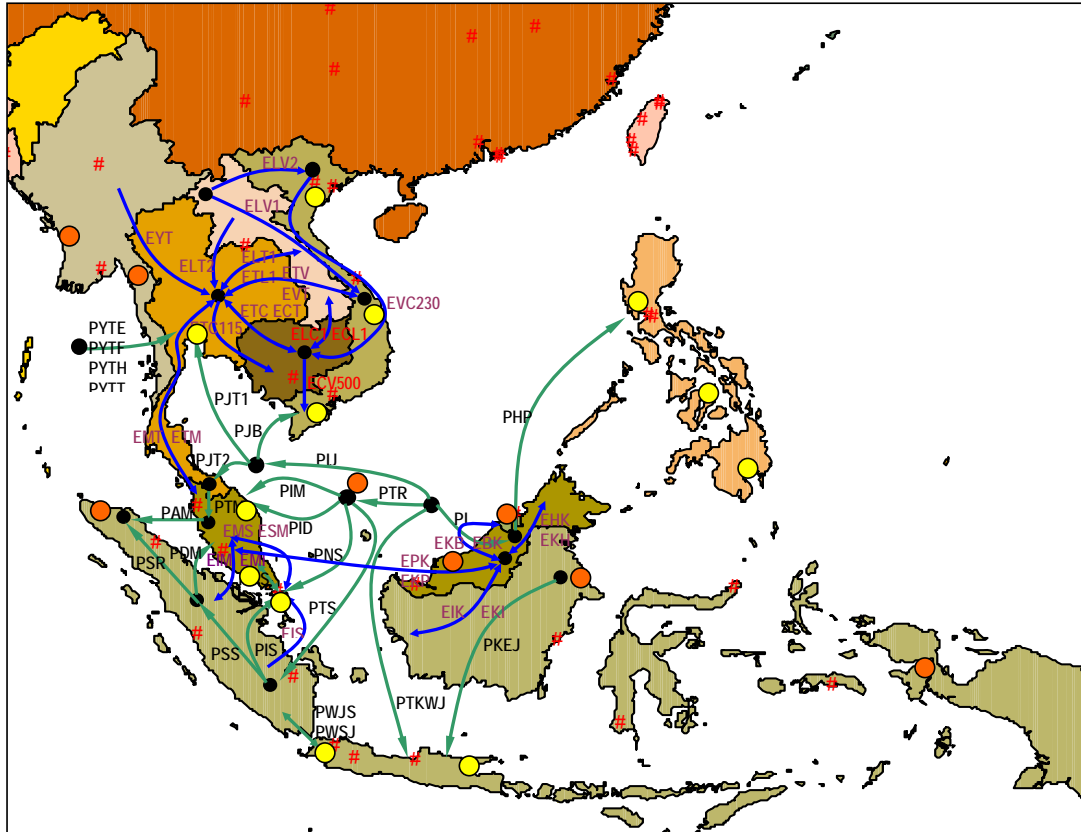
Methodology

As with the first regional study under EPSAP, the current study uses a MARKAL energy model of the ASEAN region assembled from the national MARKAL models developed by each national project team. ACE developed models for the non-participating ASEAN countries of Brunei and Singapore, while ACE and the teams together developed the options for trade in gas, electricity, LNG, coal, oil and petroleum products, both within the ASEAN region and with the rest of the world. Many of these options were based on those considered by HAPUA and ASCOPE in their planning, while national teams provided others. Data and resource options and trade from Myanmar were new to the current study.

MARKAL is a model that optimises the production, conversion, transmission and use of energy to meet projections of the demand for energy services over a relatively long period, 40 years in this case. It can solve models with a very large number of variables and constraints. For the current study, apart from the existing components making up national energy systems, the inputs include:

- Trans-ASEAN natural gas pipeline options, including but not limited to those in the TAGP study;
- Trans-ASEAN electricity grid options, including but not limited to those in the AIMS study;
- Options for the production, transport, use, import and export of LNG;
- Facilities to take account of changing world oil and petroleum product prices;
- Revised resource estimates, especially for natural gas fields within ASEAN.

A sketch map of the ASEAN region showing inter-ASEAN electricity transmission links, gas pipeline options and possible LNG import and export facilities is shown below.



Note: Electricity links blue; gas pipelines green; LNG production orange; LNG consumption yellow.

