EXECUTIVE SUMMARY

Background to the Study

This report presents the results of the first regional energy policy study carried out under the Energy Policy and Systems Analysis Project (EPSAP). Sponsored by the Australian Agency for International Development (AusAID) under Phase III of the ASEAN-Australia Economic Cooperation Program (AAECP), 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."

Countries participating in EPSAP are Indonesia, Malaysia, the Philippines Thailand and Vietnam, with a co-ordinating role played by the ASEAN Centre for Energy (ACE), which is based in Jakarta. The analytical tool used by the project is an optimising large-scale energy model called MARKAL (MARKet ALlocation).

A key output of the project is a set of national and regional energy policy analysis reports, each to be performed using the MARKAL model. The first national studies were carried out in late 2002 and early 2003. For the first regional study, the topic was selected by the EPSAP Project Co-ordinating Committee (PCC). It was carried out at ACE during the middle part of 2003 in conjunction with the Australian Managing Contractor (AMC) for the project, and national project team members temporarily attached to ACE.

Study Topic – The Trans-ASEAN Energy Network

The first regional energy policy study topic is "The Trans-ASEAN Energy Network" (TAEN). As determined by the PCC, the aim of the study is to analyse the strategies and benefits associated with increased integration and interconnection of natural gas and electricity transmission networks between the countries of ASEAN, taking account of:

- technically and economically feasible gas and electricity interconnection options between ASEAN countries;
- the objectives of fuel diversity and energy security; and
- environmental considerations including the level of greenhouse gas emissions.

The topic is an extension of that originally proposed, which was restricted to Trans-ASEAN gas pipelines. This extension acknowledged the likely strong interaction between the gas and electricity sectors as well as inteconnections in these energy forms.

The current study follows on from a number of previous studies on related topics carried out under ASEAN forums, most notably the Trans-ASEAN Gas Pipeline (TAGP) and the ASEAN Interconnection Masterplan Study (AIMS) conducted by the ASEAN Council on Petroleum (ASCOPE) and the Heads of Power Utilities / Authorities (HAPUA)respectively. Although the reports of these studies remain confidential, the results and data that have been published form a basis for the current study.

The Trans-ASEAN Energy Network study reported here was conducted to provide an alternative and more integrated view of interconnection possibilities for gas and electricity. The HAPUA analysis looks only at an electricity interconnection strategy from the viewpoint of electricity utilities while the ASCOPE study focuses on the markets for gas. The study reported here attempts to synergize the plans of both HAPUA and ASCOPE to optimise the whole energy system rather than the gas and electricity sectors one at a time. Such an analysis can avoid the need to make assumptions about development plans in closely related energy sectors and could help resolve some potential inconsistencies between different sector plans.

Potential inconsistencies between HAPUA and ASCOPE planning are now being addressed by ASEAN energy policy-makers. The current study can be regarded as an input into that process.