Facilities in the national MARKAL models (and therefore the regional MARKAL model) particularly relevant to the current study are:

- Cost-reflective pricing implicit in the optimised system, requiring comprehensive and internationally comparable data on energy taxes and subsidies.
- Reasonable model detail that allows modelling of the marginal cost of electricity (for example, a full specification of diurnal (daily) and seasonal patterns of consumption of energy services whose associated equipment uses energy).
- The ability to model changes in plant performance and lifetimes as well as changes in investment rates of return.
- Modelling features that can account for national energy policies, including taxes and subsidies on fuels.

Outputs of a MARKAL model run that are useful for analysis and comparison include:

- Total discounted system cost (specifically, differences in this cost between runs of different cases).
- The choice and timing of plant additions of various types, including additions to trading infrastructure such as gas pipelines and transmission lines.

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- Marginal values of investments, energy carriers and policy constraints, including benefit/cost ratios of investments.
 - Projections of fuel production and use, including electricity differentiated by diurnal and seasonal time slices.
 - Dollar flows in various categories such as investment, fuels and other costs.

To study the issues in the Terms of Reference, the study team devised scenarios for around 20 study cases to run with MARKAL. Each MARKAL case run produces an optimised energy development strategy for ASEAN, together with associated marginal cost pricing (including taxes and subsidies if included). These are reported in detail in the body and annexes of this report and are summarised below. All dollar amounts quoted are estimates expressed in year 2000 US\$.

Results and Consideration of Issues

The following discussion is summarised in the Study Issues Table that follows.

Table Error! No text of specified style in document.-1: ASEAN Energy Market Integration: Issue Summary

Issue	Likely Range of Change in Total Discounted System Cost (US\$billion)	Remarks	Suggested Follow-up
Uncertainty in world oil crude oil price	140 decrease to 250 increase	Remains the largest ASEAN energy exposure by far, although it was a secondary consideration in the current study.	Substitution options for oil products in the national MARKAL models should be further developed to allow study this issue later if required.
Removing technology cost differences between countries	None to 30 decrease	The basis for such large cost differences should be investigated, both to improve modelling accuracy and to identify scope for cost savings.	A project should be developed to study the basis for these cost differences for key technologies, such as in the power sector.
Impact of introducing LNG	5 decrease to 12 decrease	LNG appears to be a major factor in future ASEAN energy trade and use under most scenarios.	Gas and electricity interconnection strategy should be reviewed regularly to take account of LNG and other relevant energy trends.
Further refinement of current gas and electricity interconnection plans	5 decrease to 8 decrease	Current plans have inconsistent fuel strategies in the power sector. Some proposed interconnections appear over-ambitious.	Studies using a system-wide optimisation model such as MARKAL should be used to complement detailed technical and economic project-by-project analysis.
Pursuing improved power plant performance and life	None to 9 decrease	Major improvement has been achieved elsewhere and could be achieved in ASEAN also, over time.	Policymakers should note the scale of cost savings involved, including the potential to reduce electricity prices, and consider strategies for achieving them.
Implementing committed national energy policies	2 decrease to 5 decrease	National fuel security policies will affect the opportunities for gas and electricity trade.	The impact of the Philippines self-sufficiency policy on gas interconnection should be studied. Singapore's supply strategy is also critical for the rest of the ASEAN energy system and should be kept under close review
Fuel taxes and subsidies	Relatively small cost	Substitutability in end use is modelled only in part in the ASEAN MARKAL models. The distortion costs of fuel taxes is almost certainly larger than modelled but does not appear at this stage to be a major factor affecting energy trade.	The demand-side of the ASEAN MARKAL model needs further development if this issue is to be studied further.
Increase investment/discount rate from 10% p.a. to 15%p.a.	Not applicable	There is a shift to lower capital cost equipment, notably in the power sector, which affects trade opportunities	Energy policymakers should note the potential impact and its affect on policy, especially as private sector development becomes more prominent.

Source: MARKAL Runs: See Main Report

A key outcome of the study is that most of the issues raised in the study terms of reference have discounted cost implications for the region typically in the range of \$5-\$10 billion. These potential sums should warrant close policy attention.

Even larger sums are involved in two issues that were covered by the study. By far the largest is ASEAN exposure to ongoing high world oil prices. Sums of the order of \$100 billion of discounted value are at stake. ASEAN countries have already substantially reduced their oil-dependence in some sectors, notably power generation, but ongoing high prices will change fuel patterns downstream and indirectly, future patterns of non-oil trade. While this study did not focus on the petroleum sector, the results indicate that other issues raised in the terms of reference are more likely to affect gas and electricity trade in ASEAN more strongly for the foreseeable future.

A surprising result because of the large sum involved is the cost reduction obtained if the cost of all new gas and coal plant is brought down to be consistent with the costs provided by the Malaysia study team. The variation in the data provided by and used in many countries does not seem to be warranted by the large fraction of imported components in these plants. Discounted system costs reduce by nearly \$30 billion. Some of this may be due to data error; some high costs may be real and non-reducible. However, some costs may prove, on investigation, to be greater than they could or should be, for many possible reasons. This may involve simply correcting the data to improve model outcomes and confidence in them – a worthwhile outcome in itself. In other cases, policy action to reduce costs may be warranted. The first step is to conduct a focussed investigation of the reasons behind these differences.

Another key study outcome is the importance of LNG in the analysis of trade in the region. In every scenario studied, inclusion of LNG enables ASEAN member countries to have wider options of natural gas import origin to meet their increasing demand. In order to elaborate further the impact of allowing LNG trade in ASEAN, different levels of LNG price were investigated. At the right price, LNG becomes an economic fuel (when converted back to gas) and at a suitably low price it becomes more cost-effective than gas pipeline transport options, beginning in consumption locations furthest removed from gas sources. At a suitable price and with adequate demand, the technology also provides export opportunities for some gas fields in the ASEAN region. Three levels of LNG price delivered to the receiving port were assumed. These are \$2/GJ (base or median level), \$1.5/GJ (low level) and \$3/GJ (high level). The results indicate that the significance of LNG is in the range of \$5-12 billion depending on the LNG price. The impact of LNG price variation can be summarised as follows:

- At a low LNG price, ASEAN imports large amounts of LNG from outside ASEAN with only a small amount of LNG trade within ASEAN and additional exports. In spite of these large imports, gas pipeline trade in total is largely unaffected with the LNG replacing coal (mostly) and oil.
- A similar outcome prevails at the median LNG price level although LNG imports are reduced to around 84% of those when low prices prevail.
- With a high LNG price, imports still occur but only about 30% of those in the Reference Case. However, LNG trade within ASEAN is now stimulated as well as additional exports. The high LNG import price also causes gas pipeline trade to be higher than in the Reference Case.

Other key study outcomes include:

- LNG appears as a significant technology in every scenarios studied, to the amount of \$5-\$12 billion depending on LNG price.
- Improving plant performance and lifetime in the power sector to world's best practice is potentially worth about \$9 billion.
- For the reference case of this study, coal is the base load fuel of choice for power generation¹, consistent with AIMS but not with the assumptions of TAGP. This result is dependent of course on the assumptions for characterising the different plant types. In addition, higher investment rates of return that may be sought by the private sector in the power industry and more modular design might lead to a trend towards gas plant and away from coal. Another factor, to be considered in the third EPSAP regional study, is the impact of environment and sustainable energy policies in the energy sector.
- National energy policies can affect energy trading opportunities, particularly, and obviously, those requiring self-sufficiency or diversity in energy supply. The impact of national fuel taxes and subsidies on energy trade appears to be small but this conclusion should be re-visited.

The most striking outcome of the study is that the different cases studies can lead to different energy trade opportunities within ASEAN and therefore different trading infrastructure development. If these impacts are not understood, bad investment decisions could be made. If private operators are involved in that investment, their own due diligence studies would reveal these inconsistencies and could erode their confidence, not only in that project but in other investment projects as well.

Transmission and pipeline links not included in AIMS and TAGP that appear particularly attractive under many scenarios in this study include:

- Pipeline Sumatera (Grissik) – Singapore;
- Electricity link Malaysia (Gurun) – Thailand;
- Pipeline Yadana (Myanmar) – Thailand;
- Electricity link Vietnam – Thailand;
- Pipeline Yetagon (Myanmar) – Thailand.

Projects included in AIMS and TAGP but which this study suggests are either not necessary, premature or significantly over-sized under many scenarios considered in this study, include:

- Pipeline East Natuna – JDA;
- Pipeline Duri (Indonesia) – Malaka (Malaysia);
- Electricity link Sumatera – Peninsular Malaysia.

¹ In Case 1 before normalisation of coal and CCGT characteristics, coal supplies 54% of electricity for main 5 countries, with natural gas 22%, hydro 10% and oil, nuclear, renewable and imports supplying the remaining 14%. Coal's share increases when plant characteristics are normalised.