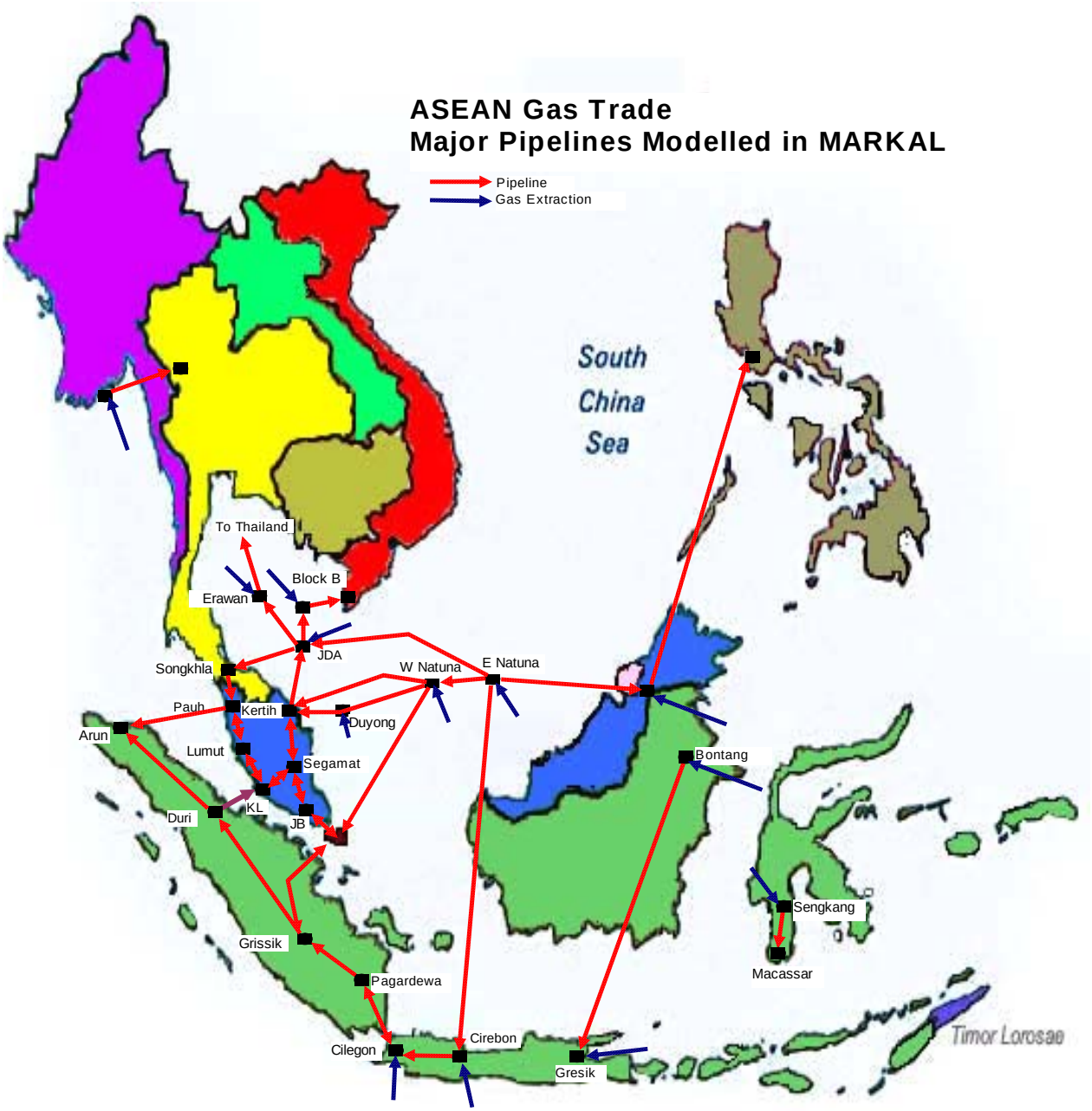
Methodology

The study was conducted using the MARKAL energy model. MARKAL is a linear programming model that represents the national energy system by a large set of equations governing system operation according to the end use, electricity generation and process technologies, using end use demands and energy sources that are input. MARKAL optimizes the chosen objective function, usually total system discounted cost, subject to meeting all system constraints that are defined.

An integrated regional MARKAL database was assembled for the study. It comprises the National MARKAL databases of the five EPSAP participating countries plus newly developed databases for Cambodia, Laos, Myanmar, Singapore and Brunei. Additional “regions” were defined in the database to model the physical infrastructure and trade linkages for cross-border energy trade in gas and electricity. The regional database contains 22 regions in all.

An important database input for the current study is the list of natural gas resources in the region along with their extraction costs and reserves. Likewise, all possible cross-border gas pipelines and electricity transmission links were reviewed, guided largely by but not limited to, the TAGP and AIMS studies.

The following figure shows the gas resources and pipeline options considered in the study.



Twenty cases were analysed in the study and this required the construction of a similar number of MARKAL scenarios that were combined with the Base data set to define the system state for each case. The cases mostly use the mid-case definition for gas reserves. Another important assumption is that the cost and technical parameters for combined cycle gas turbines (CCGT) are standardised for all countries. The model objective is the minimisation of total discounted system costs over the interval 1995 to 2030 in eight 5-year time steps. A base discount rate of 10% is used in the study with a variation of 6% for sensitivity analysis. The crude oil price is assumed constant at $25/Bbl with traded petroleum product prices and some gas extraction costs set in relation to this. Variations in the crude oil price of $20/Bbl and $30/Bbl were also included.

Results

The Base or Reference case used in the present study identifies the gas pipeline and transmission links that would be developed if an optimised strategy were followed. It shows a net benefit of greater than $4 billion compared to following just the committed expansion plan (as of 2003) and a benefit of similar size when compared to the TAGP/AIMS plans. The pipelines that would be developed under this optimised strategy and their timing are:

TAGP candidates:

- Block B to Vietnam (2010);
- East to West Natuna (2010);
- JDA to Thailand (Erawan) (2015);
- Sabah to Philippines (2015);
- East Natuna to JDA (2025);
- East Natuna to Sabah (2025).

Non–TAGP candidates:

- East Kalimantan to Jawa (2010);
- East Natuna to Jawa (2015);
- West Natuna to Singapore (current);
- Myanmar to Thailand (2015);
- Peninsula Malaysia to Singapore (2015).

The non-TAGP candidates are very important parts of the optimal strategy. Both East Kalimantan and East Natuna to Jawa are not cross-border pipelines, but rather internal to Indonesia. They are chosen as necessary to supply the main gas consumption area in Jawa that suffers from a shortage in local gas supply in the longer term.

Large-scale import of Myanmar gas to Thailand is seen as highly desirable with cheap CCGT generation available, replacing coal power generation. This is an extension of current developments. Also natural gas from Malaysia is much sought after in Singapore, substituting there for fuel oil consumption in power and industry.

The pipeline Sabah to the Philippines supplements the Malampaya field in the Philippines. It first utilises Sabah reserves; but when these become depleted, the pipeline is extended to East Natuna tapping into the large reserves there. Although chosen by the model in most cases, there could be some doubt about the viability of these pipelines since they are generally installed with a capacity around 300 PJ/a, which is far below the design capacity of 807 PJ/a on which the cost data is based. In addition, gas use for compression in transport could be significant for this development.

Of the TAGP pipelines not chosen, the model indicates that, under the study assumptions, the pipeline from JDA to Block B is not necessary to supply Vietnam as that country can meet demand from local supply.

The viability of other pipelines will be sensitive to database assumptions as indicated below:

- JDA to Songkhla –review costs for the associated gas processing plant;
- Songkhla to Pauh – review costs for the associated gas processing plant;
- Pauh to Arun – review limit on production of LNG plant at Arun; and
- Sumatera to Melaka – review options for longer-term gas supply to Sumatera.

The Terms of Reference for the study indicated that to the extent possible, account should be taken of the national energy policies in each participating country as well as objectives of fuel diversity and energy security. However, the study timing did not allow an adequate treatment of these issues since it was not possible to conduct such a review and include suitable structures in the model in the time available.

Of particular importance in this respect, all offshore gas from Myanmar is used to supply Thailand, and Malaysian gas is used extensively to supply Singapore rather than for local electricity generation. Both of these outcomes should be reviewed from a policy perspective. Any restrictions that applied to the use of Malaysian and Myanmar gas could impact considerably on the cross-border pipelines utilising those resources.

Hence an important variation from the Base Case is Case 17 where an assumption of a minimum 60% of electricity generation in Malaysia is required from natural gas and only 50% of Myanmar gas reserves can be exported to Thailand. This result in an increase in the discounted system cost of about $2.6 billion compared to the Base Case. Hence the benefit of cross-border trade is reduced somewhat but is still substantial (about $1.6 billion compared to only committed expansion). Under these circumstances gas flow is reduced greatly from Myanmar to Thailand and from Malaysia to Singapore. Gas trade is increased from East to West Natuna, from West Natuna to Singapore, and from Thailand to Malaysia. There is increased electricity generation from coal in Indonesia and Thailand but much less from coal in Malaysia being replaced by gas combined cycle plant using domestic gas.

The current study considers both gas pipelines and electricity transmission links although more emphasis has been placed on the former due to time limitations for the study. The various electricity links between Cambodia and Laos as the sources and Thailand and Vietnam as the destinations are strongly favoured by the model to take advantage of low cost hydro generation in the region. In the model, Vietnam also allows for possible electricity imports from China from 2020. Most other links identified by AIMS were also favoured with the exception of the Myanmar to Thailand link. Under the AIMS plan, this link of 1500 MW capacity is installed in 2015. Under the model assumptions, the link is generally delayed, first entering at a small capacity in 2015 but expanding to maximum capacity by 2025. However, this result may need to be reviewed given recent information that is now available about hydro costs and gas reserves in Myanmar.

Conclusions

Two major lessons from the study are:

- the necessity to consider the integrated energy system, including gas and electricity, when analysing optimal development strategies; and
- the importance of optimised planning to extract maximum benefit from cross-border investment in infrastructure and trade.

On the first point, natural gas pipelines and electricity transmission links can be both complementary and competing and so should be studied together.

As for the second point, the study found that there might not be much benefit from expanding the gas network beyond the cross-border pipelines already firmly committed. This is not so much a firm conclusion in itself but rather an indication that further major commitments should be reviewed carefully in the context of an integrated and optimised gas and electricity interconnection strategy.

A general observation in all of the cases studied is that natural gas reserves are mostly fully committed and used over the forty-year study period. In the Base Case, 82% of the mid-case reserves are consumed over this time. The unused gas is in fields that are not readily accessible, costly, or restricted in use due to some externally applied policy. Clearly, gas is a highly sought-after resource in the region that warrants further development of strategic trading infrastructure. This is so even without allowing for the full extent of possible substitution for other fuels in the industrial and transport sectors.

Further Work

For this first regional study, national and regional databases and related material were not as far developed as would be desirable. Further, although some account is taken of considerations such as fuel diversity, energy security and the environment, these issues could not be developed to the full extent desirable and await further study.

Although required by the terms of reference, it was not possible in the time available to take full account of national energy policies when conducting these studies. This does not necessarily imply an unquestioning acceptance of such policies, as studies such as this can highlight impacts and inconsistencies and make an important contribution to the formulation and review of such policies.

The current study has required assembly of a large amount of data and construction of an initial ASEAN region MARKAL database. The project will continually refine this data with more accurate and up-to-date information as it becomes available. Specific items that require review are:

- Some important data items may need review eg. the cost of gas processing plant;
- Lack of natural gas options for Sumatera within the model in the longer term may have distorted some results for cross-border pipelines;
- LNG trade both within and outside ASEAN is an alternative to local use of natural gas and inter-ASEAN pipeline trade but this option was not fully explored;

- Limited options included for expanded use of renewable fuels;
- Fuel substitution in transport and in industry generally was restricted;
- Inflexibility in the refinery sector producing refined petroleum products;
- Impact of gas compressors/line losses on pipeline viability particularly for the longer pipelines was not fully explored;
- Uncertainty in costs for some pipelines and electricity transmission links.

While such a review might modify some specific conclusions of the study, they would not change general conclusions on the importance of developing an integrated and optimised gas and electricity interconnection strategy.

Follow-up

The current study has undergone some review processes and resulting revision from the original drafts, including:

- Internal review by the AMC and ACE;
- Review by the Australian Bureau of Agricultural Economics (ABARE) and the AusAID Technical Advisory Group (TAG);
- Review by national project teams and/or NCCs;
- Consideration by the EPSAP PCC.

The study team has taken these comments into account as far as practicable when finalising the current report. However, it was not possible with the resources available to the current study to do further model runs with modified data. The comments are noted but dealing with them must await a further stage of the study.

The PCC has requested that the current revised report now be reviewed in other ASEAN energy forums, including HAPUA and ASCOPE.

The EPSAP PCC has also chosen a second regional energy policy topic for completion during 2004, entitled “ASEAN Energy Market Integration”. The PCC has noted that this study is a logical progression from the first study and will address some of the data limitations in the first regional study. The aim of the study is to examine the options and impacts of further integration of the energy markets of countries in the ASEAN region, reporting 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 proposed study should 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 HAPUA, TAGP and the first EPSAP regional study;
- 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 and import/export facilities;
- possible improved performance and longer lifetimes of energy equipment such as power stations; and
- possible changes to the investment rate of return or the availability of investment capital.